CARBON TRUST

CLASS NK WEBINAR SERIES

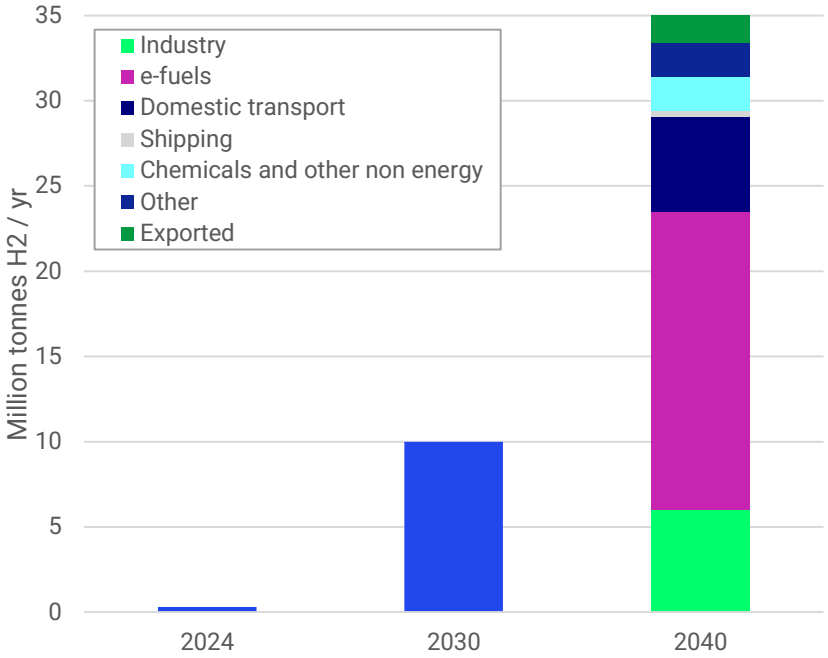
The outlook for hydrogen in Europe

June 2024

What is EU ambition for clean hydrogen?

The EU sees green hydrogen as a key means to decarbonise hard-to-abate sectors

- The EU is aiming to **reduce emissions** by **55% by 2030** and is pushing for **90% reduction by 2040** compared to 1990[1,2].
- To meet this, **EU is aiming to produce 10 million tonnes** of green hydrogen per annum **by 2030** and according to recent EC analysis, could need **35 million tonnes to meet 2040 targets**[1,2].
- This must be built from **near zero in 2024**[3]



Complied with production and demand data from EC, EU and Hydrogen Europe[1,2,3,4]

1 Recommendation for 2040 emissions reduction target (europa.eu),
2 European Climate Law - European Commission (europa.eu),
3 Clean_Hydrogen_Monitor_11-2023_DIGITAL.pdf (hydrogeneurope.eu)
4 EUR-Lex - 52024SC0063 - EN - EUR-Lex (europa.eu)

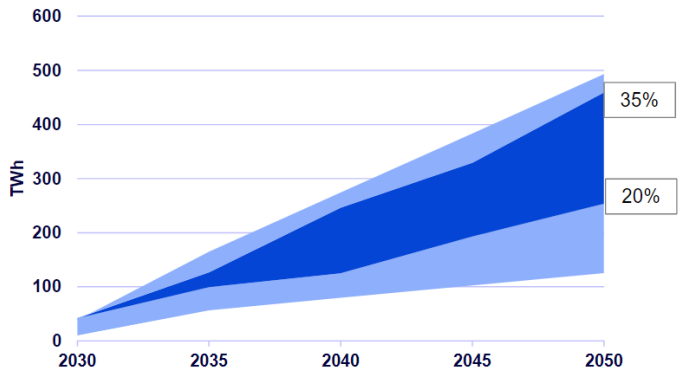
What is UK ambition for clean hydrogen?

The UK is focussing on decarbonising industrial clusters

- **Target of 10GW** of clean hydrogen production **by 2030**, with up **to 6GW from electrolytic hydrogen**
- Targeting decarbonization of **'hard to electrify'** industries, and support providing greener, flexible energy across power, heat, transport, and potentially heat in buildings.
- Valuable for **energy security** and independence by providing **flexibility and energy storage**
- Illustrative demand in 2035[1] is shown on the right.

Hydrogen demand could be 20-35% of UK final energy consumption by 2050

percentage = hydrogen as proportion of total energy consumption in 2050



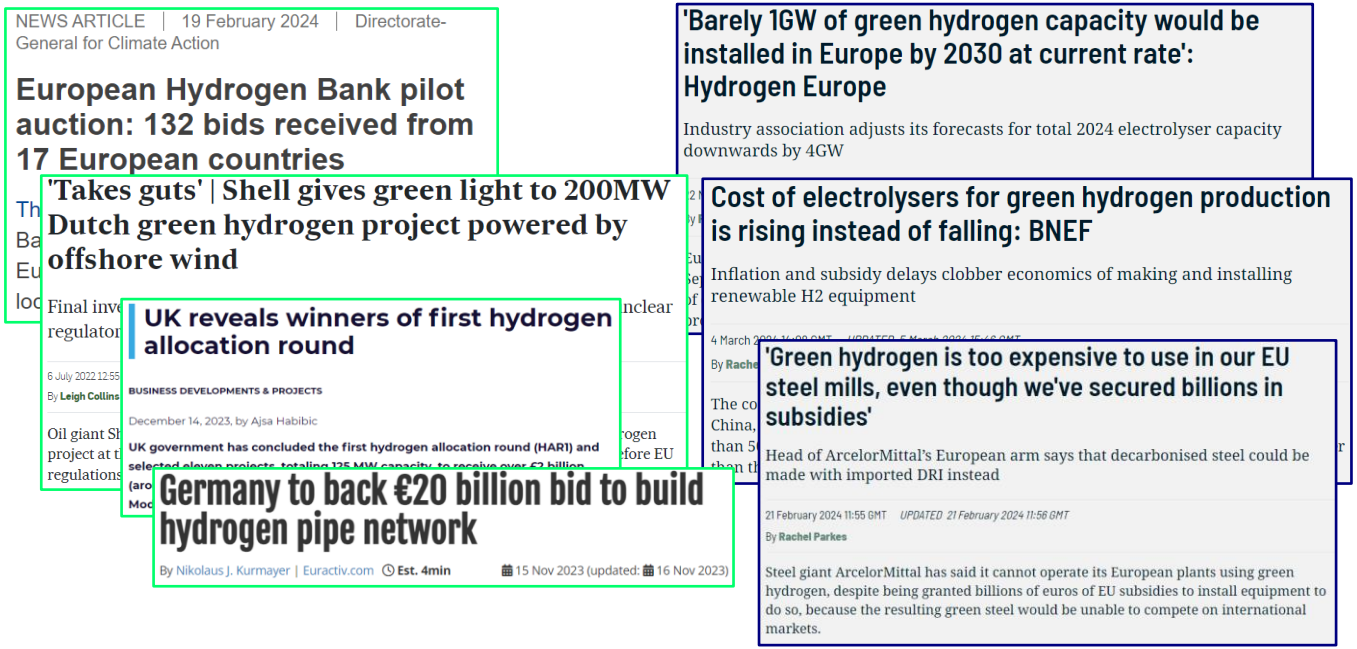
Data from UK Hydrogen Strategy Analytical Annex

Industry	*25-55 TWh by 2035*
Power	*5-30 TWh by 2035*
Heat in buildings	*0-60 TWh by 2035*
Transport	*20-30 TWh by 2035*

[1] Based on analysis for the Hydrogen Transport and Storage Networks pathway (2023)

Despite targets outcomes are less clear

This is evidenced by headlines both optimistic and pessimistic



References from Hydrogen Insight, Euractiv, RECHARGE

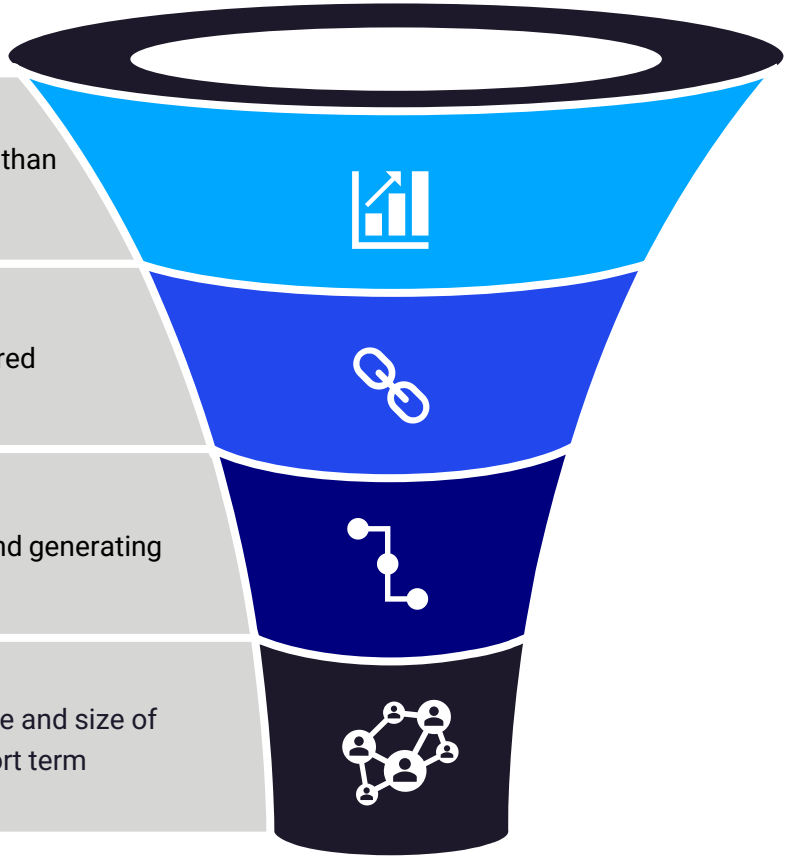
What are the barriers to hydrogen adoption?

Cost of clean hydrogen
Green and blue hydrogen are likely to be more expensive than incumbent fuels for the foreseeable future

Lack of Supply Chain
Projects are facing difficulties in sourcing the required equipment in a timely manner for projects

Supply vs demand
Generating demand is difficult when there is no supply, and generating supply is difficult when there is no demand

Lack of investor confidence
All of the above contribute to uncertainty around the role and size of opportunity around hydrogen especially in the short term



What is the status of hydrogen in Europe?

Project developers are awaiting confirmation of subsidies to reach FID

- **High costs of clean hydrogen** mean projects have been slow to hit Final investment decision (FID) and move to construction
- BCG estimates **green hydrogen at €5-8/kg** compared to **~€2-3/kg for grey hydrogen** and even less for natural gas[1]
- Therefore, many of these are waiting for production incentives including:
  - **€800m** from the **European Hydrogen Bank** auction for up to €4.50/kg renewable H2 produced[2]
    - Resulted in funding **1.5GW of production** with very low a **clearing price of €0.48 / kg**
    - 500 MW projects in **Spain and Portugal** largest projects funded
  - German-led **H2Global scheme** which could unlock **€5bn** for purchasing hydrogen from outside of Germany[2]
  - **Denmark** has awarded **$177m** in fixed payments for 10 years for **280 MW of projects**[2]

20 MW
Largest operational project

1.5 MW
Average project size in 2023[2]

200 MW
Largest Green H_2 project to hit FID

1 Turning the European Green Hydrogen Dream into Reality: A Call to Action (bcg.com)
2 Review of 2023 | Trends in the global hydrogen sector | Hydrogen news and intelligence (hydrogeninsight.com)
3 EU's Hydrogen Bank auction clears below 50 euro cent/kg, funding 1.5 GW | S&P Global Commodity Insights (spglobal.com)

How is the UK targeting barriers?

Incentives are incoming but supply chain and innovation are drawing attention

- The UK government is also pursuing **production incentives** to establish hydrogen supply and value chains:
  - Cluster sequencing is looking to **back two industrial clusters** with over **£1bn** in the NW and NE of the UK to enable **blue hydrogen** production[1]
  - **125 MW** of green hydrogen production awarded through **HAR1** and **HAR2** will back **875MW**, with applications closing April 2024[2]
  - **HAR1 projects** awarded approximately **£9.50 per kg of hydrogen** produced (HHV) for 15 years

- However, concerns around deliverability of projects have resulted in increasing focus on supply chains and innovation in clean hydrogen

- Industry is communicating that supply chains are already stretched, and crucial components require innovation

1 Cluster sequencing Phase-2: eligible projects (power CCUS, hydrogen and ICC), March 2022 - GOV.UK (www.gov.uk)
2 Hydrogen net zero investment roadmap: leading the way to net zero - GOV.UK (www.gov.uk)
3 UK allocates more than £2bn of subsidies to 11 green hydrogen projects in first auction round | Hydrogen Insight

What are the state of the art projects in Europe today?

HySynergy 1

Production: 20 MW Alkaline electrolyser

Demand: Refinery, Transport

Partners: everfuel, Nel, Crossbridge Energy

Operational? TBC (expected 2023)

Details: a 20MW electrolyser from Nel, will provide green hydrogen to decarbonise Crossbridge energy's refinery and provide fuel for everfuel's hydrogen refuelling station network.

Puertollano

Production: 20 MW PEM electrolyser

Demand: Ammonia, 3,000 tpa

Partners: Iberdrola, Fertiberia, Nel,

Operational? 2022

Details: a 20MW electrolyser from Nel, is providing green hydrogen to decarbonise Fertiberias ammonia plant, reducing carbon emissions by 48,000 tCO2/year and reduce natural gas consumption by 10%.

Holland Hydrogen 1

Production: 200 MW Alkaline electrolyser

Demand: Refinery, 60,000tpa

Partners: Shell, Worley, thyssenkrupp

Date started? FID made (2025)

Details: The largest European project to have final investment decision, a 200MW electrolyser from thyssenkrupp, will provide green hydrogen to decarbonise Shell's energy's Rotterdam refinery.

everfuel.com/projects/hysynergy/

Puertollano green hydrogen plant - Iberdrola

Shell to start building Europe's largest renewable hydrogen plant | Shell Global

Thanks for listening

For more information on Carbon Trust's Hydrogen capabilities, please contact:

Rob Bloom – Programme Manager
Rob.Bloom@carbontrust.com

Charlotte Bücke – Programme Senior Analyst
Charlotte.Bucke@carbontrust.com

The Carbon Trust is a company limited by guarantee and registered in England and Wales under company number 4190230 with its registered office at Level 5, Arbor, 255 Blackfriars Road, London SE1 9AX, UK.