Harnessing Green Hydrogen

Carving Wales' Net Zero Future

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About the report

The implementation of Green hydrogen should be at the forefront of the UK's efforts to decarbonise its power sector, transport, and industry. This is particularly true in areas with strong industrial presence where heavy industry and transportation contribute significantly to carbon emissions, green hydrogen must be used to offset this. Only making up around 2% of the renewable energy mix is Hydrogen, and only a fraction of this is classified as 'green'. This report aims to examine the current landscape in Wales surrounding the use and implementation of green hydrogen energy. It analyses its use in decarbonising existing technologies in Wales and provides recommendations to harness its full potential.

Executive Summary

As the UK transitions toward net zero, green hydrogen has emerged as a key component in this move. Green hydrogen offers the only solution that is truly carbon free and not only generates electricity but has the capacity to store and transport energy aswell, with hydrogen acting as a vector. Wales is well positioned to deploy green hydrogen and its setting provides an abundance of renewable energy sources from which green hydrogen can be drawn from and strategic infrastructure which can make hydrogen production, storage and distribution that much more efficient.

Hydrogen classification is determined from the source of material it draws from. Grey hydrogen is powered by fossil fuels, emitting significant CO_2, while blue hydrogen is cleaner the methane emissions involved presents dilemma. Green hydrogen therefore is the only carbon free solution as it's industrial process is exclusively powered by renewable energies like tidal or wind power resulting in zero emissions.

Wales possesses strong strategic advantages in becoming a leader in this transition. Geographically it gives access to offshore wind plants tidal power and established industrial clusters. However, projects are slow to start and targets are not being met because of hindered progression. Policy is fragmented and a more unified approach must be taken by both the UK and Welsh government so that the full capabilities of green hydrogen are harnessed.

Key Recommendations:

1. Integrate green hydrogen with existing renewable energy projects.
2. Develop a large-scale green hydrogen cluster in North Wales.
3. Streamline planning and permitting for green hydrogen projects by providing better funding for regulatory boards.

4. Establish a hydrogen refueling corridor along the South Wales coastline through the South West of England to London.
5. Invest in maritime hydrogen infrastructure.

With the implementation of these recommendations, Wales will better meet its net-zero targets and position itself as a leader in green hydrogen production.

Introduction

Hydrogen energy is the most versatile renewable energy. Being able to transport and store power it acts as an energy vector. Where other forms of renewable energy can only generate power Hydrogen can hold it and move it where necessary. Found in abundance around the globe and boasting the lightest molecular weight of any chemical element. Green hydrogen is produced through the process of electrolysis of water powered by electricity via renewable sources no greenhouse gases are emitted in its combustion or production. This method saves millions in $C0_2$ emissions and its beauty lies in the fact that it can be implemented in a broad range of existing applications.

Other classifications of Hydrogen cannot provide this same benefit and the use of 'grey' hydrogen is as harmful to the planet as the use of traditional fossil fuels, accounting for 830 million tonnes of carbon dioxide per year, according to the International Energy Agency (IEA).[1] The path to net-zero cannot be achieved by any method that sustains carbon emissions and fossil fuel dependency. Green hydrogen is the only viable route that offers a truly sustainable, scalable, and forward-looking solution to decarbonising hard-to-abate sectors.

The concentration of this effort should be placed in regions where there is existing industry and skilled workers. Wales is well placed for this. Its coastline provides access to the potential to tap into tidal and wind sources unlocking the potential to offset millions of tonnes of $C0_2$ emissions and unlock and store clean energy from existing developments. The investment required will be substantial, and the region must look to

a combination of government support, grants, and innovative business models to drive competition and investment in this emerging sector.

The closure of Tata Steel and the region's ongoing industrial challenges provide an opportunity to pivot towards a green hydrogen economy, but this

requires strategic planning and upskilling of the workforce. Wales' existing industrial infrastructure, combined with its renewable energy resources—from offshore wind to tidal power—offers a strong foundation for green hydrogen production.

Hydrogen Production and Classification

Hydrogen is produced from a broad range of sources of which dictate its grouping. The classification of hydrogen as 'green', 'blue' or 'grey' is determined by the material from which it is produced.

'Grey Hydrogen' is the most widely available form of hydrogen. It is produced through Steam Methane Reformation, a highly carbon-intensive process that results in CO_2 emissions of around 8-12 kg CO_2 per kg of hydrogen produced.[2]

Through carbon capture, a large portion of these emissions can be offset, producing 'blue hydrogen' a process which the Institute for Energy Economics and Financial Analysis (IEEFA) states is not clean or low carbon, nor a solution largely in part due to the emission of methane during its production.[3] Even when methane emissions are minimized to 1.54% in sensitivity analyses, testing how changes in methane levels impact the overall greenhouse emissions of blue hydrogen, studies reveal that greenhouse gas emissions from blue hydrogen still surpass those of burning natural gas directly and are only 18%–25% lower than emissions from grey hydrogen.[4]
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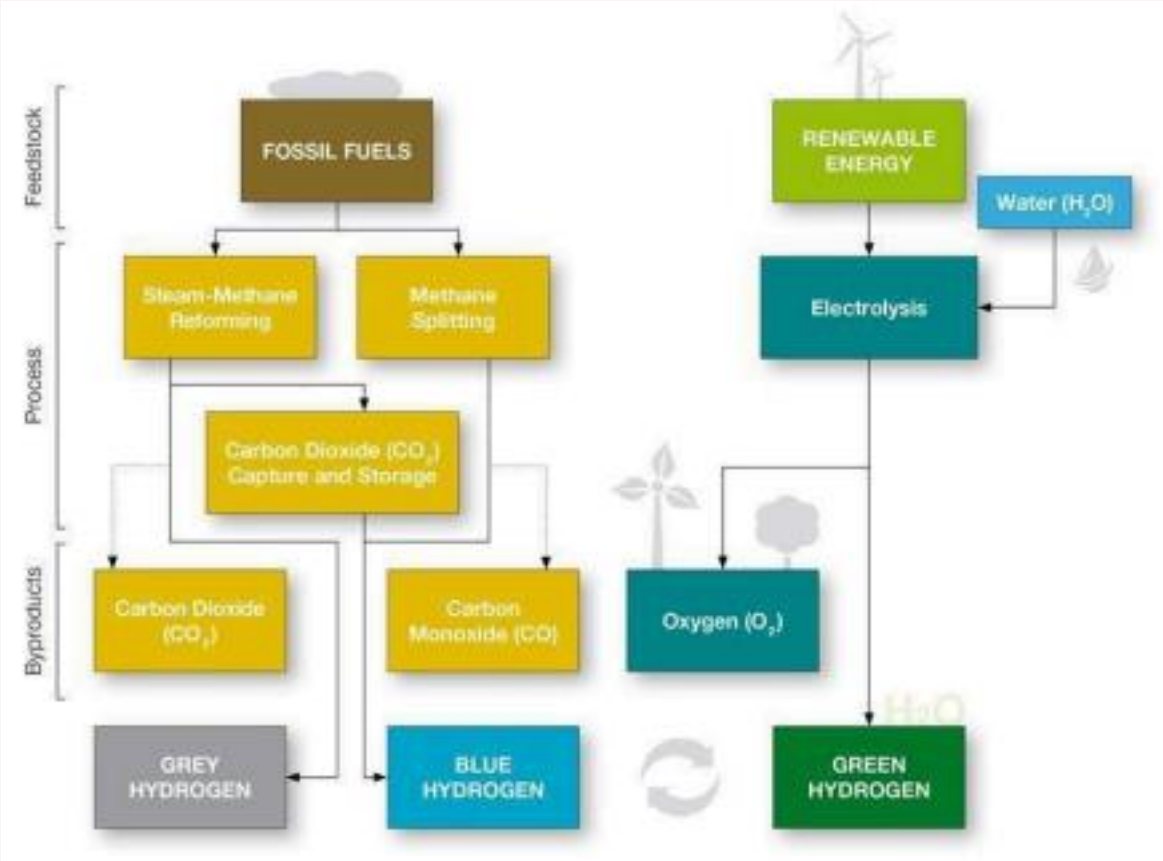
Green hydrogen presents itself as the only solution that offers a truly sustainable carbon-free path. It is produced by electrolysing water a process that involves the splitting of water molecules (H_2O) into Hydrogen (H_2) and Oxygen (O_2) by applying an electric current in an electrolyser, a device used to split water and its components. The electricity being used in the electrolyser must be sourced from a renewable energy source to result in a clean zero-emission fuel.

Figure 1. Production of Grey, Blue, and Green Hydrogen



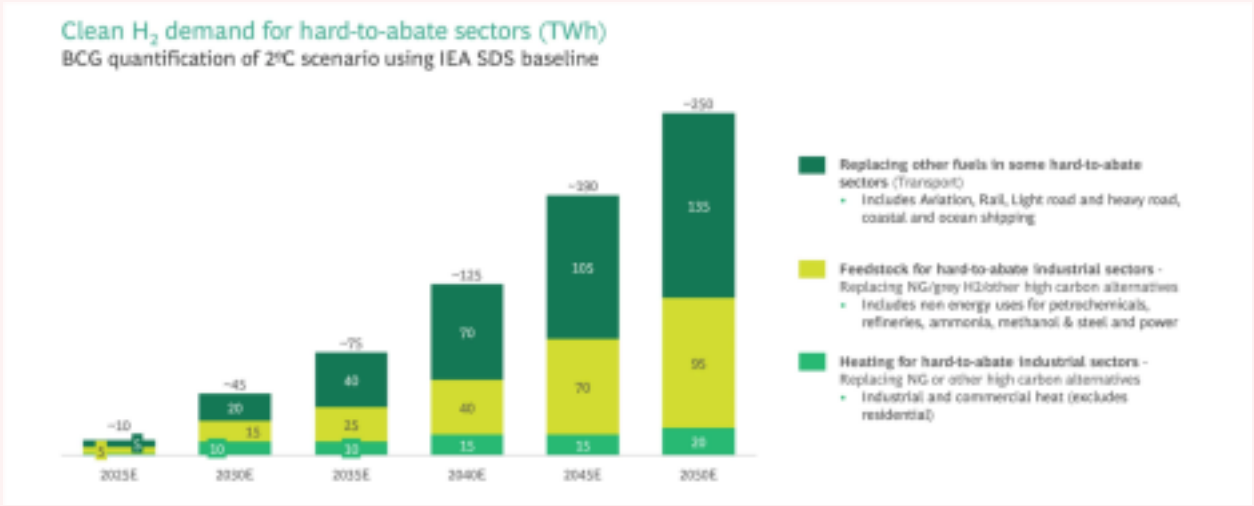
Source: RenewableUK, *Green Hydrogen: Optimising Net Zero*, 5 May 2022.

The Case for Green Hydrogen in Wales

The Government is committed to reaching its net-zero target by 2050 and decarbonising electricity by 2030. Having already cut emissions in half since 1990, the UK has made strides in reducing its carbon footprint. Yet, it is still not on track to meet its 2050 target, the slow adoption of hydrogen energy technologies being a significant factor in this. The International Hydrogen Progress Index reveals this shortfall, showing that the UK lags behind countries like Germany, Japan, and Canada, which have set more ambitious and specific short-term hydrogen-related emission reduction goals.[5]

The demand for Hydrogen is set to skyrocket as fossil fuels are abandoned and we move towards a renewable green future. Hydrogen demand could reach between 150 to 500 million metric tonnes per year. To meet this demand the UK must accelerate its adoption of large-scale green hydrogen production through the use of large clusters and implementation alongside solar, wind, and tidal power.

Figure 2. Forecast for domestic demand for Hydrogen in hard-to-abate sectors



Source: Global BCG H_2 demand model, BCG analysis
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Regional Modelling

To reach these goals and become a bigger player in the global hydrogen economy, we must take advantage of capacity in Wales. Wales's strategic advantages to produce hydrogen can be modelled regionally. The rich industrial heritage and numerous renewable and hydrogen projects are a testament to this. Through further development of green hydrogen initiatives, Wales could hold the key to meeting the UK's net-zero targets.

The geographic placement and established renewable projects make Wales a good region to exercise the potential of Green Hydrogen. Key transport links connect Wales to the North-West and the M4 connects South Wales to the west of England and London. These provide clear routes for establishing hydrogen refuelling networks. There is an abundance of renewable energies throughout the coastline of Wales harnessing the power of the wind and tides, these projects would be good sources for the production of green hydrogen. The maritime connections present hydrogen opportunities via ferry links from Wales to Ireland, and allow the opportunity to harness offshore plants. These transport links are essential as hydrogen needs physical infrastructure for distribution.

Integrating Green Hydrogen with Renewable Plants

From the outset, green hydrogen should be implemented alongside the creation of any renewable energy source. Wales hosts an abundance of renewable plants that do not harness hydrogen an addition that can make their green impact greater. Pen y Cymoedd Wind Farm demonstrates this. Having been operational since 2017, it is Wales's largest onshore wind farm, featuring 76 turbines with a total installed capacity of 228 MW. The storage system employed does not involve hydrogen and is instead stored through a co-current battery that, although effective, does not boast the same benefits as the implementation of an electrolyser that can also facilitate the production of green hydrogen.[6] This would give way to significantly more

stored energy and a longer period. Whereas a battery is simply used to store electricity and releases it back into the grid or to power electric vehicles, Green Hydrogen is more versatile.

This has already been proven successful, the SeaLhyfe project established off Le Croisic, France (Atlantic Ocean) is in its initial stages and is powered by the Floatgen floating wind turbine but has already successfully integrated offshore wind with green hydrogen production.[7]Sealhyfe produces up to 400 kilograms of hydrogen daily, capable of offsetting over 1,000 tons of CO2 annually, proving the environmental benefits of such projects. Additionally, scaling up to larger facilities like Lhyfe's planned 10 MW HOPE project, which will further offset tens of thousands of tons of CO2 annually, could result in substantial job creation.

Figure 3. SeaLhyfe Offshore Hydrogen production integrated with a floating wind turbine

Source: Lhyfe, 2024

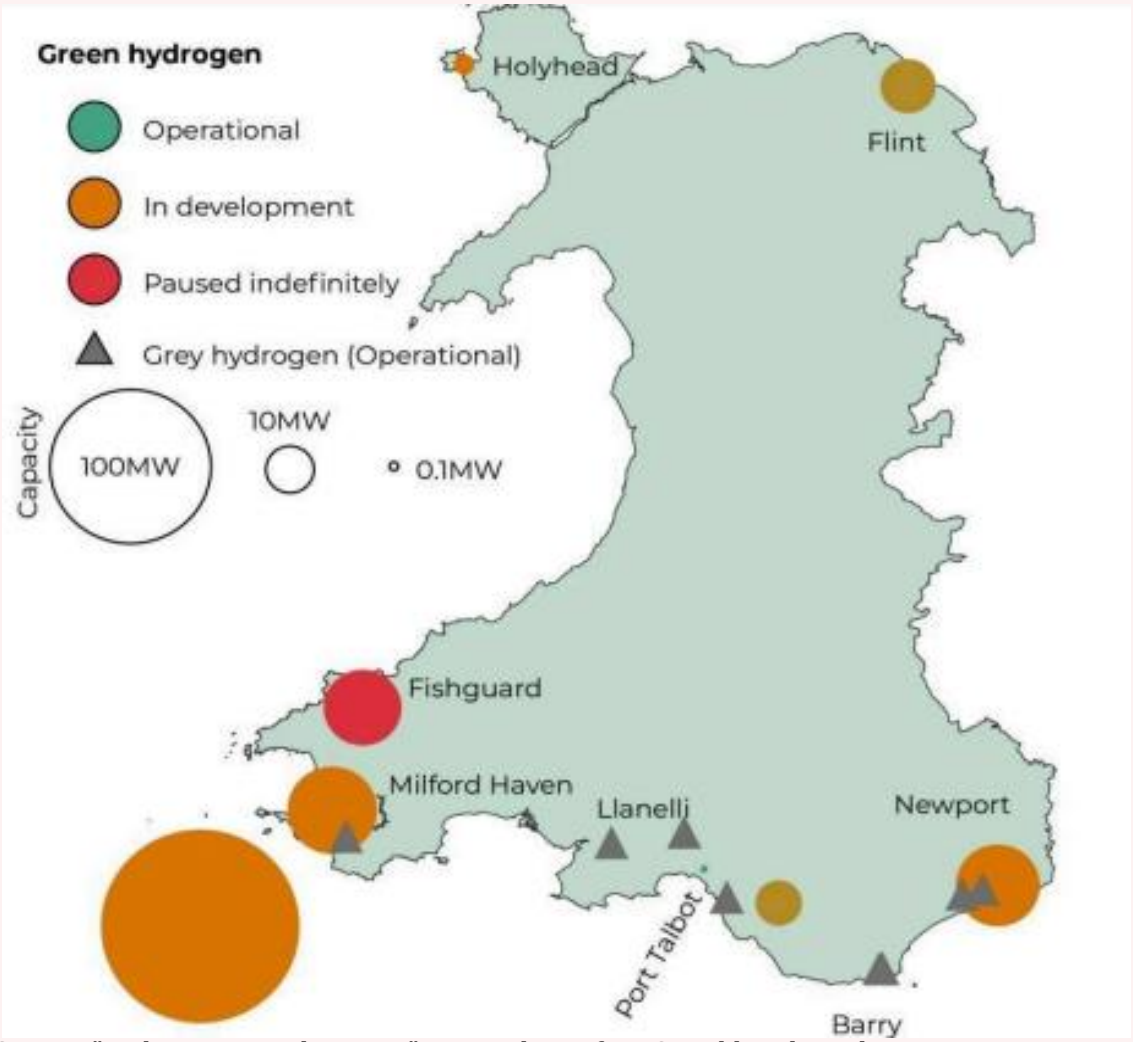
In the UK, there are plans similar to this that are ongoing. The most substantial that comes to mind is Vatenfall's hydrogen-producing offshore wind turbine, supported by a £9.3 million investment from the Net Zero

Innovation Portfolio.[8] With the electrolyser being sited directly onto the turbine energy, loss is kept to a minimum and transportation costs are nulled all while ensuring a consistent green hydrogen supply. This model should be replicated in Wales, leveraging the region's extensive offshore wind resources and maritime infrastructure.

Current and Future Operations

There are several existing initiatives overseeing the integration of Hydrogen into the energy landscape. Currently, there are no green hydrogen Large-Scale facilities to date but by the end of 2030, the South Wales Industrial Cluster (SWIC) will be well established, involving the collaboration between 47 organisations and being the largest green hydrogen initiative in Wales providing support in securing developmental funding and establishing a clear pathway toward progress.[9]

Figure 4. Map of hydrogen production projects in Wales depicted with circles coloured by project status and area scaled by capacity



Source: "Hydrogen in Wales 2024," Research Briefing, Senedd Wales, July 2024.

The map shows significant promise, yet the littering of grey hydrogen facilities down the South of Wales has to be noted. This is unsurprising considering the heavy industry. However, pushing for grey hydrogen could undermine the region's efforts to meet long-term environmental goals. Green Hydrogen provides a cleaner alternative that should be used instead.

Progress can be seen in the sheer number of projects classed as 'ongoing' and the scale of the most ambitious project yet headed by RWE holds great environmental potential and economic benefit creating up to 40 new jobs and reducing 160,000 tonnes of CO_2. Phase 1 is set to be deployed at the end of 2027.[10] This initiative was supported by the SWIC, by being supported and providing the necessary aid when tackling regulatory boards less delays mean the timeframe proposed is met. This is what the

North of Wales lacks and although it consists of less industry to decarbonise can still benefit greatly from a similar setup. Only with a unified approach can targets be better met rather than attempts in isolation that often end up failing. The existing rollout must be protected from stalling or cancellation through a robust framework that involves enhancing approval processes, providing additional financial support, and ensuring faster resolution of regulatory issues to keep projects moving forward.

Current Policy Landscape

The current Welsh government strategy is outlined in the Welsh Government's Hydrogen Pathway and Action Plan (2020) which set out objectives to develop the Hydrogen sector including creating increased demand in transport and enabling large-scale production.[12] However, the Welsh government is limited in its influence by UK government due to the scale of funding necessary. While the UK government has established its Hydrogen strategy (2021).[12] Where it establishes the deployment of hydrogen projects in Wales its focus on blue hydrogen diminishing the potential environmental benefits of green hydrogen and risks locking Wales into a fossil fuel-dependent pathway. This dual-layered approach challenges Wales, as its green energy potential is not fully leveraged due to fragmented policies and insufficient regional investment. A strategy focusing only on the deployment of green hydrogen in Wales with clear targets and sufficient funding is necessary.

There is not a sufficient plan outlining the deployment of green hydrogen only in Wales that considers a balanced approach and takes advantage of the regions existing renewable projects. By retrofitting renewable plants with green hydrogen environmental targets can be better met along with a unified plan that addresses the regional

imbalance. By providing better financial incentives and equipping agencies like the with the adequate funding they need plans to introduce green hydrogen can be swiftly implemented and Natural Resources Wales (NRW) and the Health and Safety Executive (HSE) can be better equipped to encourage and support the rollout of these projects as opposed to staling them. For these targets to be met the strategy of the UK government must take then include green hydrogen pathways in Wales and it is only with this can plans outlined by the Welsh government be bolstered.

Recommendations

1. Encourage the integration of green hydrogen into existing renewable energies where possible in the region. Wales hosts a multitude of existing renewable energies hosting over 3,500 MW of renewable electricity capacity. If even only a fraction of these are retrofitted, there are huge environmental benefits. A strategy that encourages hydrogen retrofitting that is supported by the UK government and monitored by the Welsh government would ensure that energy is no longer wasted and allows absorption in the case of oversupply.

2. Promote the development of a large-scale green hydrogen cluster in North Wales. The economic and environmental impact of the proposed SWIC in Pembroke should and can be replicated. By the development of two large clusters working in tandem Wales can enhance its Hydrogen infrastructure and present a unique opportunity for Wales to become a leader in this space.

3. Streamline Planning and Permitting for Green Hydrogen Development by providing sufficient funding to Regulatory bodies. Regulatory bodies such as the Natural Resources Wales (NRW) and the Health and Safety Executive (HSE) need to update their regulations as the slow process is taxing and damaging to the project, slowing the deployment of infrastructure and delaying economic growth. More adequate
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funding could combat this, as they would be better equipped to handle the number of applications and accelerate the infrastructure deployment.

4. Create a path for refuelling stations along the coastline of South Wales

following the coastline connecting to South West England and London. The UK government should set out a plan that introduces hydrogen infrastructure refuelling structures following the M4 transport link into Wales where there are already existing fuel stations powered by green hydrogen. This should be done in collaboration with the Welsh government which can ensure that the project works in alignment with its own local energy and transport aims.

5. The UK government should prioritise maritime infrastructure to create port infrastructure for hydrogen transportation and distribution should be developed. The transport links from Holyhead should be used to store and distribute green hydrogen this would encourage broader adoption and integration of hydrogen technologies. To achieve this the government should work with private investors and provide financial incentives to accelerate development.

Endnotes

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