

Hydrogen Market Attractiveness Report (HyMAR)

Summary slides for non-subscribers

11th May 2021



Our European Hydrogen Market service offers regular insights, policy/market updates & roundtable discussions

Hydrogen Market Attractiveness Report (HyMAR)



- Hydrogen market sizing: demand scenarios by country and sector
- Summary of policy developments and incentives across Europe
- Analysis of demand and supply drivers
- Global electrolyser project database

Strategic Insight Reports



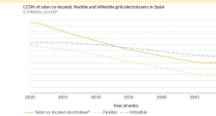
- Regular insight reports on topical issues in the evolving European hydrogen market covering country, policy and technology deep dives
- Upcoming reports on next slide

Policy updates & thought leadership



- Regular updates on European Hydrogen policies and incentives across power, heat, transport and industry
- Thought leadership on required policies and incentives to grow hydrogen sector

Investment case analysis



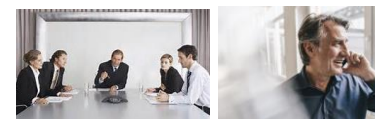
- Hydrogen production economics based on Aurora's in-house power, natural gas and carbon price forecasts
- Granular electrolyser business cases, including grid-connected inflexible and optimised production models, and co-location with renewables

Group Meetings



- Presentation of Market Attractiveness reports and Strategic Insight reports
- Networking opportunity with developers, investors and Governments – the 'go-to' roundtable to discuss hydrogen developments in Europe

Workshops and analyst support



- Bilateral workshops to discuss Aurora's analysis and specific implications
- Ongoing analyst support to answer questions about our research

Access anytime via EOS online platform

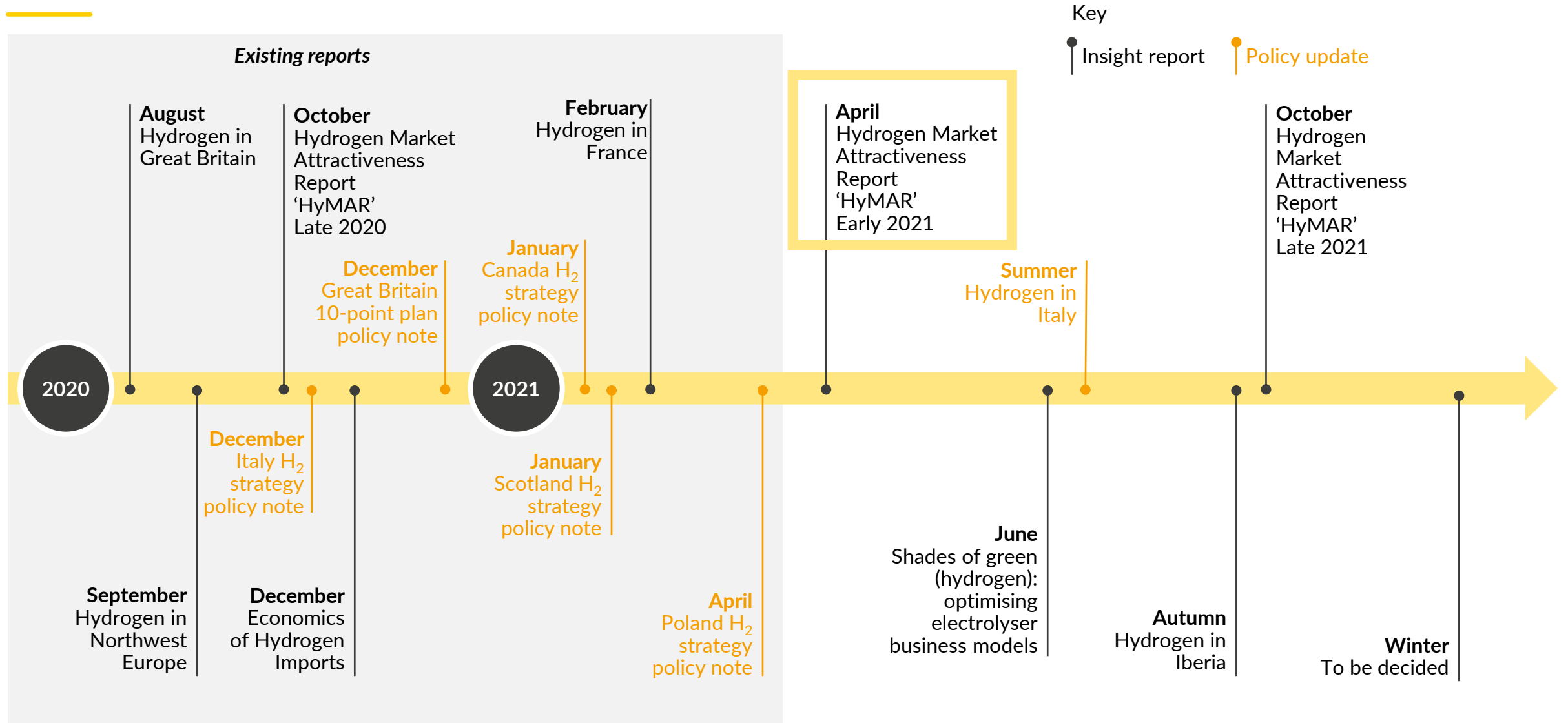


For more information, please contact Alan Jabbour, Commercial Associate - Hydrogen & Global Commodities
















alan.jabbour@auroraER.com
+44 (0) 07425 647505

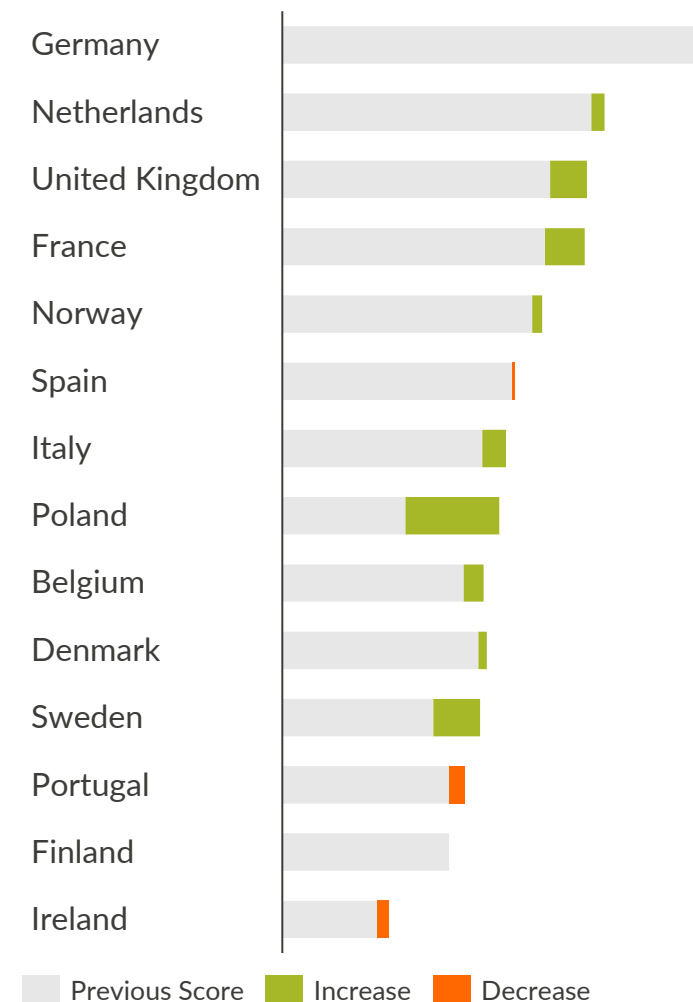
Timeline of strategic insight reports and policy updates



Germany, The Netherlands and the UK remain the most attractive for hydrogen investment; Poland's strategy pushes it up four places

Country	Rank	Previous Rank	Comments
Germany	1	 1	Considerable additions to electrolyser project pipeline
Netherlands	2	 2	Considerable additions to electrolyser project pipeline
United Kingdom	3	 3	Considerable additions to electrolyser and SMR project pipeline
France	4	 4	Supportive policy announcement
Norway	5	 5	
Spain	6	 6	
Italy	7	 7	
Poland	8	 12	New hydrogen strategy published
Belgium	9	 10	
Denmark	10	 8	
Sweden	11	 11	Low power prices and grid carbon intensity ¹ , and low industrial power prices favourable for grid-connected electrolysers Considerable additions to electrolyser database
Portugal	12	 9	
Finland	13	-	New addition to the HyMAR index
Ireland	14	 13	

Overall Scores² and changes since September 2020

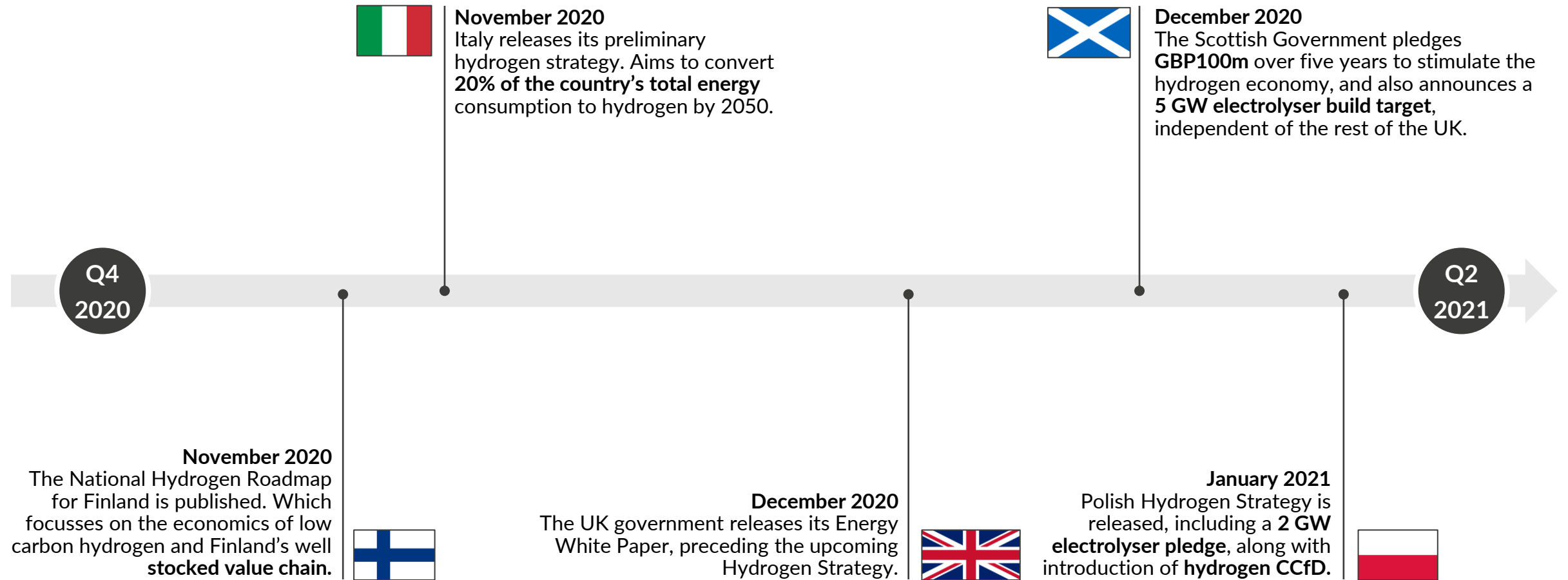


The full HyMAR report, available to subscribers, includes data on all metrics feeding into the index.

1) Modified and new metric respectively 2) Full score breakdown available to subscribers

Since our previous HyMAR report, Finland, Italy, the UK, Scotland and Poland have launched hydrogen strategies and other policies

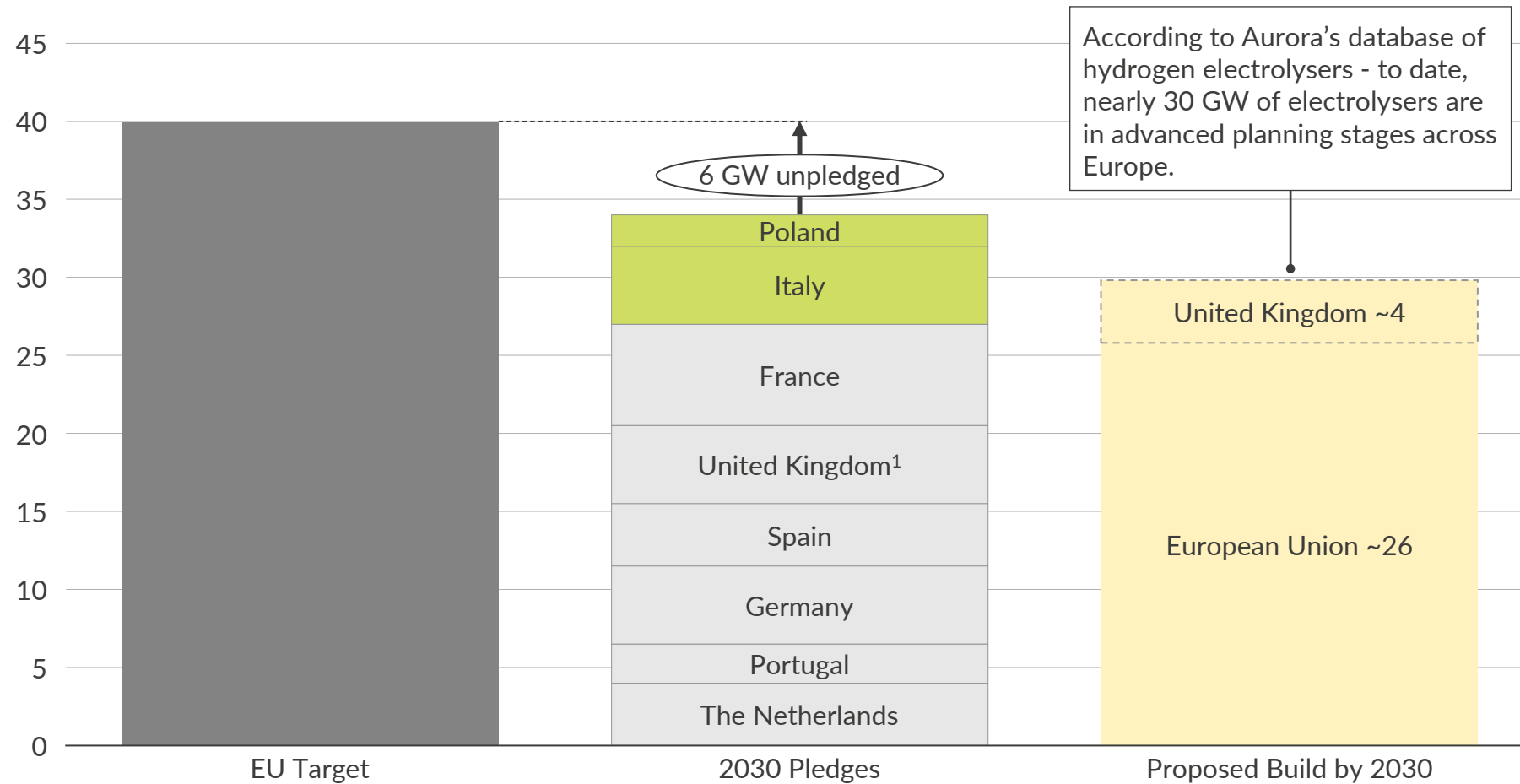
Timeline of policy announcements since November 2020



The full HyMAR report contains detailed analysis of the latest hydrogen strategies and policies across Europe

Eight countries have collectively pledged to deliver 34 GW of electrolysers by 2030 – more than half the EU’s target

Current H₂ electrolyser capacity pledges and actual planned construction
GW



According to Aurora’s database of hydrogen electrolysers - to date, nearly 30 GW of electrolysers are in advanced planning stages across Europe.

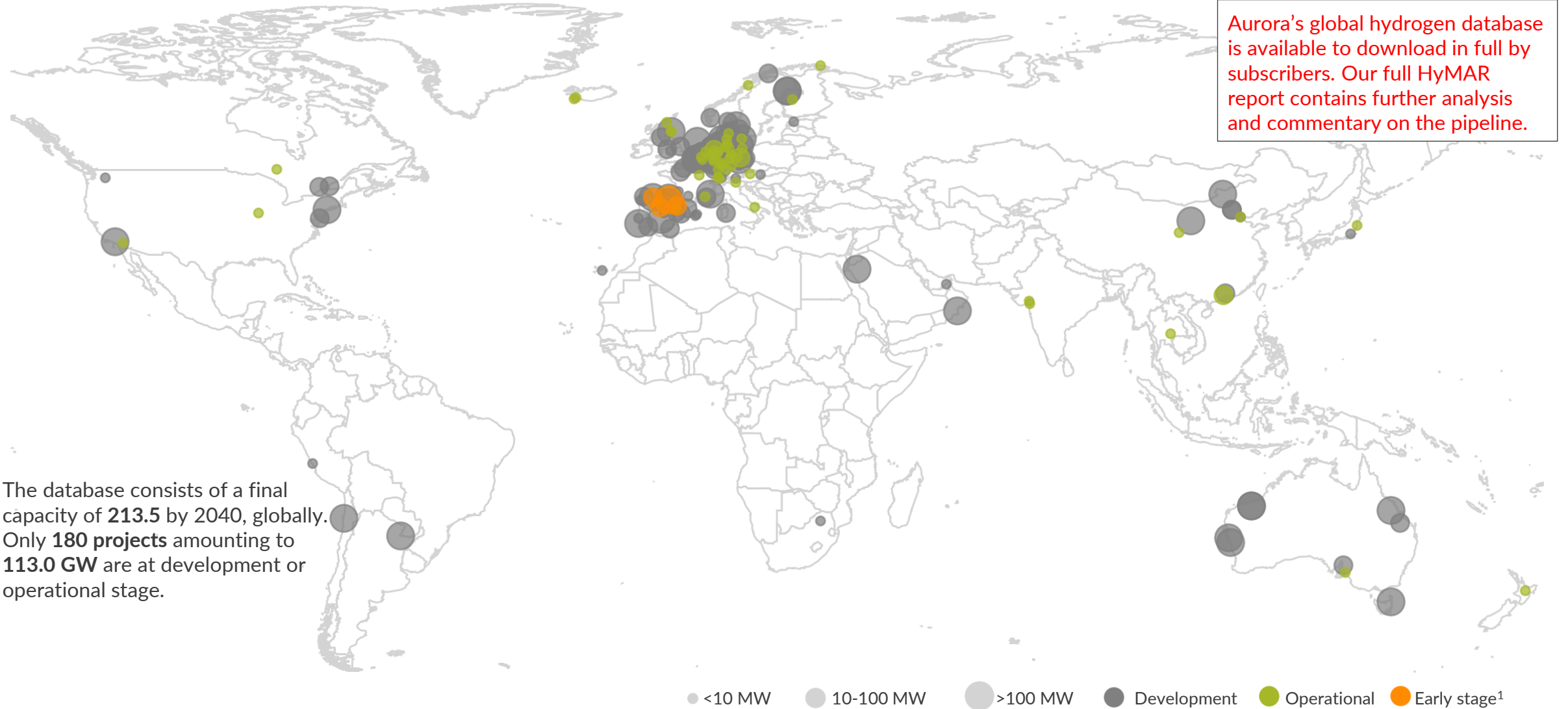
Comments

- In its strategy, the EU aims for at least 40 GW of electrolyser capacity across all of Europe by 2030. It remains unclear whether the 40 GW target includes the UK or not.
- Combining all electrolyser pledges across Europe, 34 GW are currently accounted for.
- Aurora’s global electrolyser database is available to subscribers.

■ EU Target ■ Added since last iteration of HyMAR ■ Proposed Build

1) The UK target is for 5 GW of low carbon hydrogen production, and is not limited to electrolysers.

Aurora's electrolyser database identifies a 213.5 GW pipeline of projects planned for delivery by 2040 globally, centred in Europe



Aurora's global hydrogen database is available to download in full by subscribers. Our full HyMAR report contains further analysis and commentary on the pipeline.

The database consists of a final capacity of **213.5** by 2040, globally. Only **180 projects** amounting to **113.0 GW** are at development or operational stage.

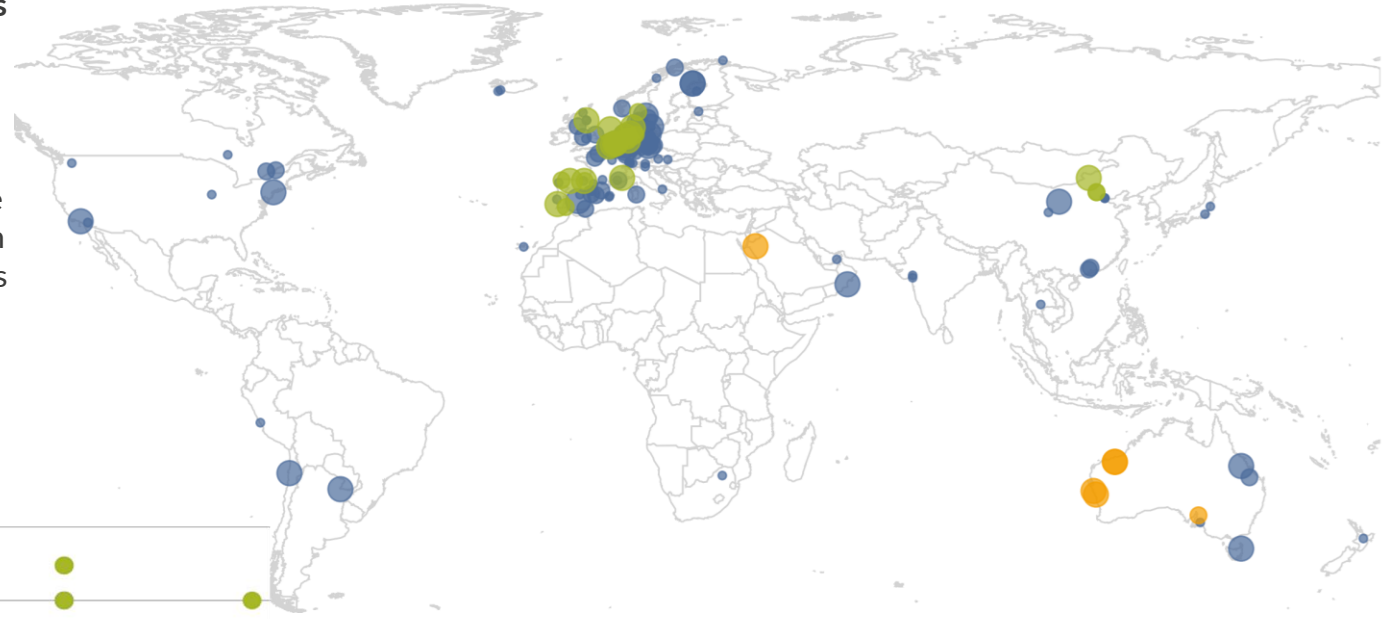
1) We define early stage projects as those 8+ years away from commissioning, or large-scale programs still in planning or discussion stages. Early stage projects encompassing more than any single country are not shown in the map



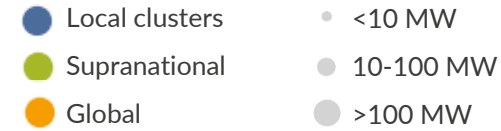
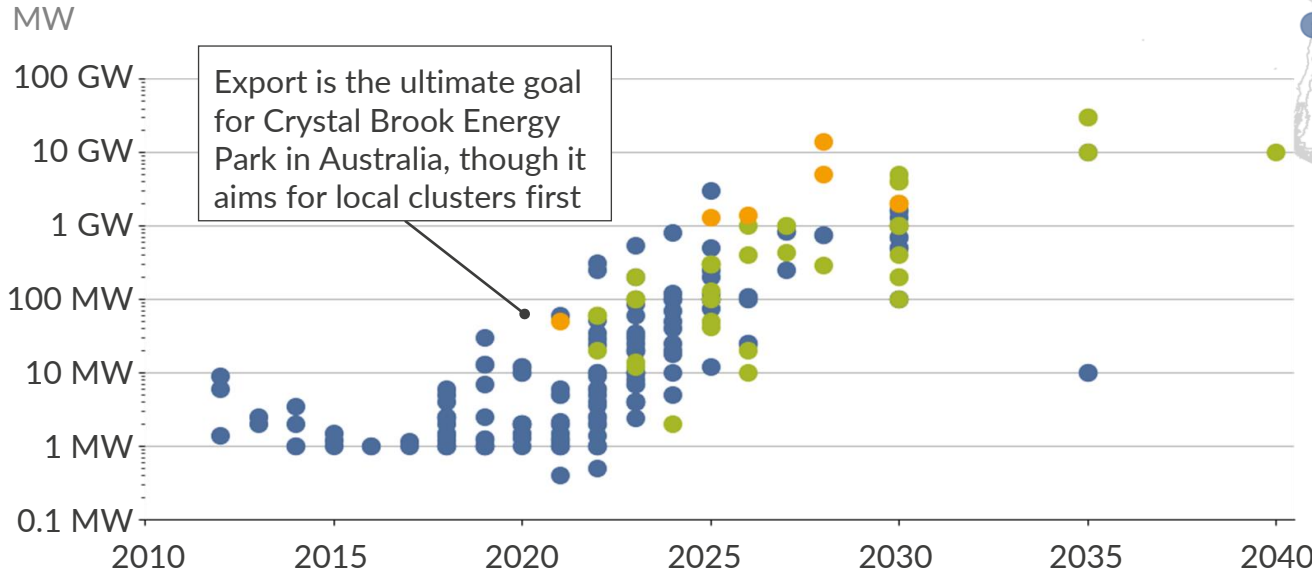
Aurora's electrolyser database consists of 247 projects, and shows a clear trend towards global hydrogen export schemes

Globally, GW-scale projects are aimed to be deployed by the mid-2020s

- Individual electrolysers in the 2030s are three orders of magnitude larger in size than those that are planned to be deployed by the early 2020s
- There is a shift in the business cases, the earlier years of the database consist of local cluster projects in which hydrogen is consumed within couple of kilometres of the facility. From early 2020s on, electrolysers are planned to be deployed in regions that benefit from cheap electricity, exporting the produced hydrogen to demand centres



H₂ electrolyser installations (by year)





European electrolyser projects focus on industrial sector as the end user; power input is most commonly from wind farms

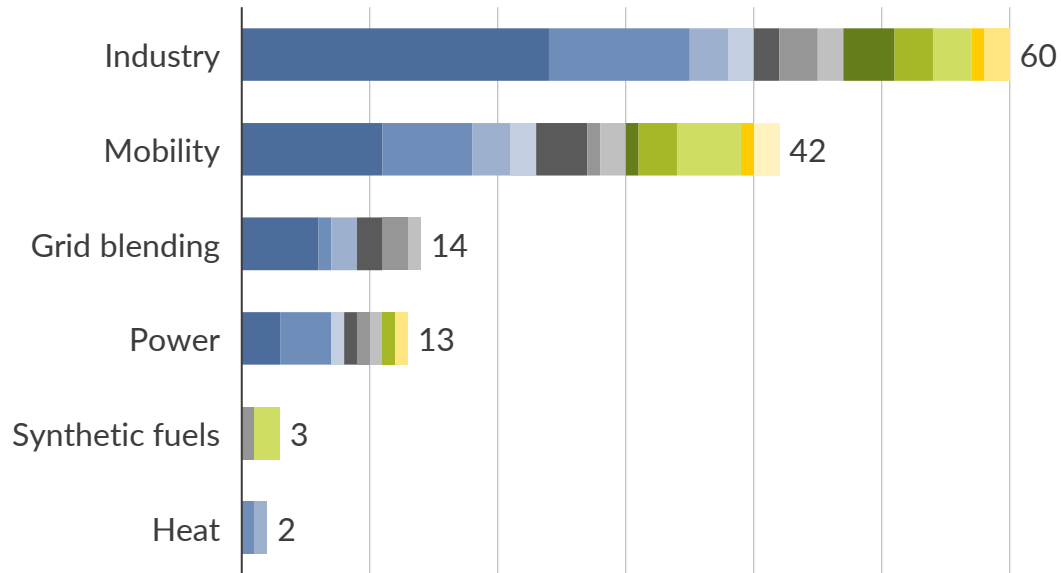
A large portion of the projects have an end use focus on mobility or industrial sectors

- European projects indicating an end use cover 32.4 GW out of 84.4 GW total capacity of projects excluding early stage projects
- More than half of projects including **industry** as the end user are located in Germany and the Netherlands
- No **grid blending** projects in the Nordics due to the limited natural gas grid

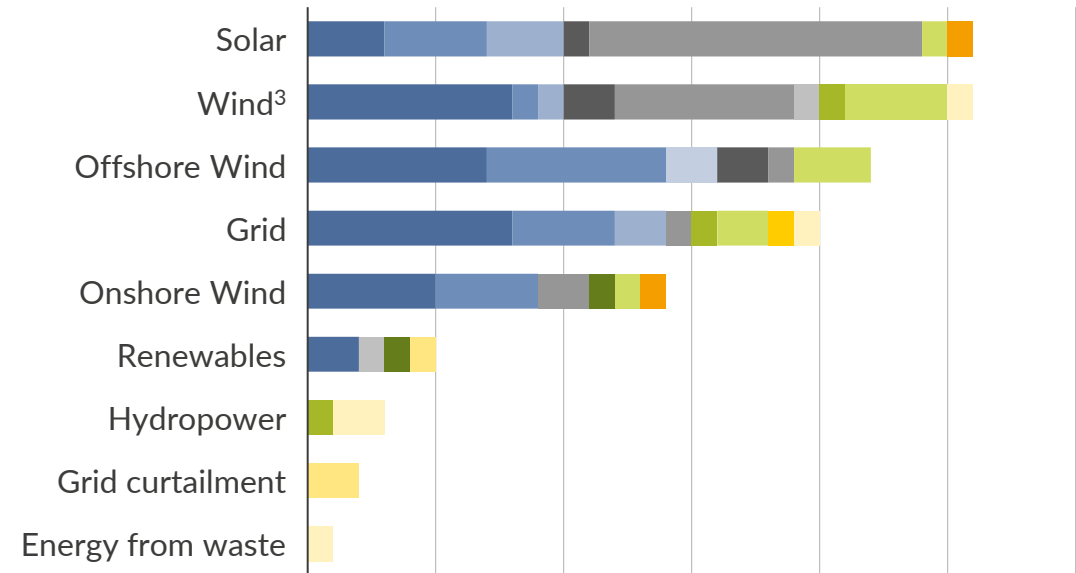
Only 46% of the European projects indicate the power source, most frequently wind or solar energy is chosen¹

- **Globally**, 132 projects indicate a power source², mostly located in **Europe**.
- **Wind energy** is mentioned in 62 projects within Europe, a quarter of which use offshore wind energy for hydrogen production
- **Solar energy** is chosen most frequently in Spain

Number of project by end use for European countries



Number of project by power source for European countries

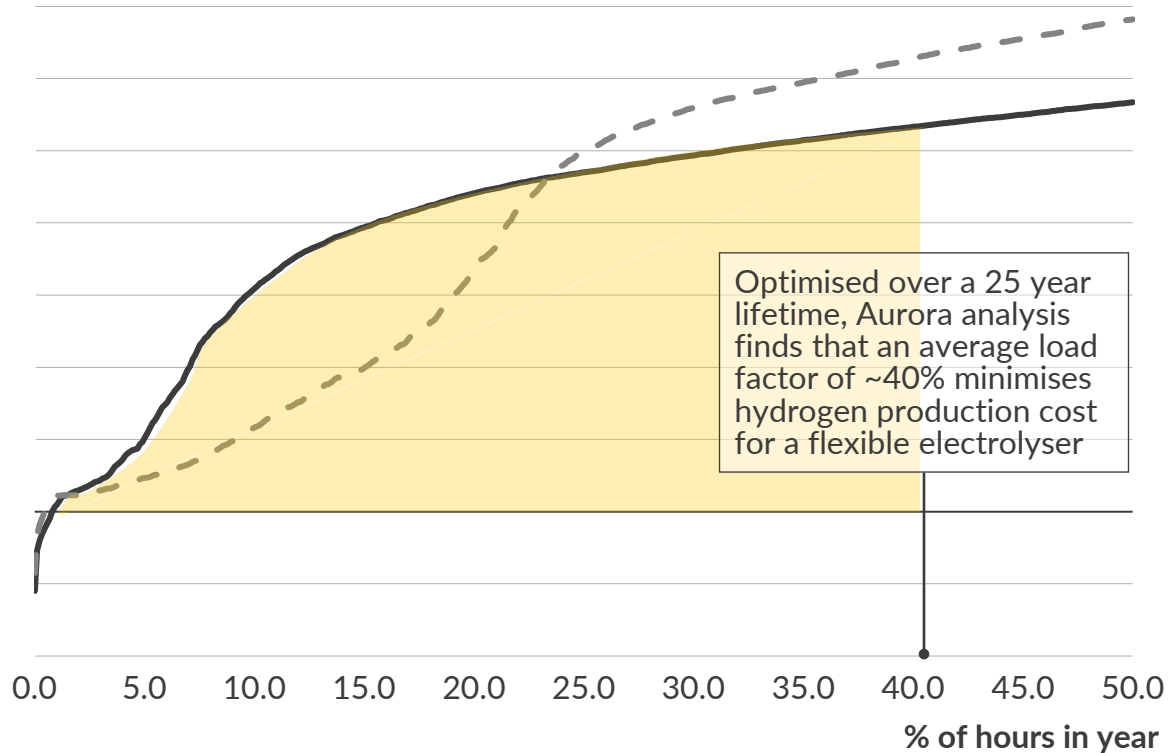


■ DEU ■ NLD ■ FRA ■ BEL ■ GBR ■ ESP ■ ITA ■ SWE ■ NOR ■ DNK ■ PRT ■ FIN ■ AUT ■ Others*

1) Some projects indicate multiple power sources 2) The database consists of 222 projects globally 3) Projects with unspecified wind resource (i.e. onshore vs offshore)

Grid-connected electrolysers can lower costs by producing during the cheapest 40% of hours; France has the lowest ‘bottom prices’

Chart showing bottom half of the price duration curve for GB in 2025 and 2035
EUR/MWh

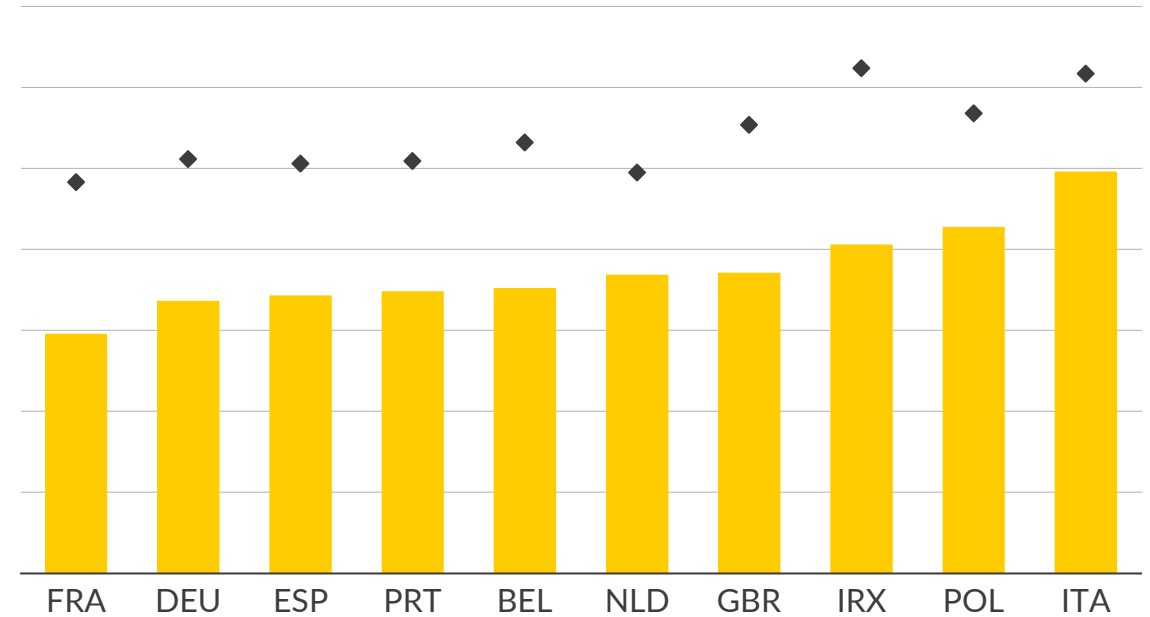


- A flexible electrolyser is able to operate at any number of hours, and chooses to run when power prices are cheapest
- The shaded area below the curve gives the cost of power for a flexible electrolyser; in 2035 it is substantially lower than in 2025

— 2025 - - 2035

1) Defined here as being the annual average of wholesale power prices below the 40th percentile

Average baseload and bottom prices¹ in the 2020s
EUR/MWh

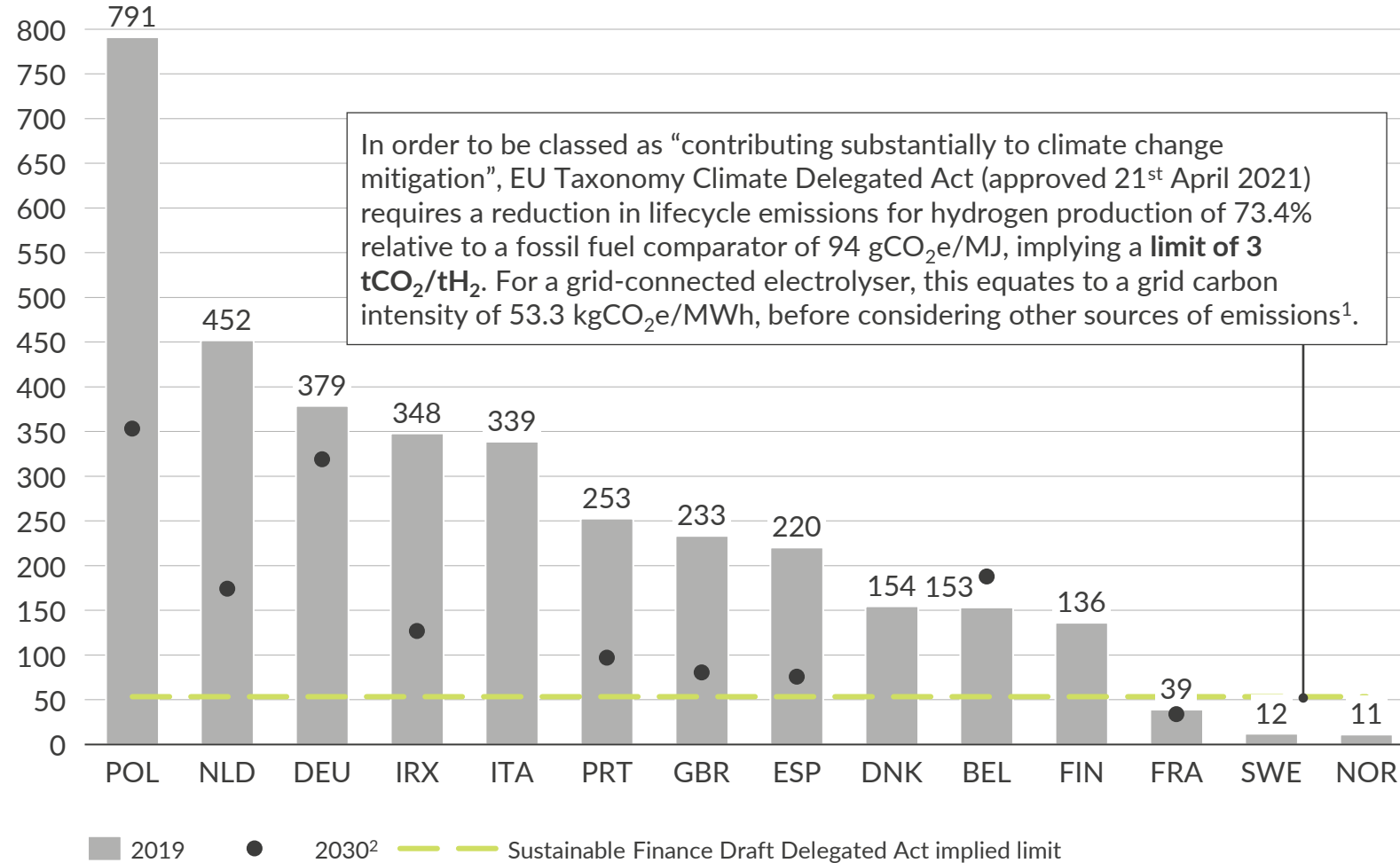


- Countries with strong intermittent renewables build such as France, Germany, Spain and Portugal will see the lowest bottom prices
- Flexible electrolysers still have to pay additional costs such as taxes, network costs and environmental levies
- Aurora's forthcoming Insight Report (June 2021) will focus on the optimisation of flexible and co-located electrolysers, to minimise production costs

◆ 2020s average wholesale price ■ Bottom price

Only three countries have sufficiently low grid carbon intensities to meet EU’s new low-carbon hydrogen threshold by inflexible electrolysis

Carbon intensity of power grid
kgCO₂e/MWh generation

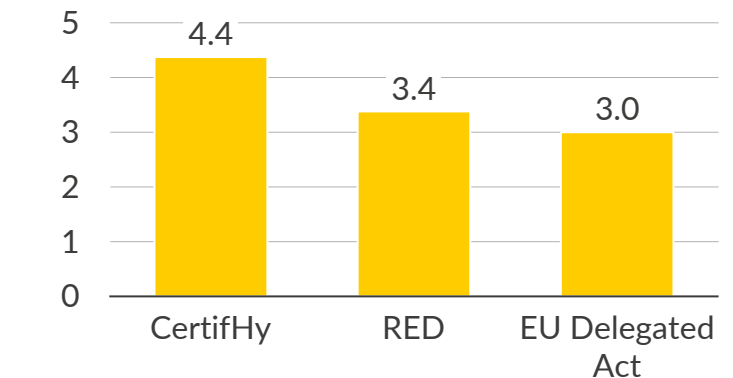


Definition of renewable hydrogen

The definition of renewable hydrogen is likely to be a key determinant in terms of eligibility for policy support.

Aurora's forthcoming Insight Report (June 2021) will analyse the carbon intensity of production from flexible electrolysers in key countries across Europe

Proposed thresholds for renewable hydrogen



1) For an electrolyser running at baseload capacity and 70% efficiency. Note that the EU emissions cap includes lifecycle emissions, therefore the actual grid carbon intensity threshold will be slightly lower. 2) Aurora Central forecast. Where blank, data is unavailable.

Takeaways



Germany remains the most attractive European country for investments in hydrogen.

Aurora's global electrolyser database shows 213.5 GW of electrolyser capacity is under development globally, of which 182.3 GW is within Europe. As such, Europe will remain a leading producer and distributor of hydrogen in the near term.



Italy, Finland, the UK, and Poland have all announced hydrogen strategies or other policies since the last HyMAR. Italy commits the most public funds (EUR10bn), and sets perhaps the most ambitious final energy from hydrogen penetration goal (20% by 2050). Italy's strategy also leverages its geography more aggressively than other European strategies published, positioning itself as a future Hydrogen distribution hub, importing from North Africa and leveraging its natural gas transmission network. New incentive schemes in Poland and the UK are expected to become available from 2022.



Hydrogen production via electrolysis remains expensive and existing support schemes offering cheap power or relief from taxes are unable to make green hydrogen competitive with blue – despite this, the countries with the largest potential hydrogen economies are pursuing rebate or exemption schemes, including the UK, Germany, and France. Co-location with renewables and innovative electrolyser business models will likely offer a solution to this in the longer-term.

Details and disclaimer

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Date

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Prepared by

Dilara Caglayan

dilara.caglayan@auroraer.com

Nicholas Symons

nicholas.symons@auroraer.com

Caspar Whitehead

caspar.whitehead@auroraer.com

Approved by

Richard Howard

richard.howard@auroraer.com

Anise Ganbold

anise.ganbold@auroraer.com

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