UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Hydrogen Strategy: UK vs Germany

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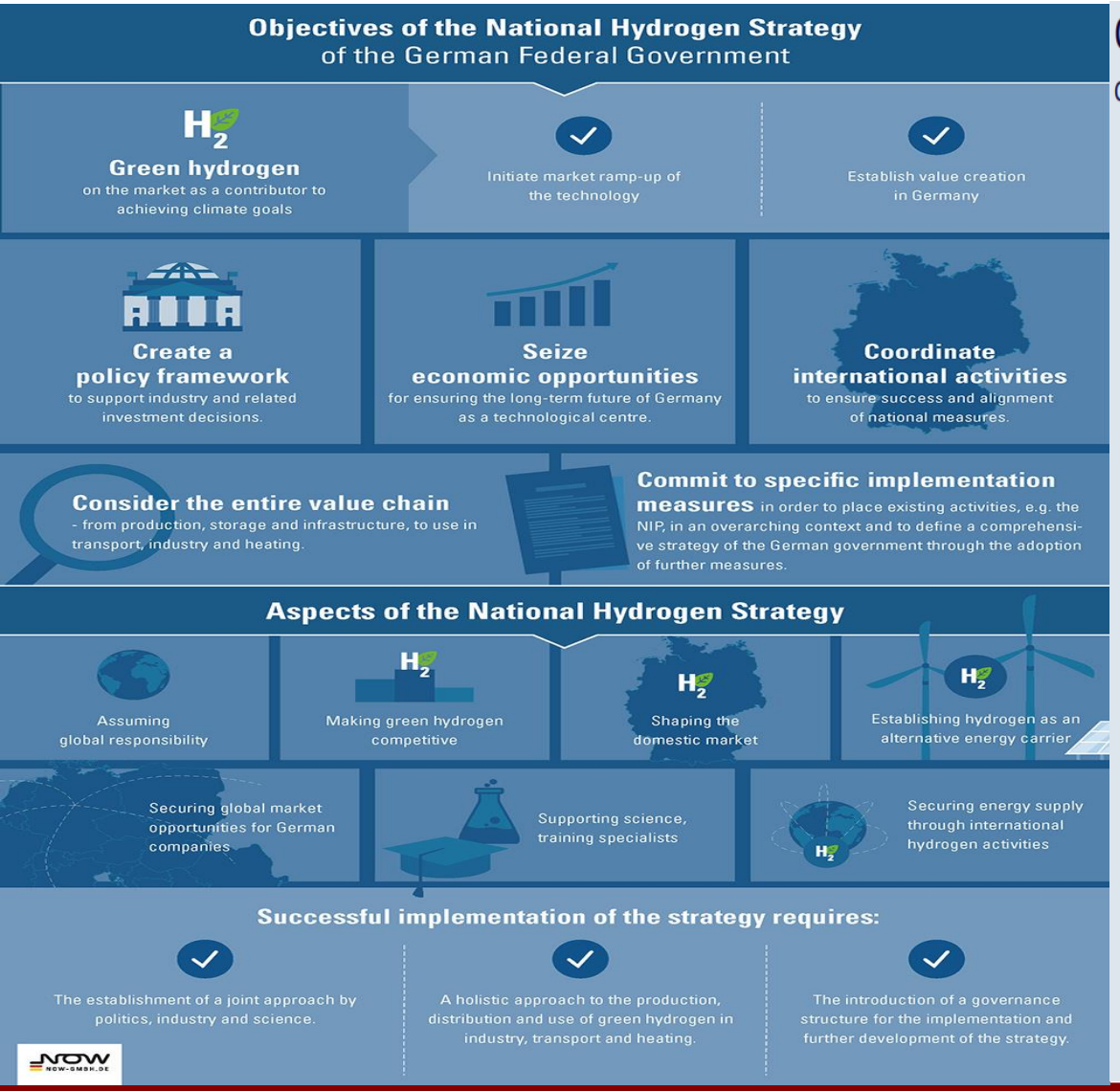
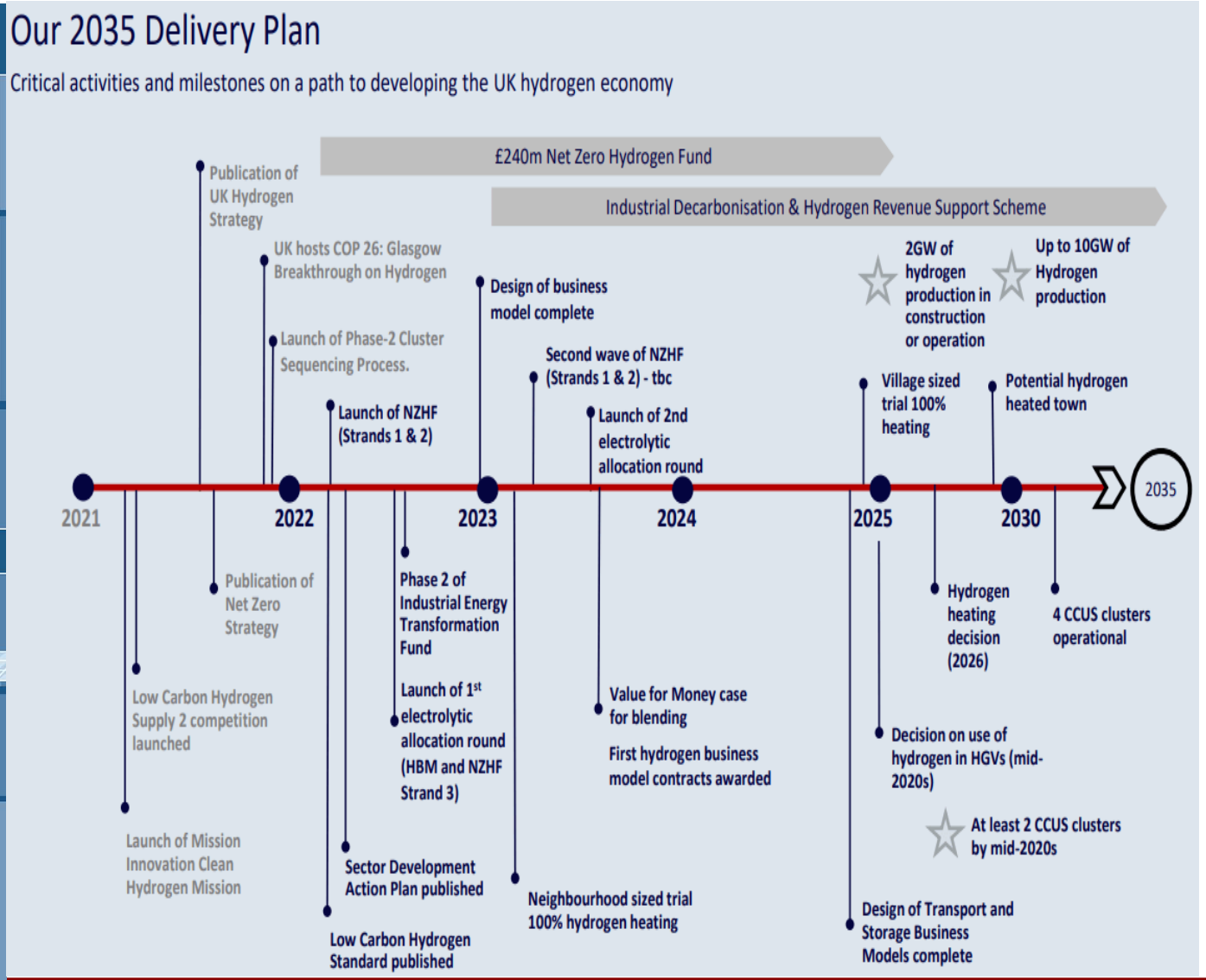
Italy IAEE International Conference July 25, 2023

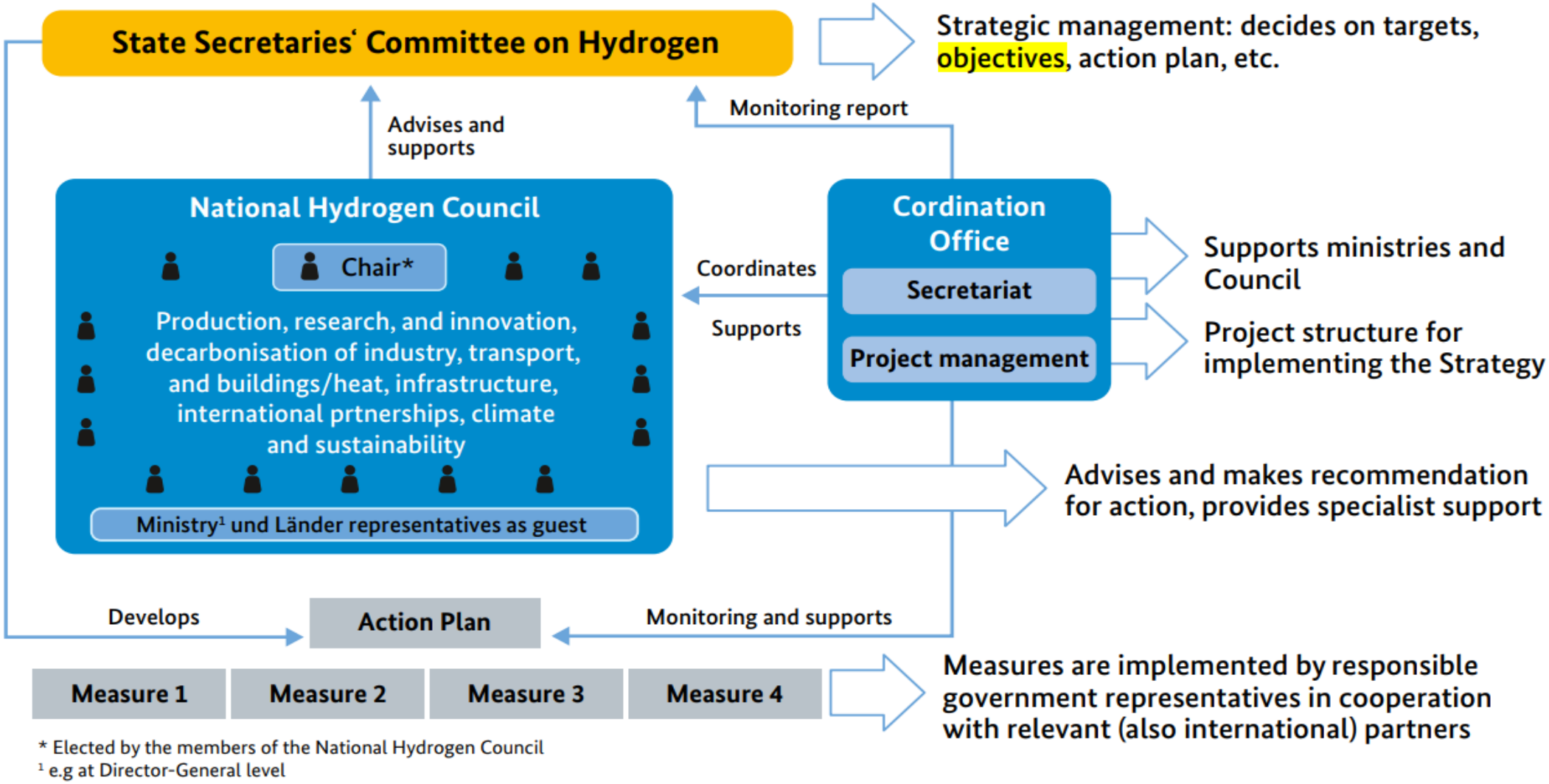
Contents

What are objectives of hydrogen strategy?



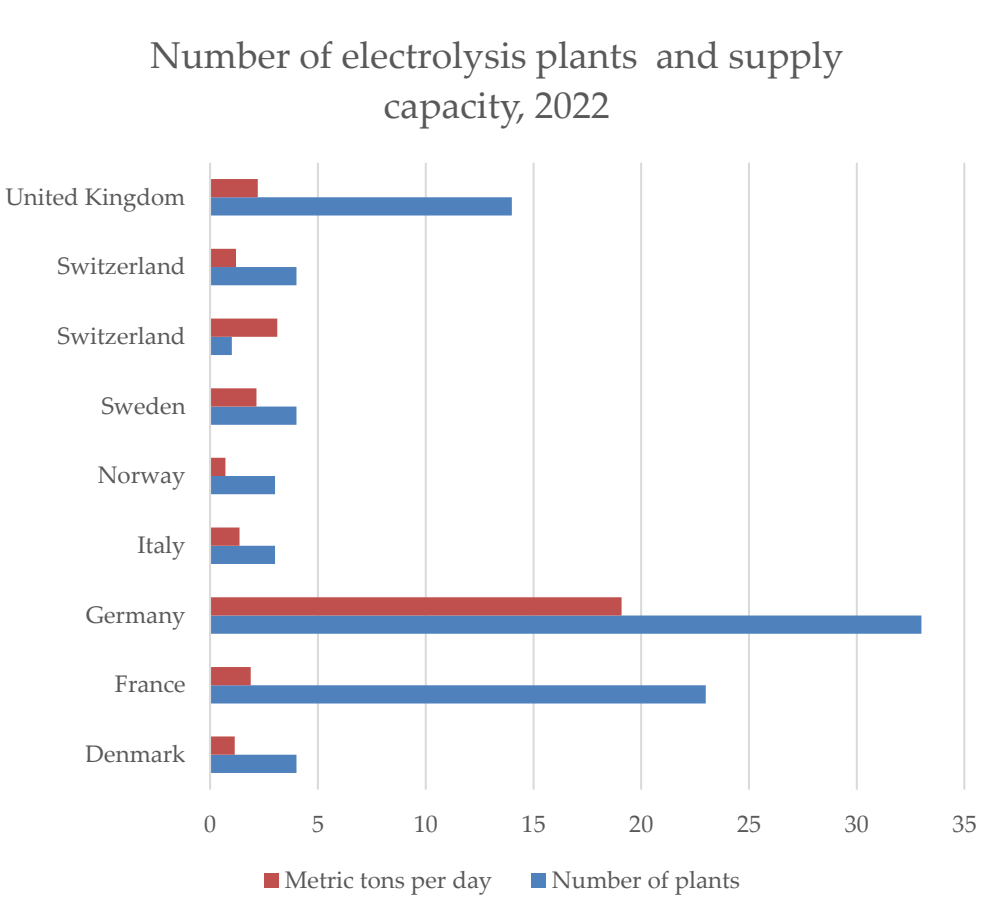


Governance Structure of Germany Hydrogen Strategy

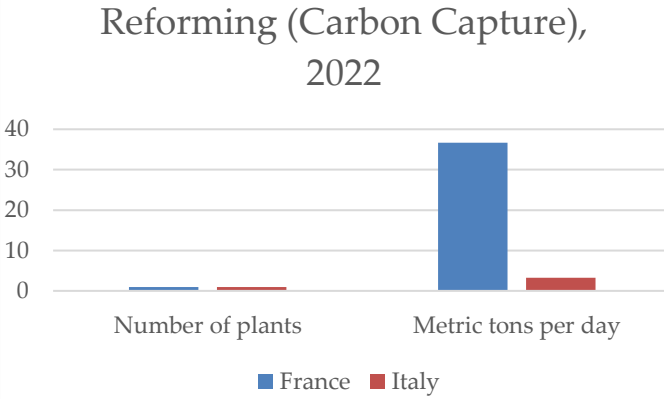


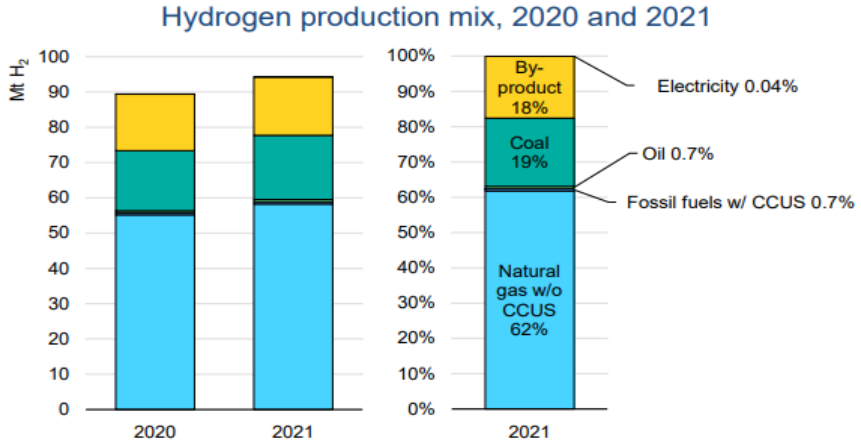
* Elected by the members of the National Hydrogen Council
[1] e.g at Director-General level

Status Quo of Germany and UK in Global Hydrogen Landscape



	Reforming without CCS	
	Number of plants	Metric tons per day
Denmark	3	83.8
France	11	1664.2
France	11	248.2
Germany	44	5002.9
Italy	30	2108.7
Norway	5	733.3
Sweden	11	531.2
Switzerland	4	57.9
United Kingdom	26	1757.5





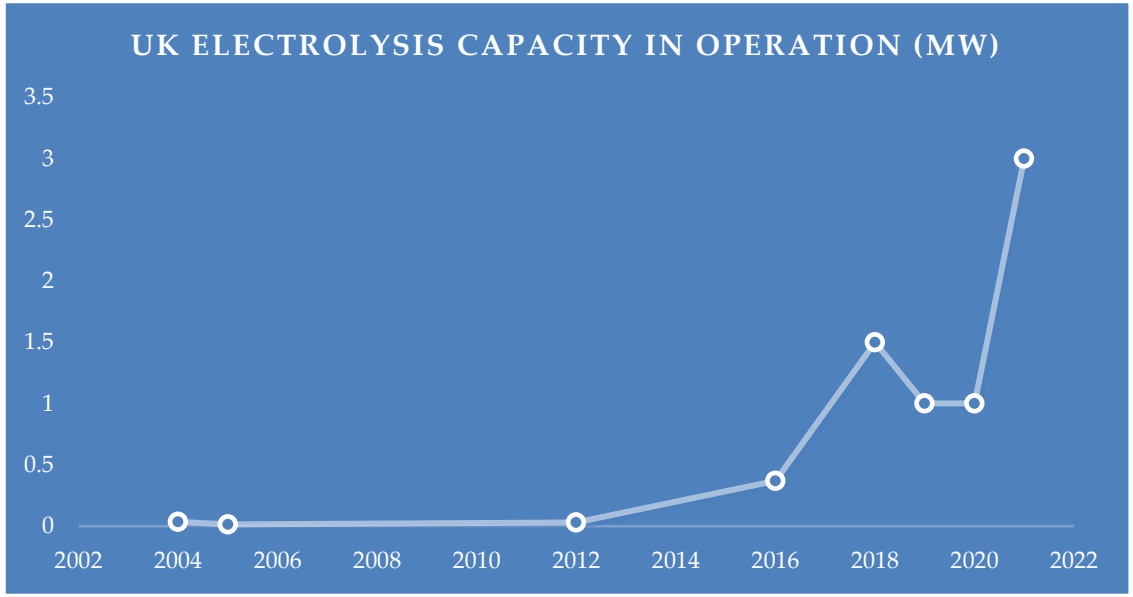
- Only France and Italy currently operate SMR with CCS in Europe

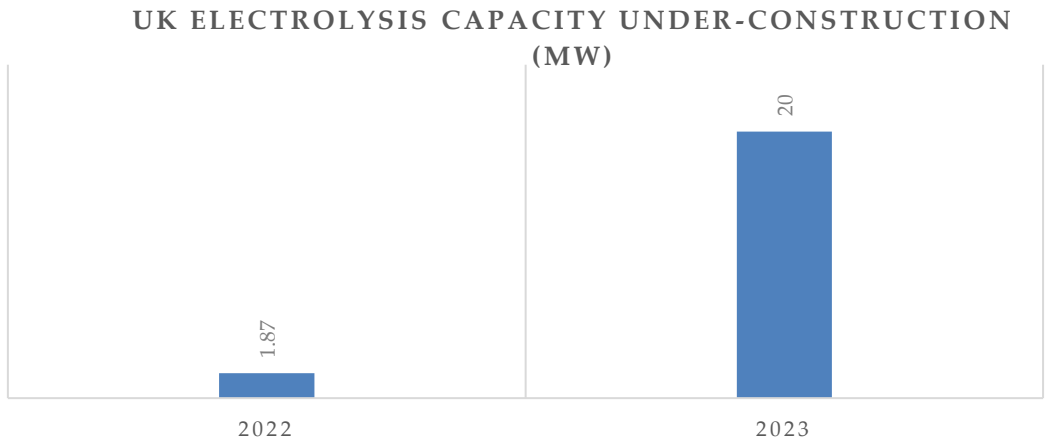
Source: Fuel cells and hydrogen observatory 2022 https://www.fchobservatory.eu/observatory/technology-and-market/hydrogen-supply-capacity

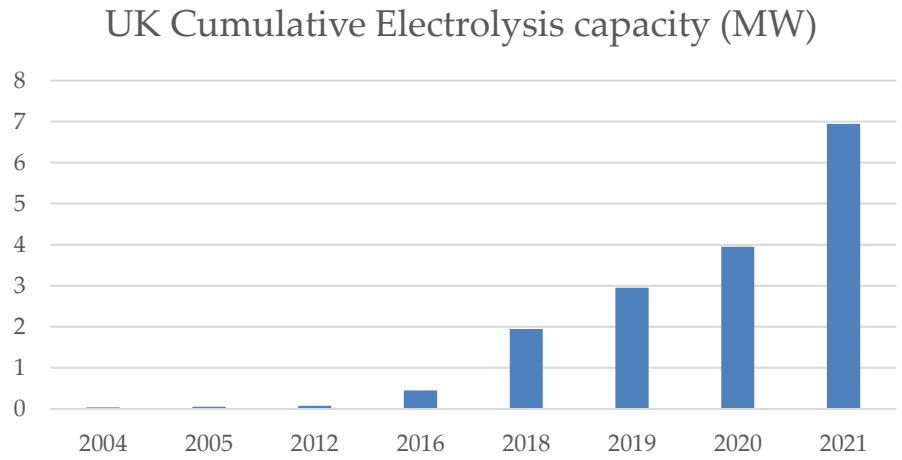
Source: IEA Global Hydrogen Review 2022 https://www.iea.org/reports/global-hydrogen-review-2022

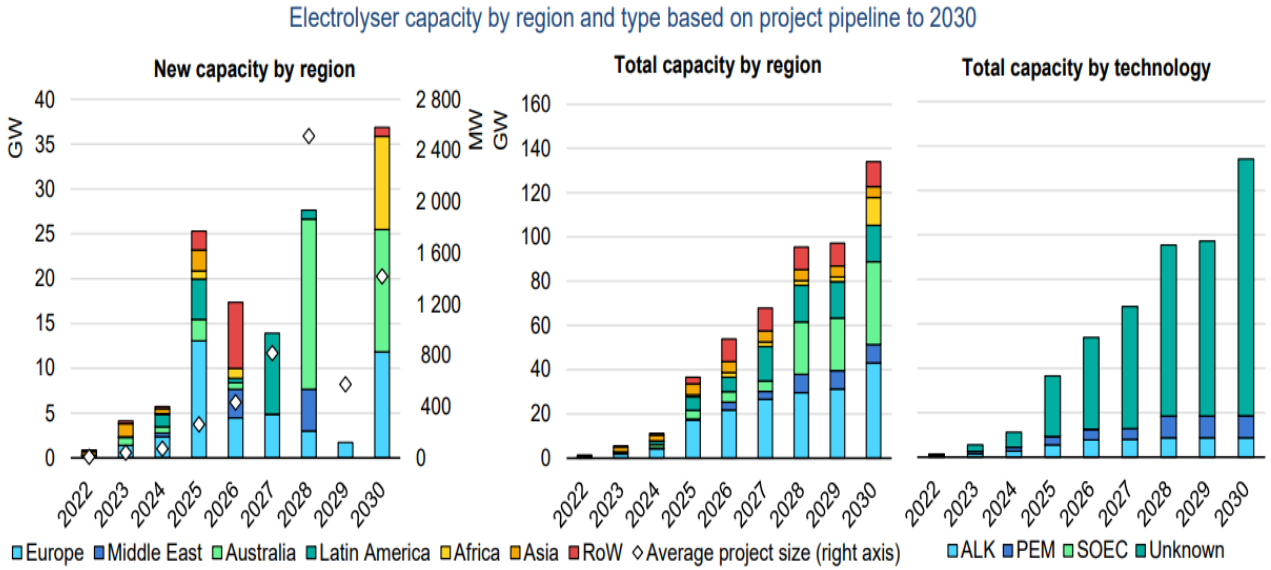
SUPPLY AND DEMAND OF HYDROGEN OUTLOOK

Electrolysis Technology Capacity



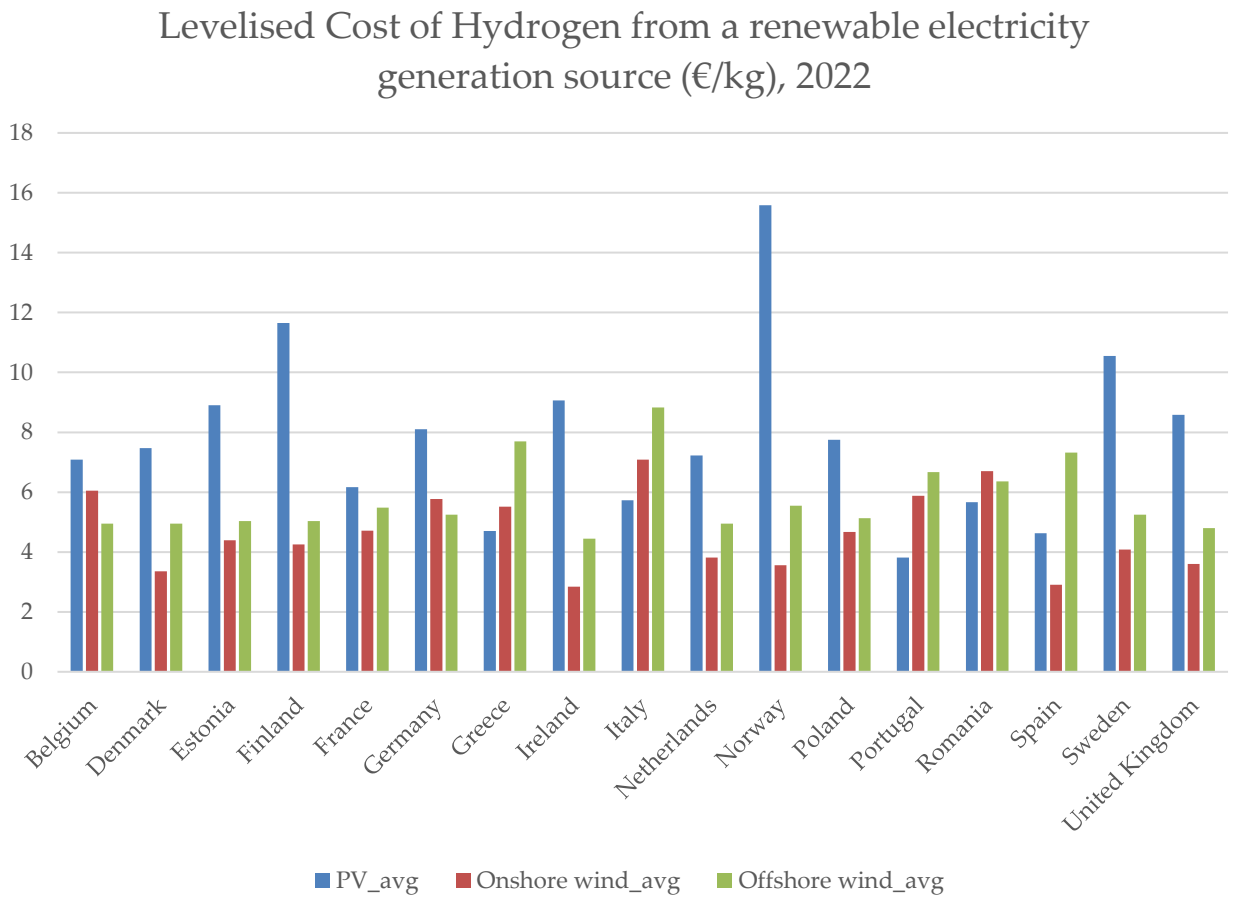


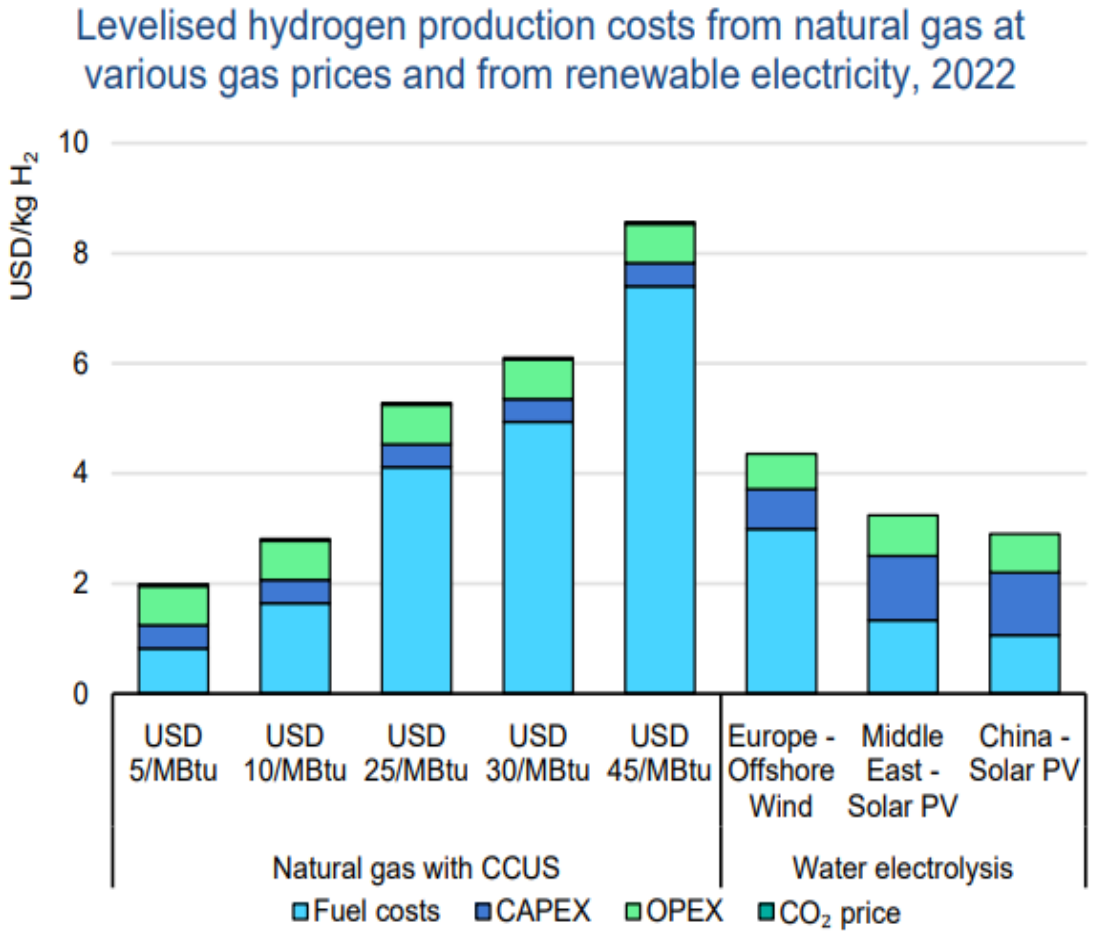




Source: Fuel cells and hydrogen observatory 2022

Levelised Hydrogen Production Cost

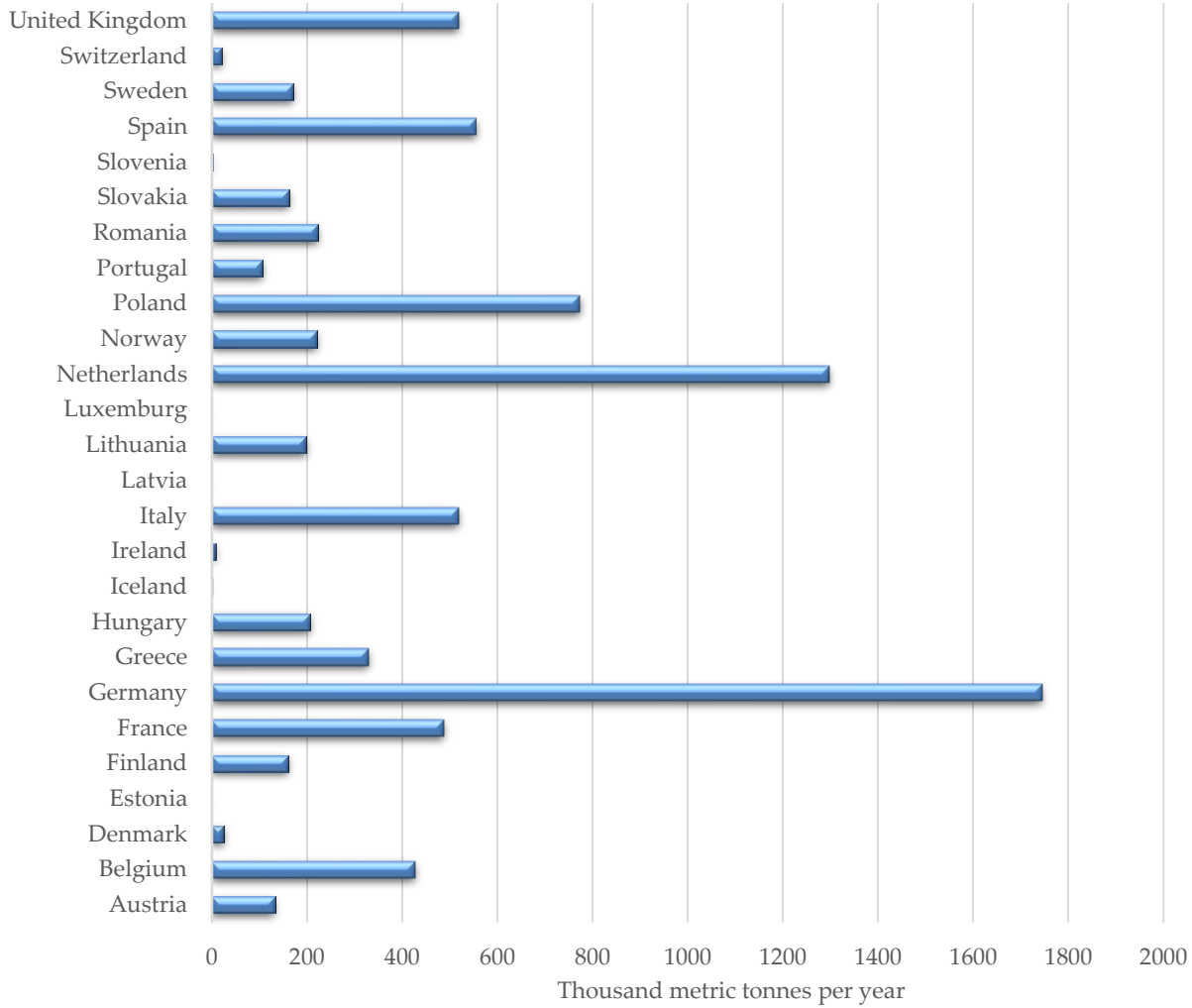


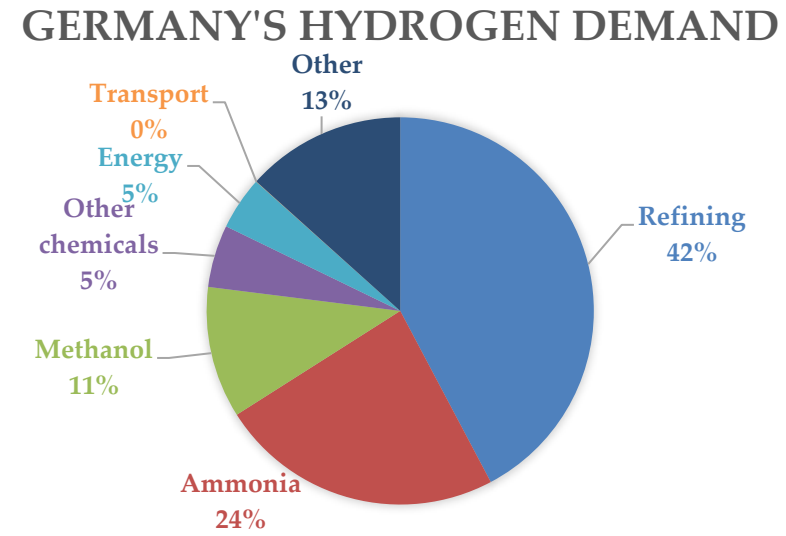


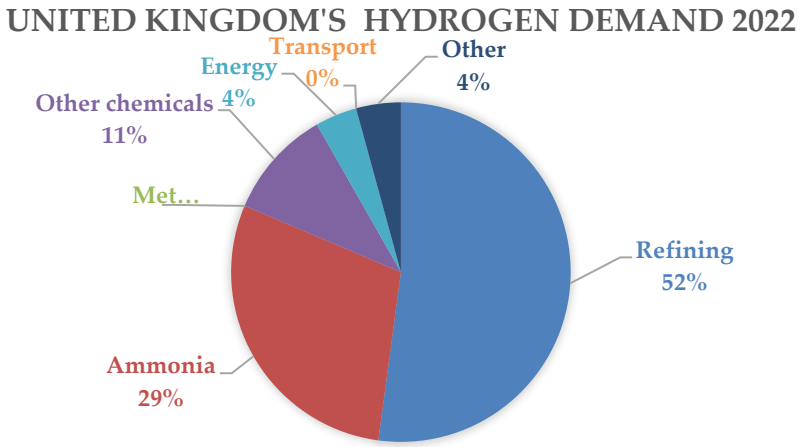
Source: Fuel cells and hydrogen observatory 2022

Source: IEA Global Hydrogen Review 2022 https://www.iea.org/reports/global-hydrogen-review-2022

Hydrogen Demand in Europe 2022

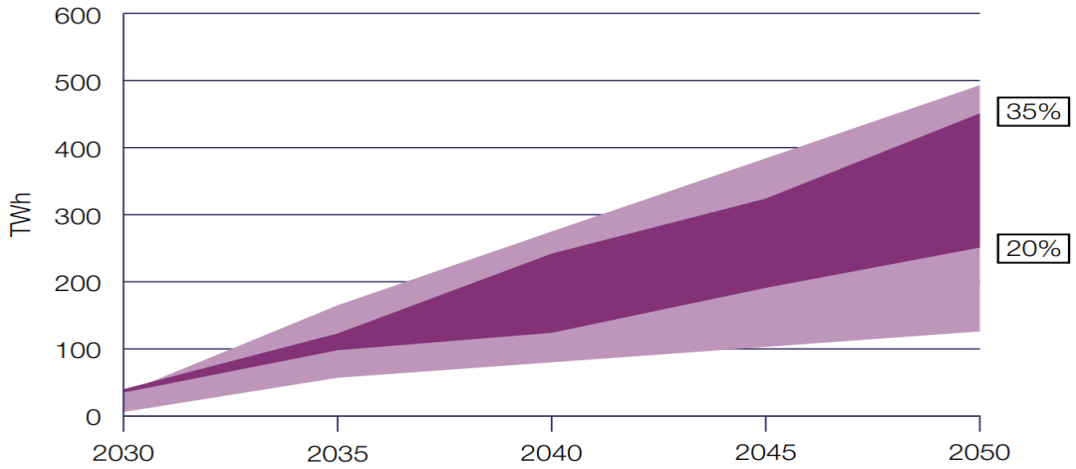




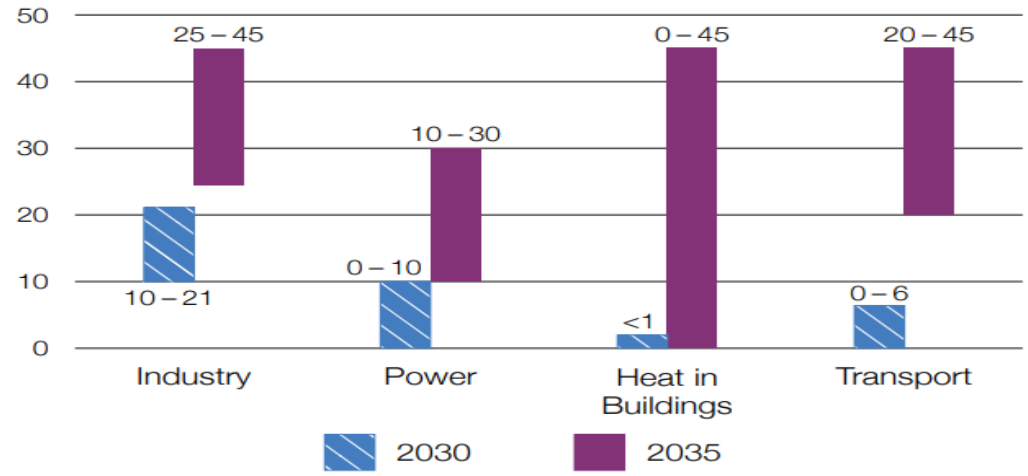


Source: Fuel cells and hydrogen observatory 2022

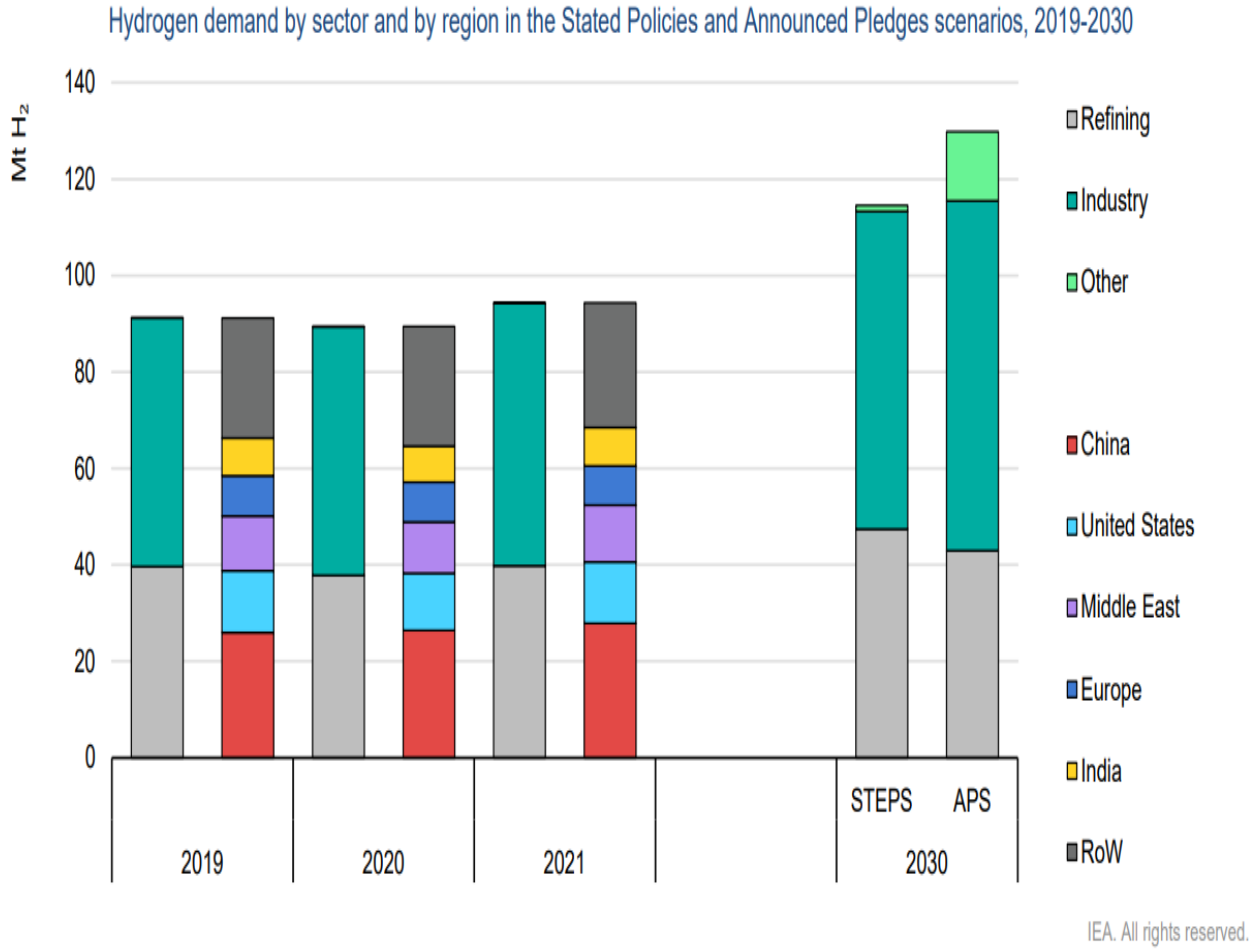
Evolution of UK Future Hydrogen Demand



% = hydrogen as proportion of total energy consumption in 2050



Source: UK Hydrogen Strategy 2022 UK hydrogen strategy - GOV.UK (www.gov.uk)



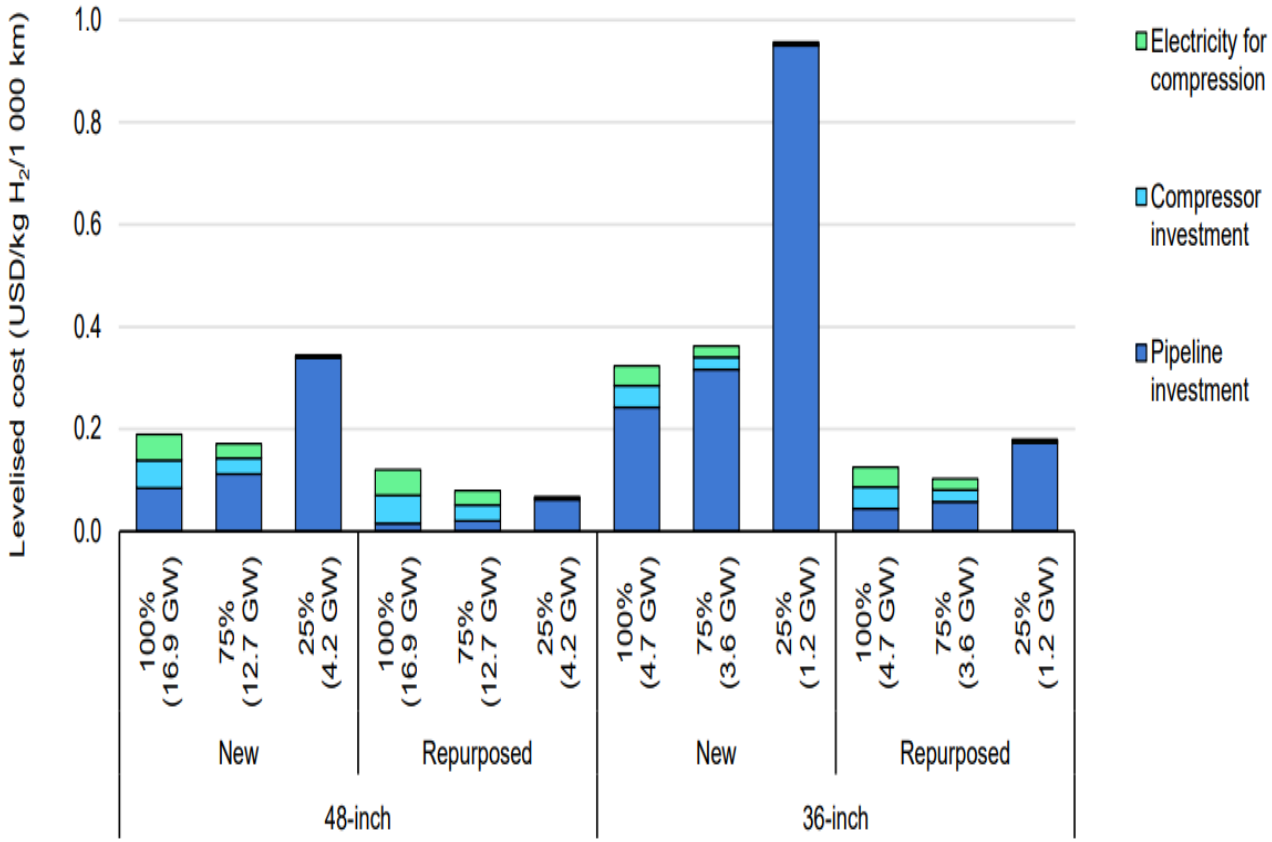
Notes: Mt H_2 = million tonnes of hydrogen; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario. *Other* includes transport, buildings, power generation sectors and production of hydrogen-derived fuels and hydrogen blending.

Source: IEA Global Hydrogen Review 2022 https://www.iea.org/reports/global-hydrogen-review-2022

HYDROGEN INFRASTRUCTURE, INVESTMENT AND TRADE

Hydrogen Infrastructure Cost and Facilities

Levelised cost of hydrogen transmission based on pipeline diameter and throughput capacity

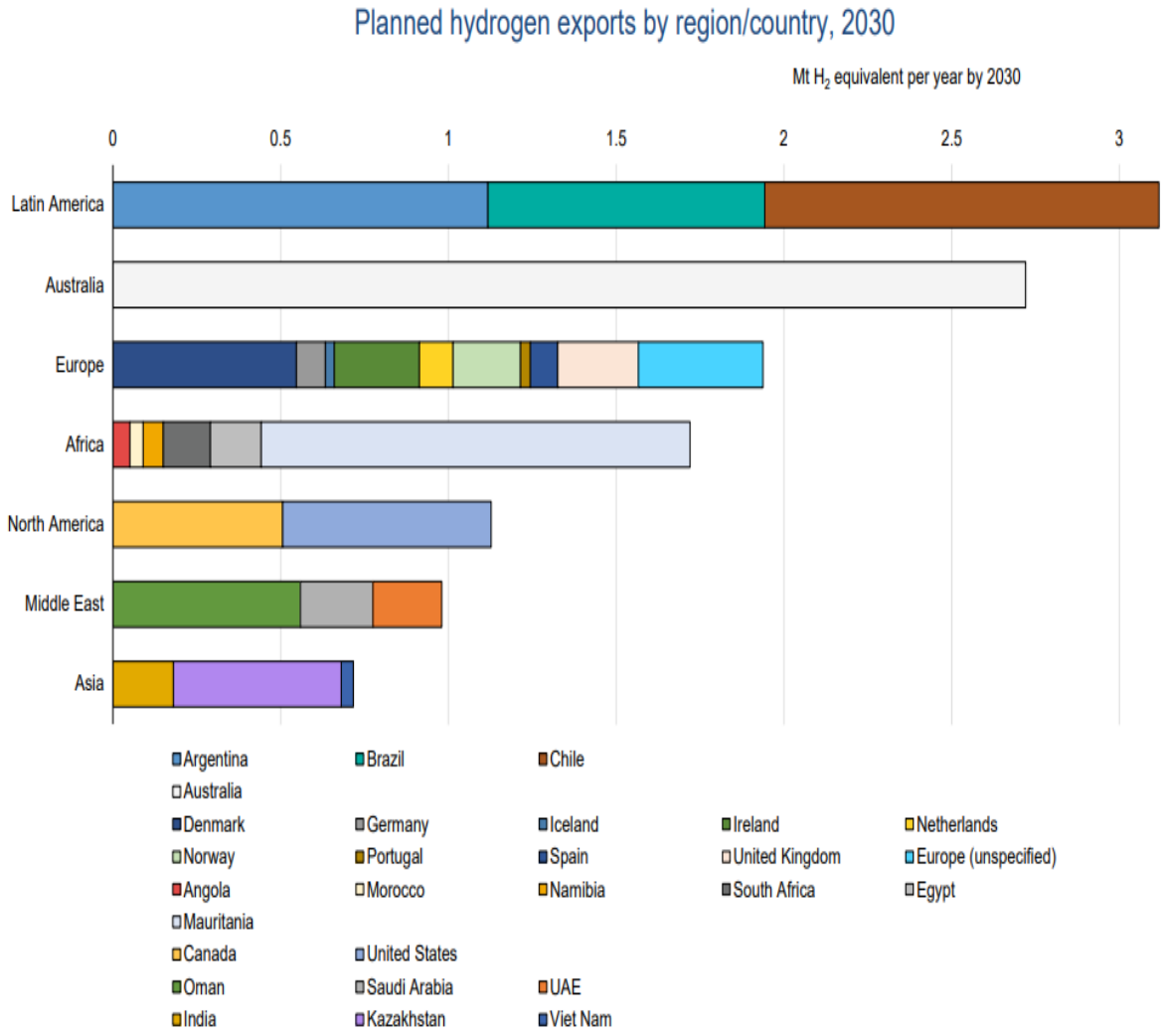


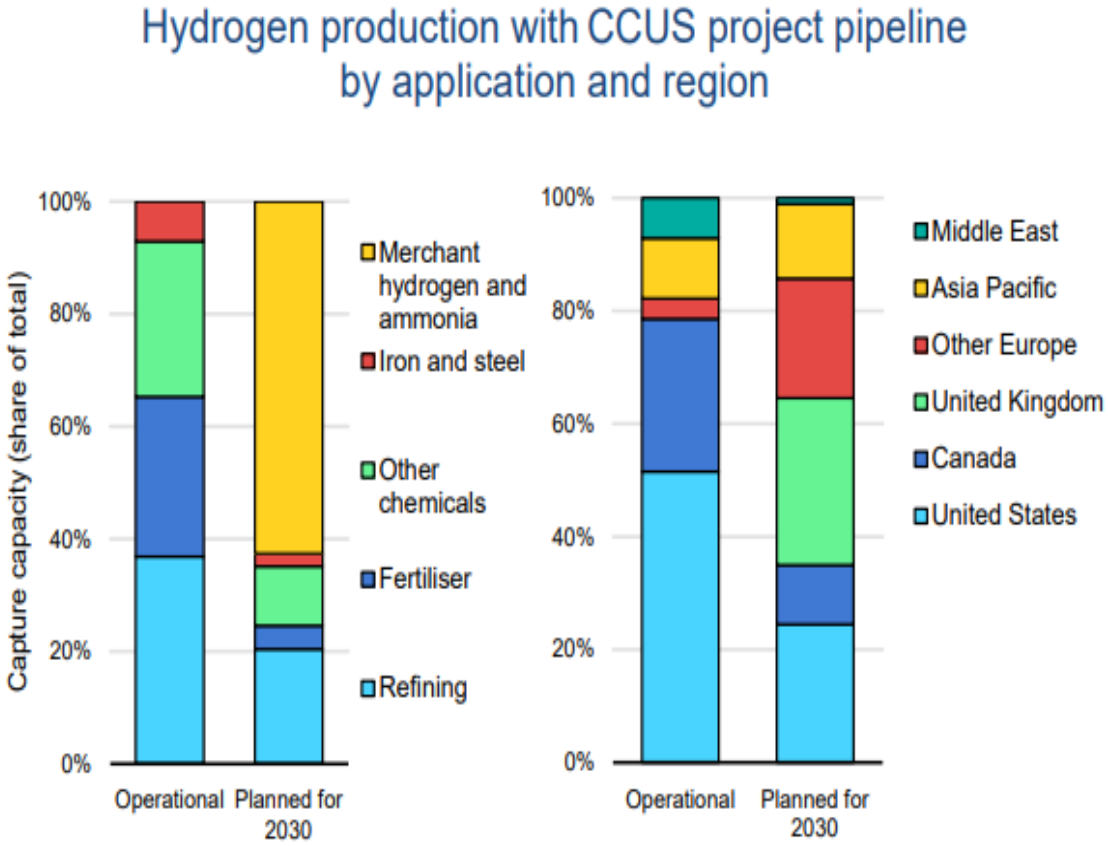
Planned underground hydrogen storage facilities

Type	Project name	Country	Project start year	Operator/developer	Working storage (GWh)	Status
Salt cavern	Green Hydrogen Hub	Denmark	2025	Gas Storage Denmark A/S, Corre Energy BV, Eurowind Energy A/S	250	Feasibility study
	HyGreen Provence	France	2028	Engie, Storengy	200	Feasibility study
	Stor'Hy Cerville	France	2026	Storengy	0.3	Concept (Demo)
	H2 Gronau-EPE	Germany	2027	RWE Gas Storage West	115	Feasibility study
	Energiepark Bad Lauchstädt	Germany	2027	VNG Gasspeicher, ONTRAS Gastransport, DBI, Terrawatt, Uniper	150	Feasibility study
	HyStock Zuidwending	Netherlands	2027	Gasunie	165 (per cavern, up to 4 caverns)	Feasibility study
	Damaslawek	Poland	2030	Gaz-System	-	Concept
	H2toES Cuenca Vasco-Cantábrica	Spain	-	Repsol	-	Concept
	Humber Hydrogen Storage	United Kingdom	2028	Equinor, SSE Thermal	320	Feasibility study
	HyNet/HyKeuper	United Kingdom	2030	INOVYN, Costain, Geostock	70 (per cavern, up to 19 caverns)	Feasibility study
	HySecure	United Kingdom	mid-2020s	Storengy, Inovvn, Element Energy	40	Concept
	Advanced Clean Energy Storage	United States	2025	Mitsubishi Power, Magnum Development	150 (per cavern, up to 100 caverns)	Feasibility study
	Hydrogen City – South Texas	United States	2026	Green Hydrogen International, Energy Estate	120 (per cavern, initially 2 caverns and possibly, up to 50)	Concept

Source: IEA Global Hydrogen Review 2022 https://www.iea.org/reports/global-hydrogen-review-2022

Potential Hydrogen Exports and Applications





Source: IEA Global Hydrogen Review 2022 https://www.iea.org/reports/global-hydrogen-review-2022

Hydrogen Investment Roadmap

Major policies		Core objectives of the strategy	Production and procurement forecasts
Budget	**Policy details**	(1) Green hydrogen will play a central role in the promotion and completion of Germany's energy transition policy ・For decarbonization ・As a means of storing renewable energy ・As an energy source ・As raw material (2) Fulfilling the global responsibility to meet the challenge of reducing CO_2 emissions (3) Building a hydrogen society is a collective task for the EU	Hydrogen use in Germany 2030: 90-110 TWh 2050: ~380 TWh Green hydrogen production Domestic production 2030: 14 TWh (4,000 hours full-load operation of water electrolyzer, average energy efficiency ratio 70%) Facility capacity 2030: 5 GW 2040: 10 GW or more Imports 2030: Almost none 2050: Imports will account for the majority of demand
3.6 billion euros	Support for conversion to fuel cells for automobiles, trains, and coastal and inland water transportation vessels (~2023)		
3.4 billion euros	Support for development of hydrogen refueling and recharging infrastructure (~2023)		
1.91 billion euros	Support for hydrogen technology research (e.g., NIP II, a program for innovation in hydrogen and fuel cell technology) (~2026)		
1.1 billion euros	Support for PtL facilities that convert electricity to liquid fuel (~2023)		
1 billion euros	Investment in new technologies and large-scale facilities (~2023)		
700 million euros	Support for the introduction of fuel cell heaters (~2024)		
600 million euros	Support for hydrogen research and industrialization through the Real-World Laboratories program (~2023)		
50 million euros	Support for research on the practical application of fuel cell powered airplanes and ships (~2024)		
Total 12.36 billion euros			
+			
9 billion euros	Appropriation from Coronavirus economic stimulus package ・Support for the launch of the hydrogen market (7 billion euros) ・International collaboration and cooperation (2 billion euros)		

https://www.mitsui.com/mgssi/en/report/detail/__icsFiles/afieldfile/2021/02/19/2012_fuhrmann_e.pdf

Why invest in UK Hydrogen?

A sector with striving ambitions and major opportunities for growth

- Up to **10GW** ambition by 2030, at least half from electrolytic hydrogen
- **£240mn** Net Zero Hydrogen Fund provides CAPEX/DEVEX support
- Up to **35%** of UK's energy consumption could be hydrogen by 2050
- **20GW** of potential hydrogen projects identified in the UK pipeline (through to 2037)
- More than **£150mn** will be spent from the Net Zero Innovation Portfolio on hydrogen innovation
- Up to **£18bn** private financial capacity available from UK Infrastructure Bank for sectors including H2

Hydrogen net zero investment roadmap - GOV.UK (www.gov.uk)

How Successful the Hydrogen Strategy will be?

Challenges

- Regulatory issues
- Hydrogen production technology cost uncertainty
- Wide infrastructure investment gap
- Hydrogen demand uncertainty

Thank You

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