

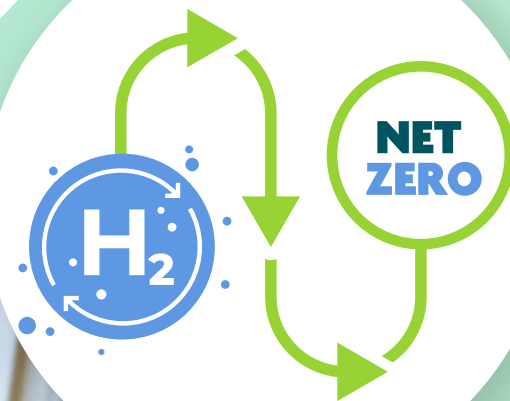


# Hydrogen in the UK: Moving from Strategy to Delivery

November 2021



Then Minister for Clean Growth, **Rt Hon. Kwasi Kwarteng MP**, launches the Hydrogen Taskforce in March 2020.



## Introduction

Hydrogen has a key role to play in delivering cost effective, deep decarbonisation as the UK looks to meet its net zero by 2050 ambitions. We must build on the strong foundations that have been laid and work together to rapidly scale hydrogen solutions over the next decade. As global activity in hydrogen swiftly accelerates, the UK Government and hydrogen industry must respond to ensure that we capitalise on the economic opportunity presented by this critical resource.

2021 has been a significant year for hydrogen in the UK. **The UK Hydrogen Strategy** marked a key step on the road to establishing hydrogen as a key energy vector in the delivery of net zero. However, whilst the publication of the strategy was an important milestone, marking the culmination of many months work, it also signalled the beginning of the next, and equally important, stage of activity.

As progress in the sector moves from high-level strategy to delivery, a greater focus on detailed policy and regulatory design is now required, ensuring that all parts of the UK value chain are considered. Hydrogen has the potential to deliver significant economic, environmental and energy system benefits to our country. However, these benefits will only be realised if industry and government work together to deliver hydrogen at scale over the next decade.

In March 2020, the Hydrogen Taskforce was launched in the House of Commons, bringing together the organisations leading on hydrogen in the UK. These organisations have worked together, through the Taskforce, to develop a common vision for hydrogen and a collective position on the next steps needed to make this vision a reality. The Taskforce has worked closely with the Government to support the development of the UK Hydrogen Strategy, the hydrogen business models and the Net Zero Hydrogen Fund.

Eighteen months on from the launch of the Hydrogen Taskforce, the landscape has evolved significantly. The sector has matured and now stands on the brink of large-scale commercialisation. However, there is still much to be done if hydrogen is to play a key role in delivering net zero.

To that end, the Hydrogen Taskforce is also evolving, relaunching as Hydrogen UK, a trade association with new structures and services, capable of supporting the industry through this next phase of activity.

There is still much work to be done to develop the necessary policy frameworks that will allow hydrogen to come forward at scale. While there has been significant progress in developing solutions to support hydrogen production, until these are available, investors cannot take investment decisions and production projects will remain on hold. Similarly, more attention should be placed on end-use sector technologies and the infrastructure that will link supply and demand.



Hydrogen UK recommends that industry and government come together on the following activities to ensure that hydrogen in the UK moves successfully from strategy to delivery:

1

Scale production rapidly by making hydrogen business models available to producers by mid-2022

2

Stimulate demand for hydrogen by developing detailed and distinct policy and regulatory frameworks to create markets in end-use sectors

3

Provide links between supply and demand by establishing mechanisms to unlock capital investment in distribution and storage infrastructure

4

Develop the necessary training and support to ensure the UK has the skilled workforce to deliver on its hydrogen ambitions

5

Ensure that no one is left behind by working with a wide range of stakeholders to build a hydrogen society

## Hydrogen: Meeting the net zero gap

Meeting our net zero obligation and tackling climate change is one of the greatest challenges facing the UK. Approaching this challenge in a pragmatic, collaborative and equitable manner will be key to ensuring that the UK emerges from the energy transition with a resilient and affordable energy system, supported by a thriving low-carbon economy.

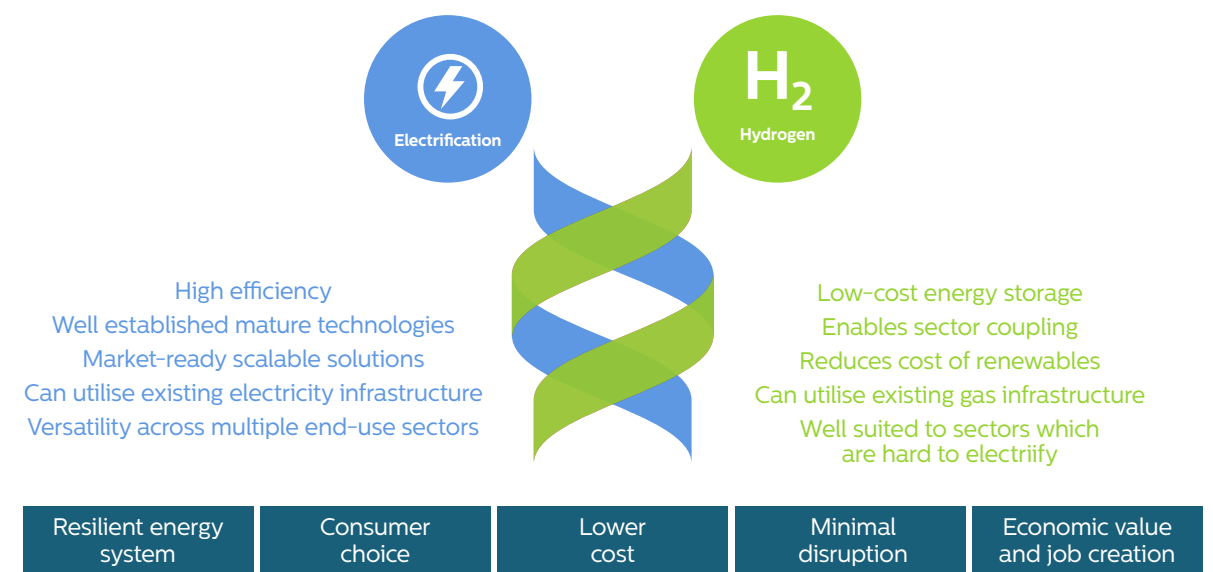
Delivering net zero will require multiple energy vectors and technologies that are able to service our diverse and evolving energy needs. It will also require a holistic approach that places the consumer at the heart of the transition.

The Climate Change Committee (CCC) notes that hydrogen is a key energy vector as the UK looks to deliver on its climate change commitments. Readily available, low-cost, low-carbon hydrogen at scale would significantly decrease risk, and the cost of delivering net zero and our **Sixth Carbon Budget**.

Hydrogen is a key strategic enabler of other important activities on the route to net zero, including:

- The growth of the renewable electricity sector – hydrogen provides a storage mechanism that reduces curtailment and enables greater deployment of renewables. Electrolysers can help to balance the grid and provide resilience to the electricity system.
- Decarbonisation of hard-to-abate sectors – industry, heavy-duty or high utilisation vehicles, homes, businesses and dispatchable power generation.
- Reducing pressure on electricity infrastructure – hydrogen provides an alternative energy vector for transporting energy. Utilising the gas grid alongside the electricity grid will reduce pressure and create a more resilient energy system.

Hydrogen provides the perfect complement to electrification. The two energy vectors have different characteristics and applications. Developing and integrating the two pathways will be a key priority over the next decade, unlocking many benefits for the UK.

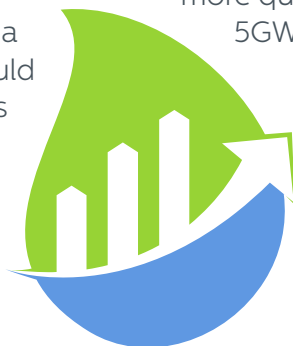




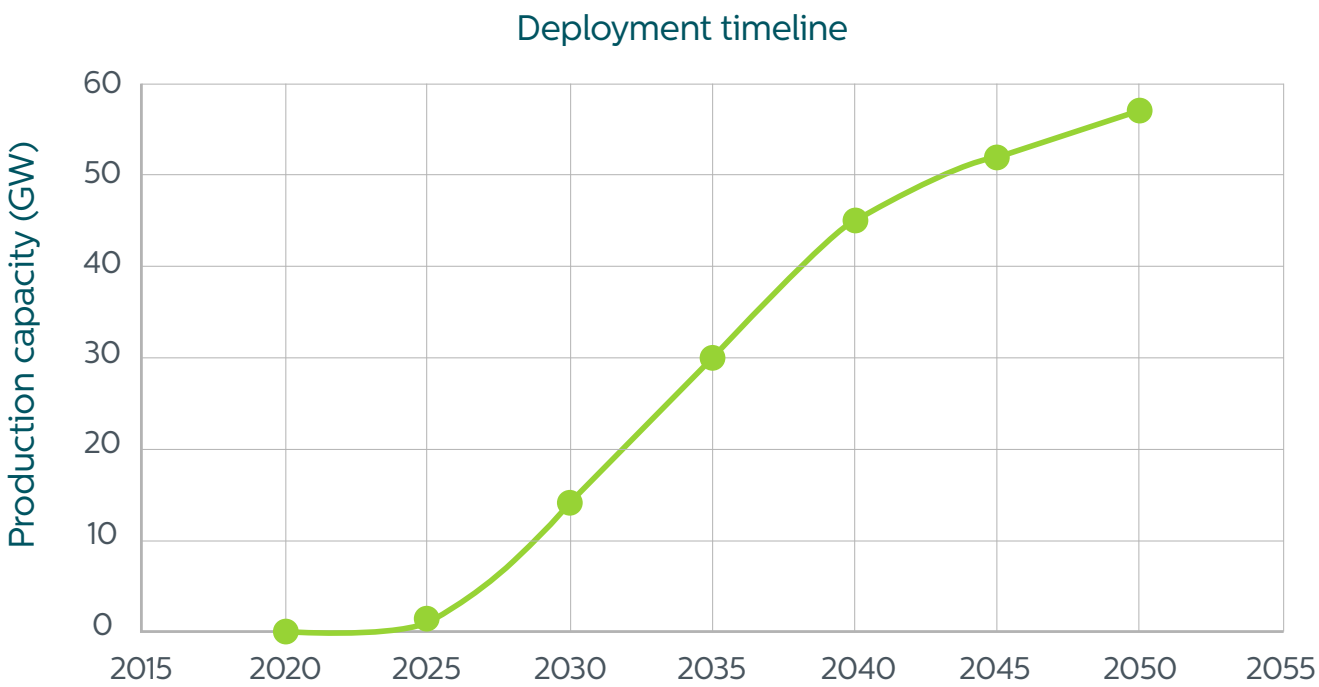
# Building on the UK's 5GW production target

In *The Ten Point Plan for a Green Industrial Revolution*, the UK Government set an ambition to deliver 5GW of hydrogen production capacity by 2030. This is equivalent to 33TWh of low-carbon hydrogen by 2030. The Government has also indicated in its **Net Zero Strategy** that up to 17GW of hydrogen may be required by 2035 should hydrogen be required to play a significant role in heat. By 2050, the UK could need up to 475TWh to deliver net zero; this would leave a 442TWh hydrogen gap that must be delivered in 20 years.

Most of this capacity should be in place by 2040 to ensure that the supporting infrastructure can be delivered. The cost of meeting our net zero target as well as the Sixth Carbon budget would also be significantly reduced if hydrogen production was scaled more quickly during the 2020s and the 5GW production target increased.



Hydrogen UK suggests the following high-level timeline for deployment is necessary for the UK to meet its net zero commitments:



Graph 1: Production deployment timeline

Hydrogen UK has developed three scenarios that outline what could be delivered in the UK by 2030, based on different assumptions.

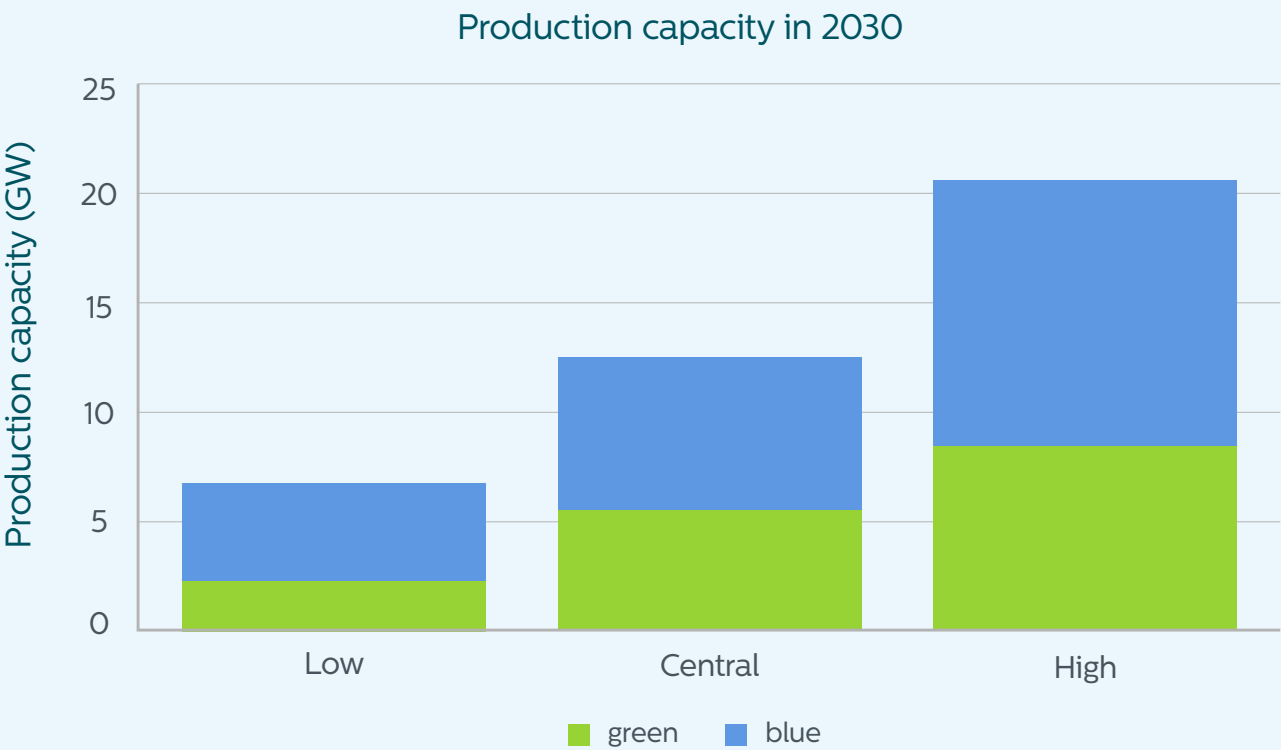
For context, these scenarios have been outlined alongside the UK Government's commitment to hydrogen in *The Ten Point Plan for a Green Industrial Revolution*. The high scenario has been developed by combining the 2030 ambitions of the projects in the UK pipeline. It assumes that they all deliver 100% of their projected targets.<sup>1</sup> The central and low scenarios have been developed based on sensitivity analysis of the end-use sector technologies.

In October 2021, the Government announced that East Coast Cluster and HyNet were selected as Track 1 Clusters under the CCUS Cluster Sequencing Programme. These two clusters alone could deliver more than the 5GW target set by the Government for 2030, provided the

necessary support schemes and policies come forward in a timely manner.

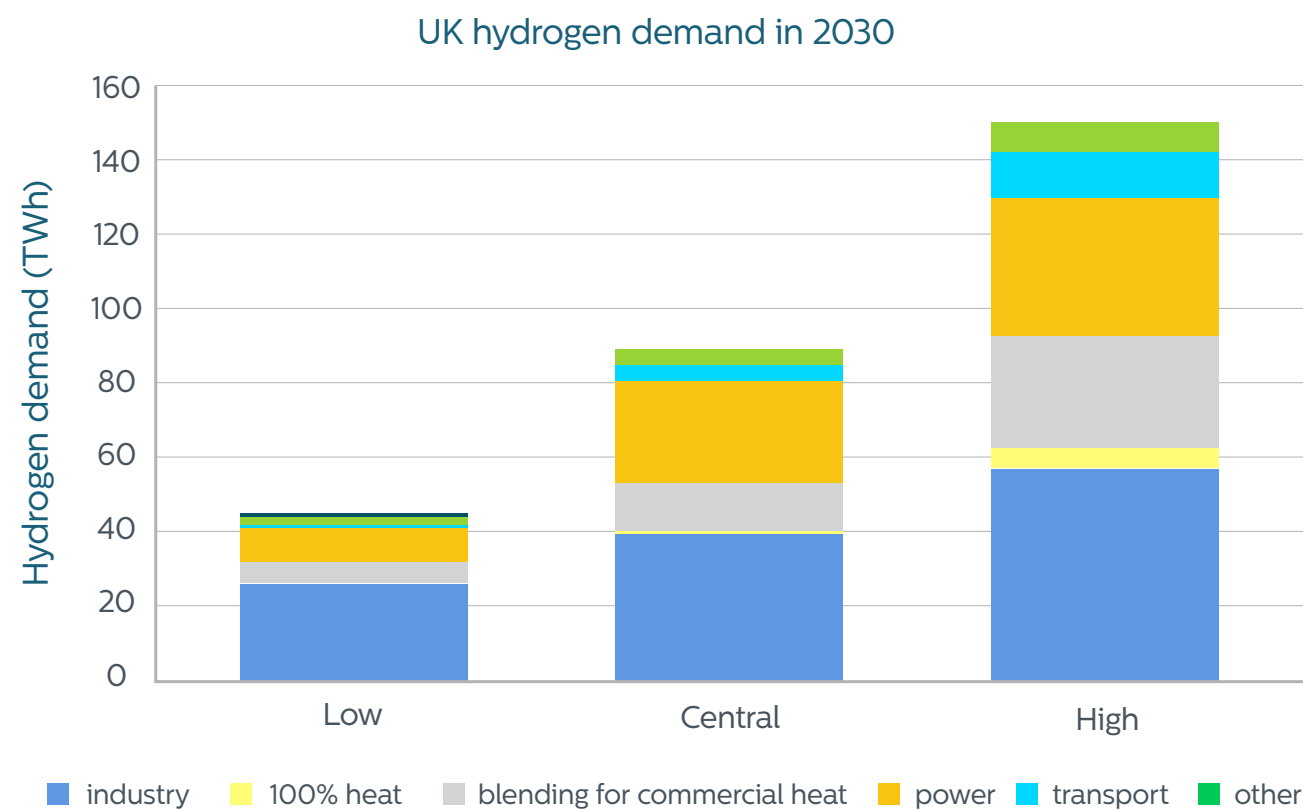
This further supports the feasibility of HUK's production timeline and demonstrates that the UK could be significantly more ambitious in its 2030 production capacity target. The total production capacity within the UK pipeline is more than four times the UK's current ambition, and whilst it is unlikely that all these projects will be realised at the scale they are targeting, it shows that there is scope for the UK to set a higher target.

There are strong synergies between nuclear and hydrogen and this form of energy generation will play a key role in hydrogen production, post 2030 (further adding to the production capacity in the UK) – the Nuclear Industry Council estimates that nuclear could deliver 75TWh of hydrogen by 2050. It is important that the regulatory environment provides a level playing field to drive different methods of low-carbon hydrogen production, including nuclear hydrogen.



Graph 2: Production capacities in 2030

<sup>1</sup> In practice, it is unlikely that the high scenario will materialise, as it implies the achievement of maximal estimates for both green and blue production as well as for demand across all sectors. However, it is a way of demonstrating the potential supply of and demand for hydrogen in the UK economy.



Graph 3: Hydrogen demand in 2030

		Government 10pt plan	Scenario 1 Low	Scenario 2 Central	Scenario 3 High
<b>Production – installed capacity (GW)</b>		<b>5</b>	<b>7</b>	<b>14</b>	<b>22</b>
Blue			5	8	13
Green			2	6	9
<b>Demand – TWh</b>		<b>42</b>	<b>44</b>	<b>90</b>	<b>151</b>
Industry			26	40	57
Blending for domestic and commercial heat			6	14	31
Power			9	27	37
Transport			1	5	12
100% domestic and commercial heat			0	0	6
Other (e.g. CHP, ammonia)			2	4	8
<b>Impact</b>					
Carbon abatement (MtCO <sub>2</sub> e)		42 (cumulative)	13.7 (annual)	16.9 (annual)	29.1 (annual)
GVA – £bn			7.2	14.2	23.6
Jobs		8000	29,700	58,500	96,800

Table 4: The UK Government’s 10 Point Plan as compared to Hydrogen UK’s Three Scenarios

## Next steps for scaling hydrogen in the UK

### 1 Scale production rapidly by making hydrogen business models available to producers by mid-2022

Hydrogen business models are the revenue support scheme that will make hydrogen production projects economically viable and enable investment in large-scale projects. The Contract for Difference (CfD) model proposed by the Government has been very successful in scaling deployment and reducing costs of renewable generation technologies, such as offshore wind. This approach, applied to hydrogen, will be critical in enabling production to achieve similar scale and cost down over the next decade. The Government has consulted on the scheme, which is welcome, but it is vital that momentum is maintained, and the business

models are made available by mid-2022 at the latest. Without business models there will be no confidence from investors and public and private finance will be impossible to access.

It is estimated that by 2050 the UK will require between 225–475TWh of hydrogen production to meet net zero.<sup>2,3</sup> This is roughly the total energy demand serviced by the power domain in the UK today.<sup>4</sup> Developing this production capacity and associated infrastructure within this timeframe is achievable but becomes increasingly challenging with delays to the first large-scale production projects moving from planning to delivery.



Table 3: Hydrogen UK’s recommended timeline for business models

The availability of hydrogen business models is key to early-stage projects entering the delivery phase. Hydrogen UK welcomed the Department of Business, Energy and Industrial Strategy’s (BEIS) consultation but urges the Government to move swiftly from consultation to implementation.

Hydrogen UK considers that the timely availability of business models, whilst not sufficient in themselves, are a prerequisite to unlock the wider hydrogen value chain and will have significant knock-on impact on other key steps on the road to net zero.

<sup>2</sup>CCC The Sixth Carbon Budget

<sup>3</sup>National Grid Future Energy Scenarios

<sup>4</sup>BEIS Energy Consumption in the UK 2020

Hydrogen UK is committed to working with the UK Government to bring forward the business models as quickly as possible.

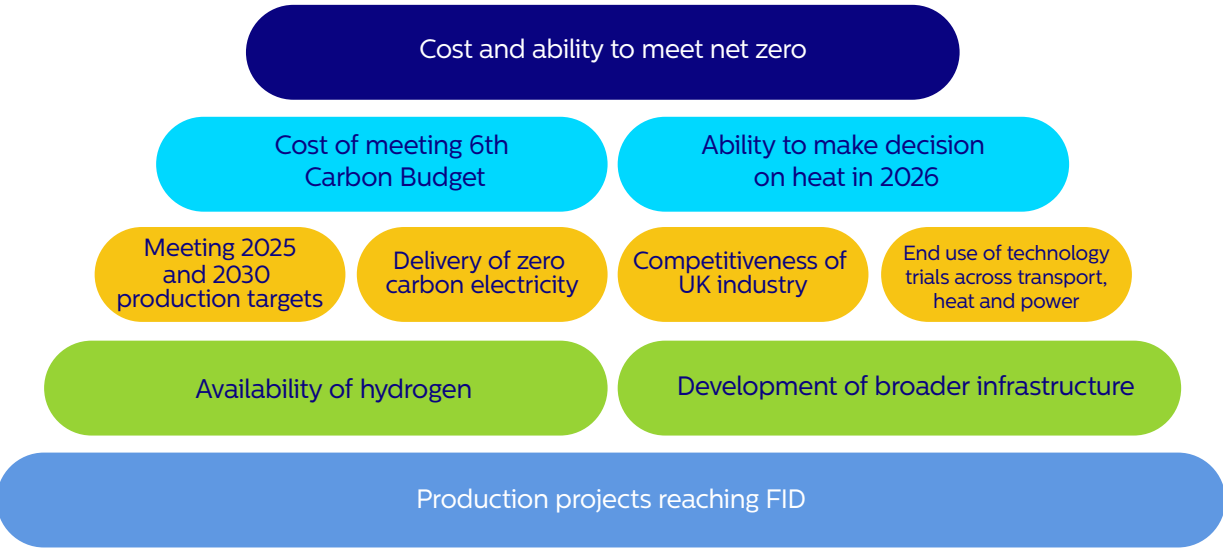
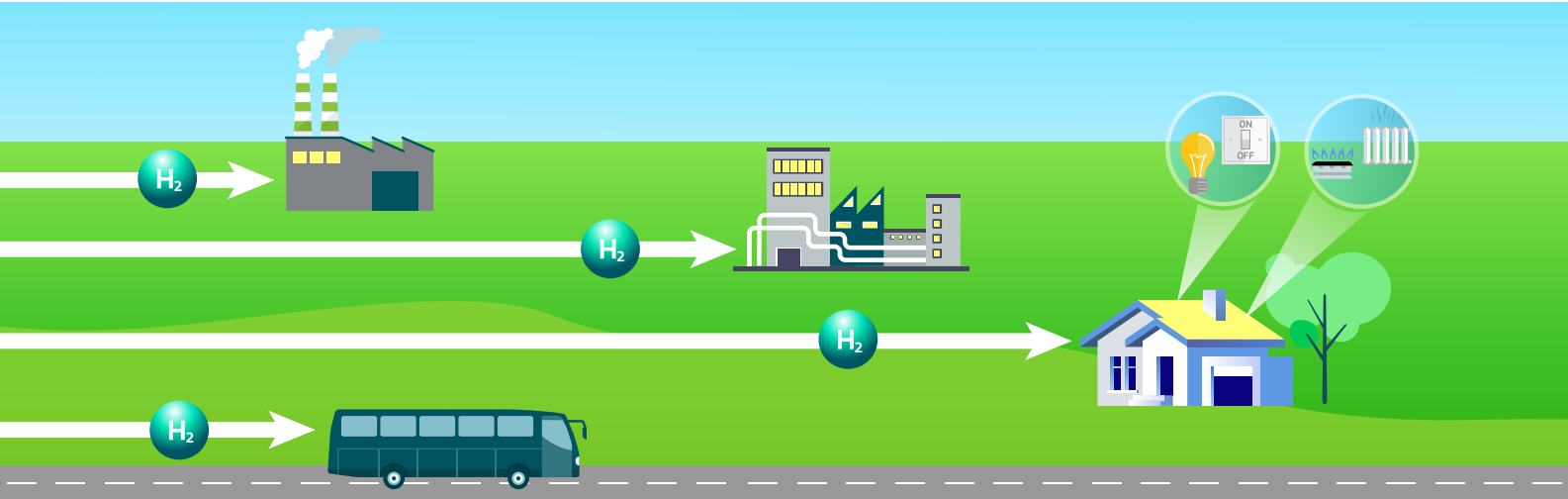






Table 4: Dependencies associated with the UK hydrogen business models

2 Stimulate demand for hydrogen by developing detailed and distinct policy and regulatory frameworks to create markets in end-use sectors

Much progress has been made in developing the support schemes required to scale hydrogen production in the UK. However, production is just one part of the hydrogen value chain, and a holistic approach must be adopted if hydrogen is to scale in a sustainable manner. Creating demand side pull for hydrogen is an important enabler of the adoption of hydrogen solutions in the market.

Hydrogen has applications across the energy system, including power generation, industrial application, domestic and commercial heat in buildings, and transport. Each of these end-use sectors has different characteristics, technological requirements, commercial models and practical considerations. It must also be noted that each of these sectors are made up of numerous applications which must all be considered distinctly.



End use sector	Applications	Possible policies and regulatory support
 Heat	100% hydrogen boilers	<ul style="list-style-type: none"><li>• Mandating hydrogen-ready boilers</li><li>• Setting carbon intensity target for the gas grid</li><li>• Green gas tariffs</li><li>• Inclusion of hydrogen within the Green Gas Support Scheme</li><li>• Expanding trials of hydrogen heating</li></ul>
	Hydrogen fuel cell mCHP	
	Blending	
 Transport	Cars	<ul style="list-style-type: none"><li>• Public procurement schemes</li><li>• Vehicle subsidy support schemes</li><li>• Bring forward phase out dates for fossil fuels in larger vehicles</li><li>• Greater support for trials of aviation and maritime applications</li><li>• Targets for hydrogen refuelling stations</li></ul>
	Vans	
	Buses	
	HGVs	
	Maritime	
	Aviation	
 Industry	Rail	<ul style="list-style-type: none"><li>• Introduce Carbon CfDs</li><li>• Public procurement scheme</li><li>• Carbon border adjustment</li><li>• Tradeable performance standards</li></ul>
	Multiple end-use of applications across production of steel, glass, ceramics, chemicals, cement, transport, pulp and paper, food and drink, and textiles.	
 Power Generation	Blending into existing gas CCGT	<ul style="list-style-type: none"><li>• Inclusion of hydrogen within capacity markets</li><li>• Government guarantees</li><li>• CfD payments</li></ul>
	100% hydrogen CCGT	
	Flexible markets	

The wide range of applications that hydrogen can service is one of its key benefits. The heterogenous nature of these applications creates a level of complexity when considering the regulatory and policy levers required to stimulate demand for hydrogen.

Hydrogen UK is committed to working with the UK Government to examine and evaluate the options for stimulating demand for hydrogen and work to deliver the detailed designs of the necessary policy and regulatory schemes.

### 3 Provide links between supply and demand by establishing mechanisms to unlock capital investment in distribution and storage infrastructure

**Alongside the creation of markets for hydrogen, development of the distribution and storage infrastructure required to connect supply and demand will be key to the realisation of hydrogen at scale.**

Storage assets will be required for managing both seasonal and daily demand variation and for storing excess hydrogen that could be produced at times of high renewable electricity output. Hydrogen cannot be produced or utilised cost-effectively at scale without storage. The amount of hydrogen storage required will depend on the eventual demand-side profile but is likely to be around 5TWh by 2030.<sup>5</sup> Storage assets have long lead times and, therefore, developing support mechanisms that enable investment in storage should be a key priority.

Likewise, distribution that links supply and demand is a crucial element of the hydrogen value chain. Early-stage projects will require new dedicated hydrogen infrastructure to transport hydrogen from the point of production to early-stage end-users. All hydrogen clusters will require investment in new infrastructure. Early investment in this infrastructure will also

encourage new production projects, stimulate innovation, and stimulate interest amongst potential end-users.

In the longer term, the UK is home to one of the most extensive gas grids in the world, with 85% of homes and businesses connected. Decarbonising and leveraging this asset, and connecting renewable power generation and end-use energy demand, should be a key priority. This decarbonisation should begin now with blending of hydrogen and natural gas.

Currently, there is no mechanism that enables networks to invest in hydrogen infrastructure. It will be necessary to establish a regulatory regime that supports first-of-a-kind infrastructure and creates successful commercial models to support the storage that will be required to provide resilience in the UK energy system.

Hydrogen UK is committed to working with the UK Government and the regulator to develop the evidence base and mechanisms to support distribution and storage infrastructure.

### 4 Develop the necessary training and support to ensure the UK has the skilled workforce to deliver on its hydrogen ambitions

**Hydrogen presents a significant opportunity to the UK to deliver economic value and highly skilled jobs. In 2020, we developed an Economic Impact Assessment demonstrating that investment in hydrogen could unlock £18bn in GVA and support 75,000 jobs in the UK by 2035.<sup>6</sup>**

In addition, hydrogen is gaining increasing momentum internationally, with many countries recognising the critical role that it will play in reducing emissions. This presents significant opportunity in a growing market that is expected to reach \$2.5tn by 2050. Industry is committed to working with the Government to position the UK as a global leader in hydrogen solutions to capitalise on this emerging opportunity.

Hydrogen will play a critical role in reducing emissions in the UK and delivering highly skilled jobs. This will only be possible, however, with a cohesive, co-ordinated, and forward-looking drive to expand and develop the UK workforce's hydrogen skills. The UK has a strong existing domestic workforce that has many of the necessary skills and is primed to capitalise on the opportunity presented by hydrogen. However, these workers will need to be upskilled in areas specific to hydrogen. The UK should also look to address its grassroots educational programmes by supporting degrees and courses relevant to the hydrogen sector.

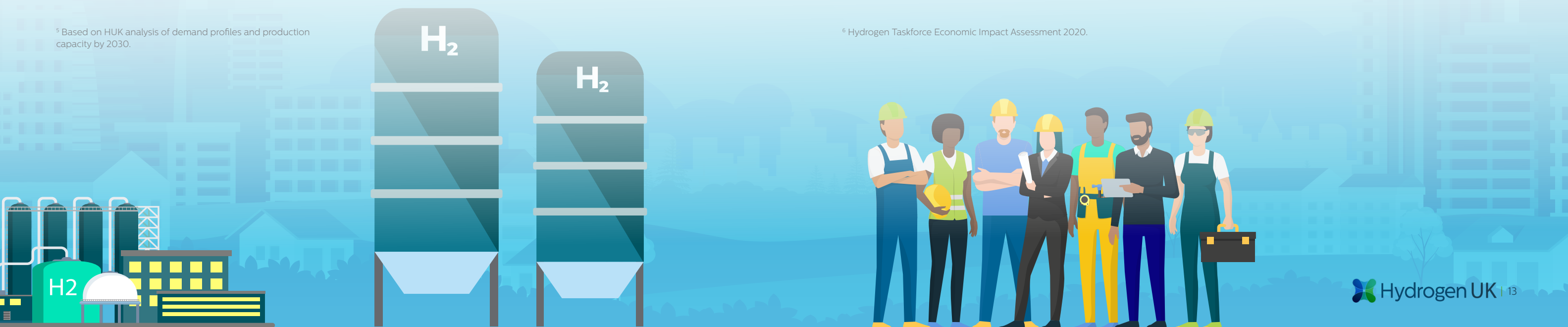
It is imperative that this skills gap is addressed with some urgency, as it will take a minimum of two years from commencement of learning and practical experience for a worker to be sufficiently skilled to add value to the market. The UK has a broad base of relevant engineering skills in its workforce, but not in sufficient numbers for the energy transformation programme required to meet net zero by 2050.

Lessons should be learnt from similar major infrastructure programmes, such as the Government's Smart Metering Implementation Programme. In this case, significant time was required to achieve a critical mass of skills and experience to deliver the programme at scale. Government and industry should take note of this and other programmes' experience in cross-skilling, up-skilling and developing new skilled workers.

Hydrogen UK is committed to working with the government to deliver a comprehensive jobs and skills programme aimed at ensuring that the UK workforce is ready to deliver on our hydrogen ambitions.

<sup>5</sup> Based on HUK analysis of demand profiles and production capacity by 2030.

<sup>6</sup> Hydrogen Taskforce Economic Impact Assessment 2020.





## 5 Ensure that no one is left behind by working with a wide range of stakeholders to build a hydrogen society

We believe the UK can reduce its carbon emissions, create new green jobs across the country and stay at the forefront of low-carbon innovation by having hydrogen as a key part of the energy system. One of the challenges, however, is a generally low level of knowledge about hydrogen and its applications.

We are running a campaign, **Building a Hydrogen Society**, to promote a better understanding of the benefits that low-carbon hydrogen offers the UK.

Our campaign website provides valuable and accessible information, showing how hydrogen will help the UK meet its net zero targets and build a prosperous and innovative low-carbon economy that will enable everyone to have a better quality of life. The website provides case studies of industry action and efforts from communities to turn the Hydrogen Society into a reality. It also outlines how UK and local government can play their part in realising this vision.

Hydrogen UK is reaching out to decision makers, MPs, local authorities, and other opinion leaders offering to work with them in making the case for hydrogen in a low-carbon UK. We are planning further activities, including holding webinars and workshops to support local authorities and other interested organisations in identifying and taking forward the opportunities that low-carbon hydrogen offers.



To learn more,  
please use this  
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### Hydrogen Society

A prosperous, innovative and decarbonised UK

Hydrogen UK is committed to working with the UK Government and other stakeholders to promote a better understanding of the benefits that hydrogen offers.

## About Hydrogen UK

### Hydrogen UK mission

Hydrogen UK's mission is to work with government, business and consumers to ensure that hydrogen can play its full part in the UK's transition to a low-carbon economy. We want to support the UK to be a world leader in developing and deploying hydrogen solutions.

#### Hydrogen UK works to:

- promote policies and initiatives to grow the market for hydrogen applications and help the UK to achieve its target of net zero emissions by 2050;
- support initiatives to deliver excellence throughout the supply chain and create a globally attractive export;
- produce robust analysis to show government and the public how hydrogen can contribute to a low-carbon energy mix, along with other decarbonised technologies;
- educate and excite stakeholders and end-users about the potential for hydrogen to improve society through campaigns in the UK and globally; and
- collaborate, where appropriate, with other national and international associations to promote the interests of the hydrogen industry.

We are constructive, collaborative and committed to achieving our vision. We engage with trade associations, academics, professional institutions and other opinion formers in building broad coalitions to build consensus around industry structure and policy changes.

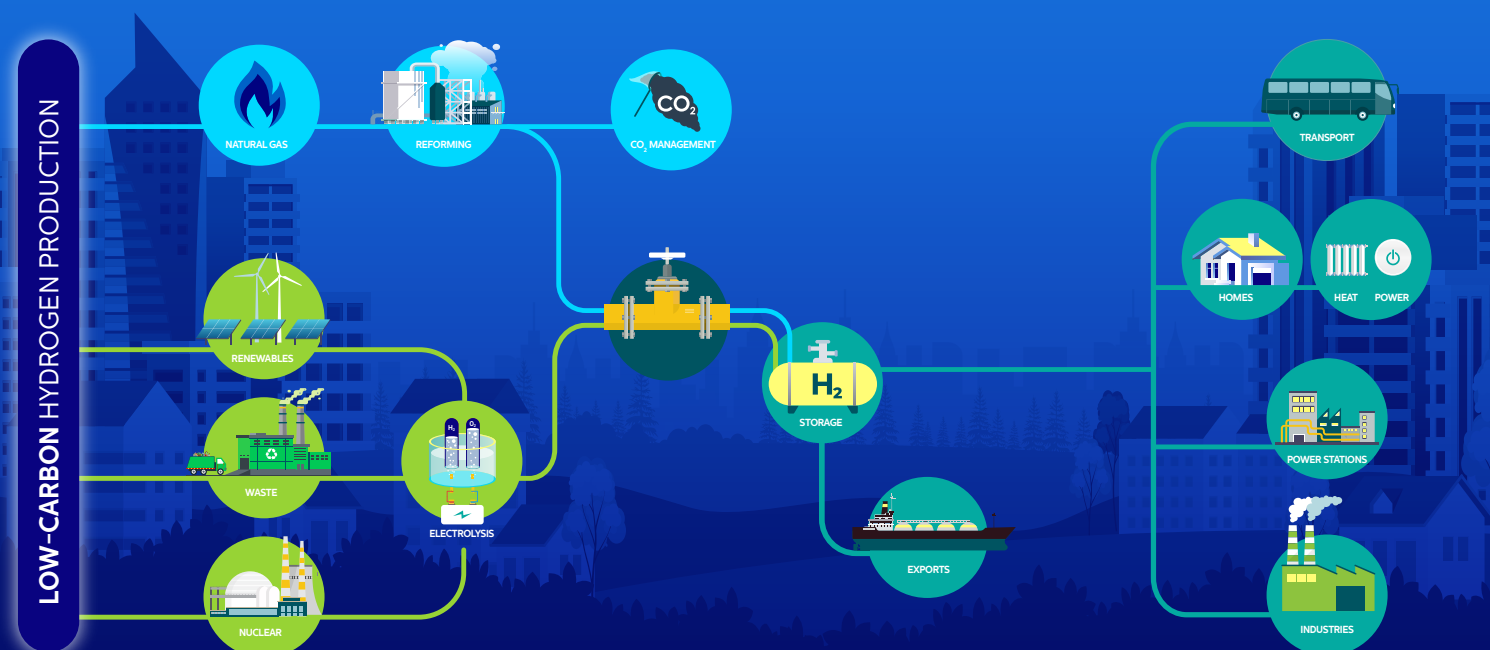
#### Working groups

Hydrogen UK currently has 10 working groups which bring together members across different areas of the value chain and develop thought leadership on the necessary policies and actions that need to be implemented to see projects come forward.

- Green (Electrolytic) Production
- Blue (CCUS-enabled) Production
- Networks
- Storage
- Heat
- Power Generation
- Transport
- Industry
- Jobs and Skills
- Policy and Communications

For more information on how to get involved with Hydrogen UK please contact [secretariat@hydrogen-uk.org](mailto:secretariat@hydrogen-uk.org)

## The Clean Hydrogen Journey



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