Hydrogen policy and market overview in Europe

28 April 2025

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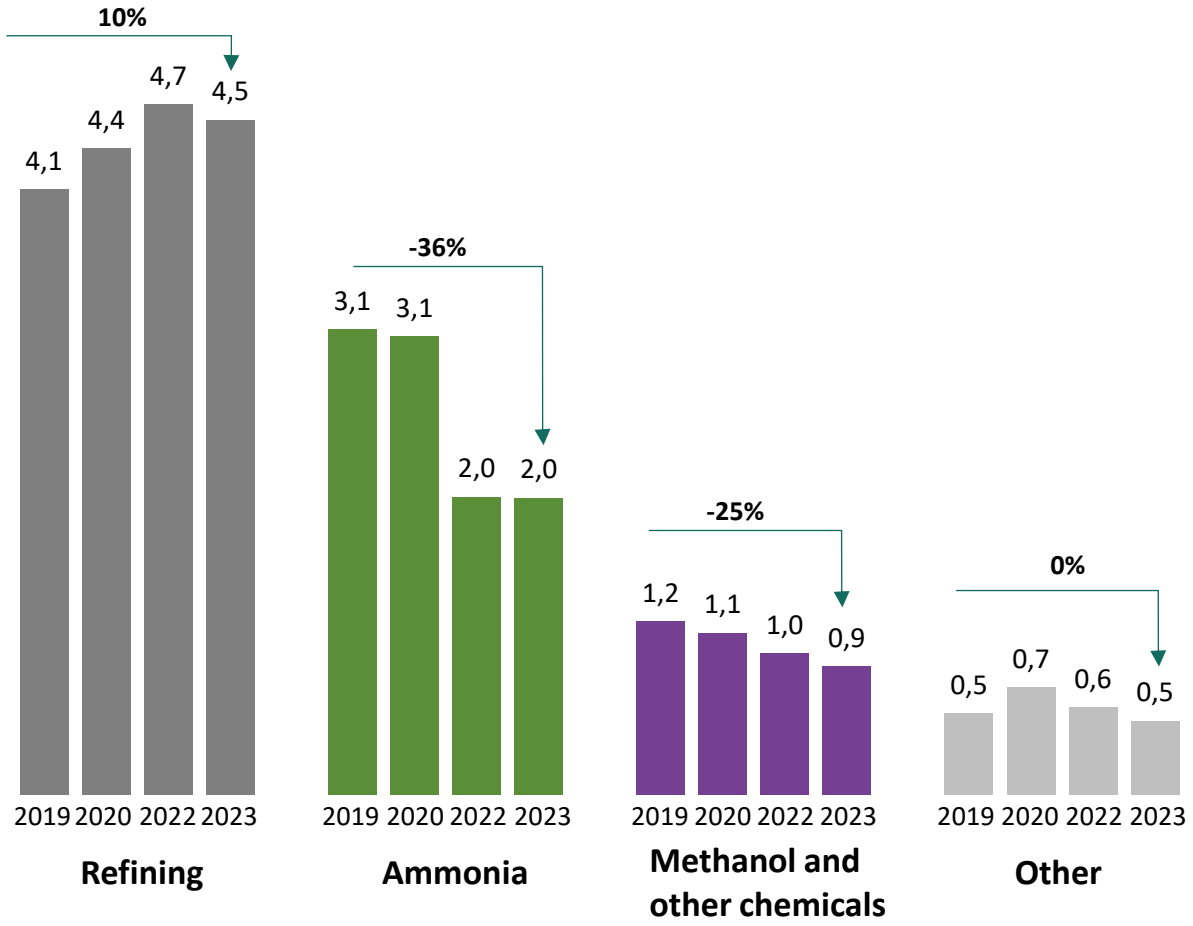
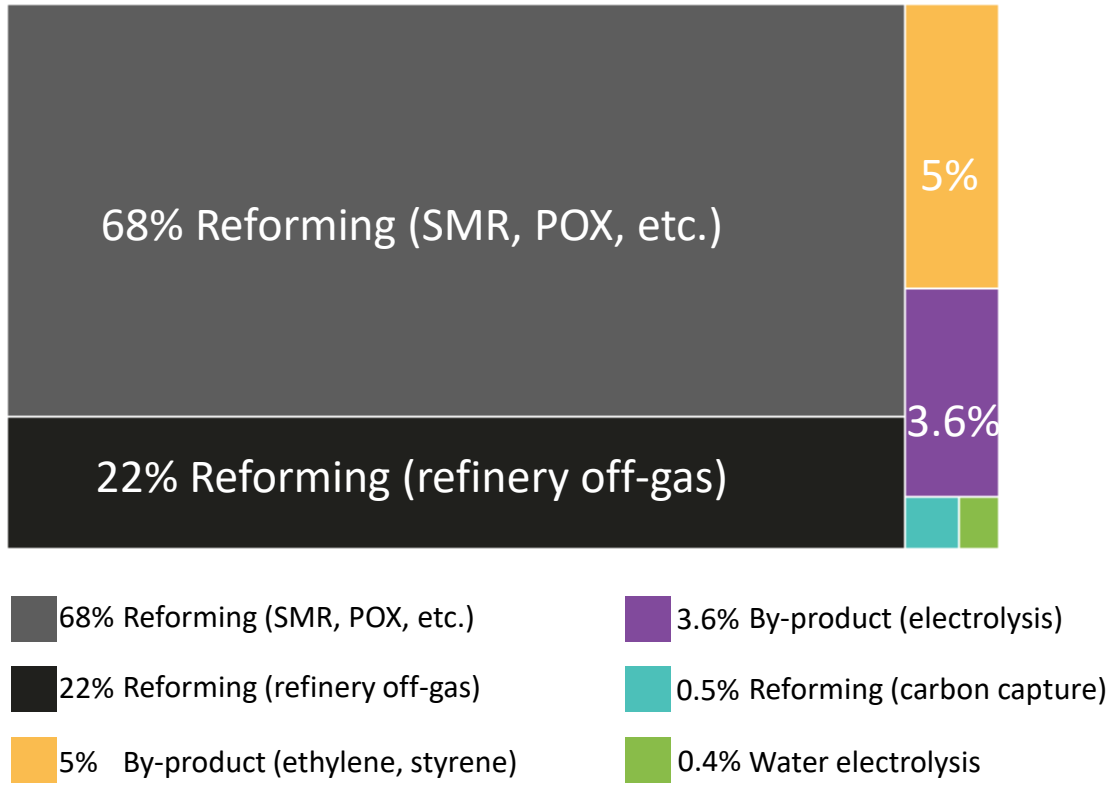
Hydrogen Europe

7.9 Mt of hydrogen was consumed in 2023 but its consumption has not yet recovered after the gas prices increases in 2022

European hydrogen demand per sector 2019-2023 (Mt)



Hydrogen production capacity in 2023 in Europe by production process (% of total)

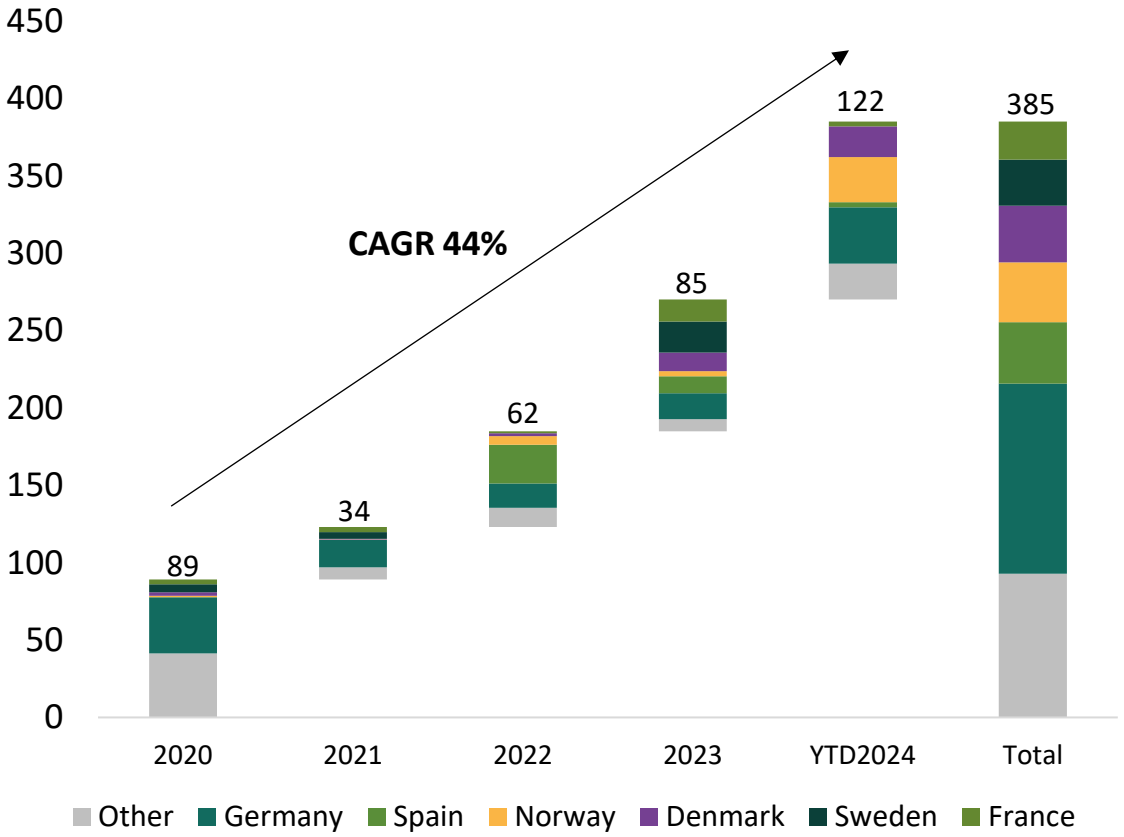


Notes: 2021 values are not available as Hydrogen Europe did not estimate hydrogen demand for that year. Total hydrogen demand in refining includes 2.5 Mt of dedicated hydrogen production and 2.0 Mt by-product hydrogen produced during refining processes and ethylene/styrene production. "Other" as an end-use refers to hydrogen used in industrial heating, mobility and unknown applications.

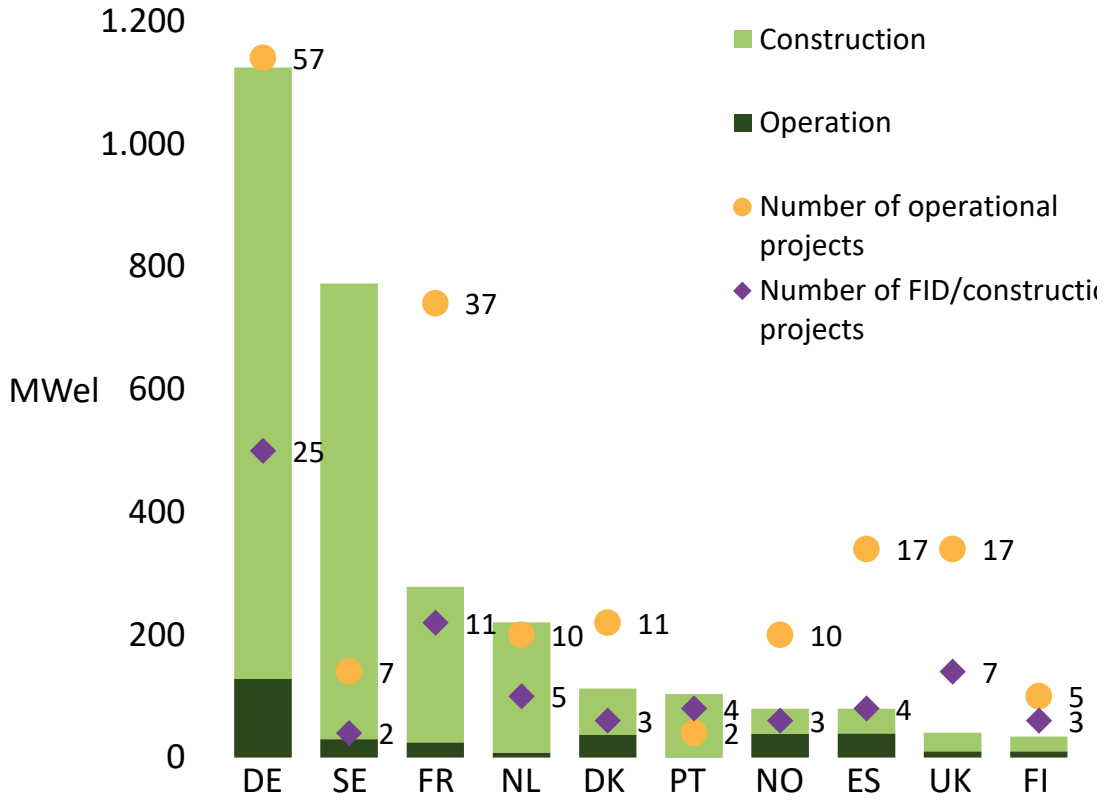
Source: Hydrogen Europe

Electrolyser capacity in Europe more than doubled in the past two years, but only 3% of the project pipeline capacity is under construction (2.6 GW_{el})

Installed and operational water electrolysis capacity installed in (MW_{el}) by Sept 2024



Top 10 countries in Europe with largest operational and under construction water electrolysis capacity and number of projects by September 2024 (MW_{el})

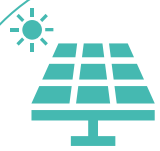


Notes: Actual capacity is slightly higher due to untracked small-scale electrolysers of less than 0.3 MW.

A framework to reach demand targets

Regulatory certainty framing the functioning of the market

2030 Targets



RED III

Renewables energy targets, **RFNBOs binding targets in industry and transport**

RED III

- Industry: 42% of all H2 consumed from **RFNBO**
- Transport: 5.5 % adv biofuels + RFNBO (1% min RFNBO)

ReFuel Aviation

Quotas for **sustainable aviation fuels (SAF) and specific quotas for synthetic fuels**

ReFuel Aviation

- 6% Sustainable aviation fuels
- 1.2% **synthetic fuels** (RFNBO + LC electricity H2)

FuelEU Maritime

GHG saving targets and **specific quotas for RFNBOs**

FuelEU Maritime

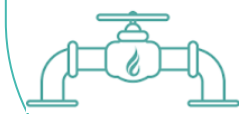
- 6% GHG savings through low carbon fuels. Multipliers for H2
- 1% RFNBO by 2031, 2% RFNBO by 2034

CO2 Standards for Light & heavy duty vehicles

Targets for the share of new sales of zero emissions

CO2 Standards for LDVs and HDVs

- LDVs: -55% for cars, -50% for vans (-100% by 2035)
- HDVs: -45% for trucks (90% by 2040), -90% for urban buses



Gas & hydrogen Package

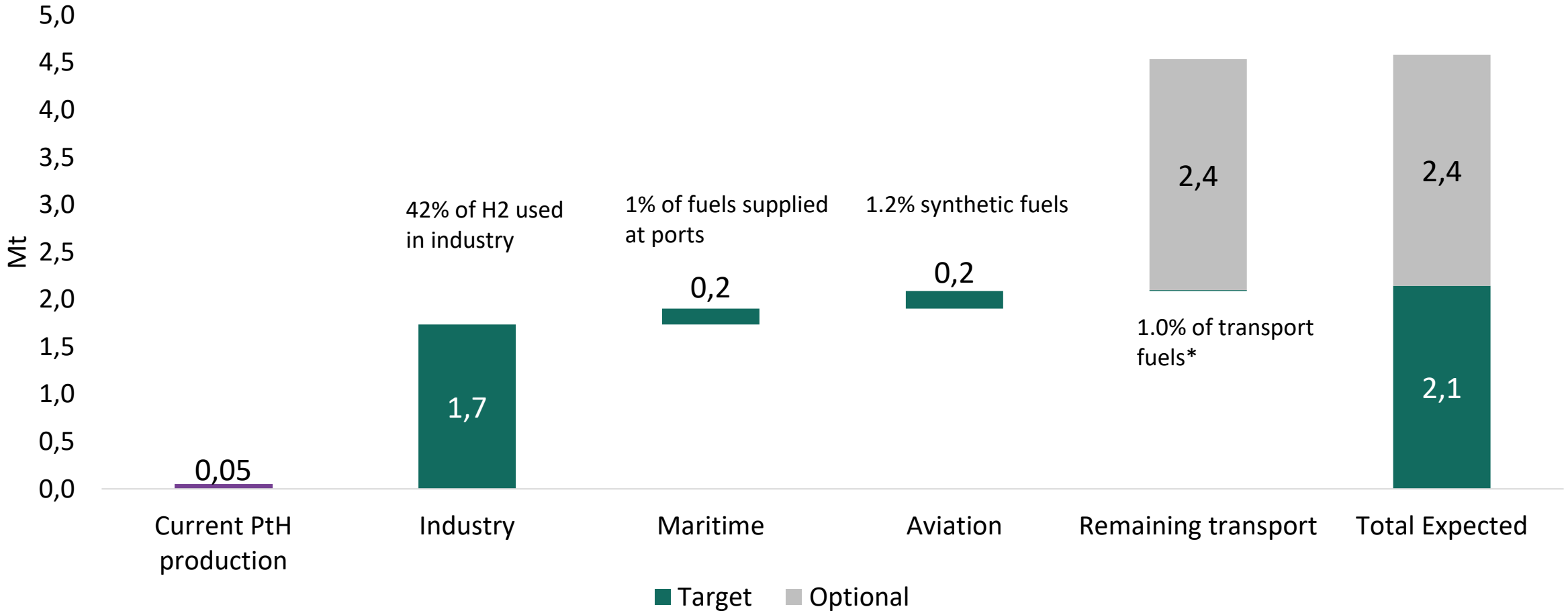
H2 Grid development (TYNDP) and operational rules, creation of ENNOH

Gas & hydrogen Package

- Low carbon Hydrogen *(NO TARGET)*
- Blending allowance, gas quality

If implemented in its full force, dedicated targets in industry and transport will drive demand of RFNBO to a minimum of 2.1 Mt by 2030

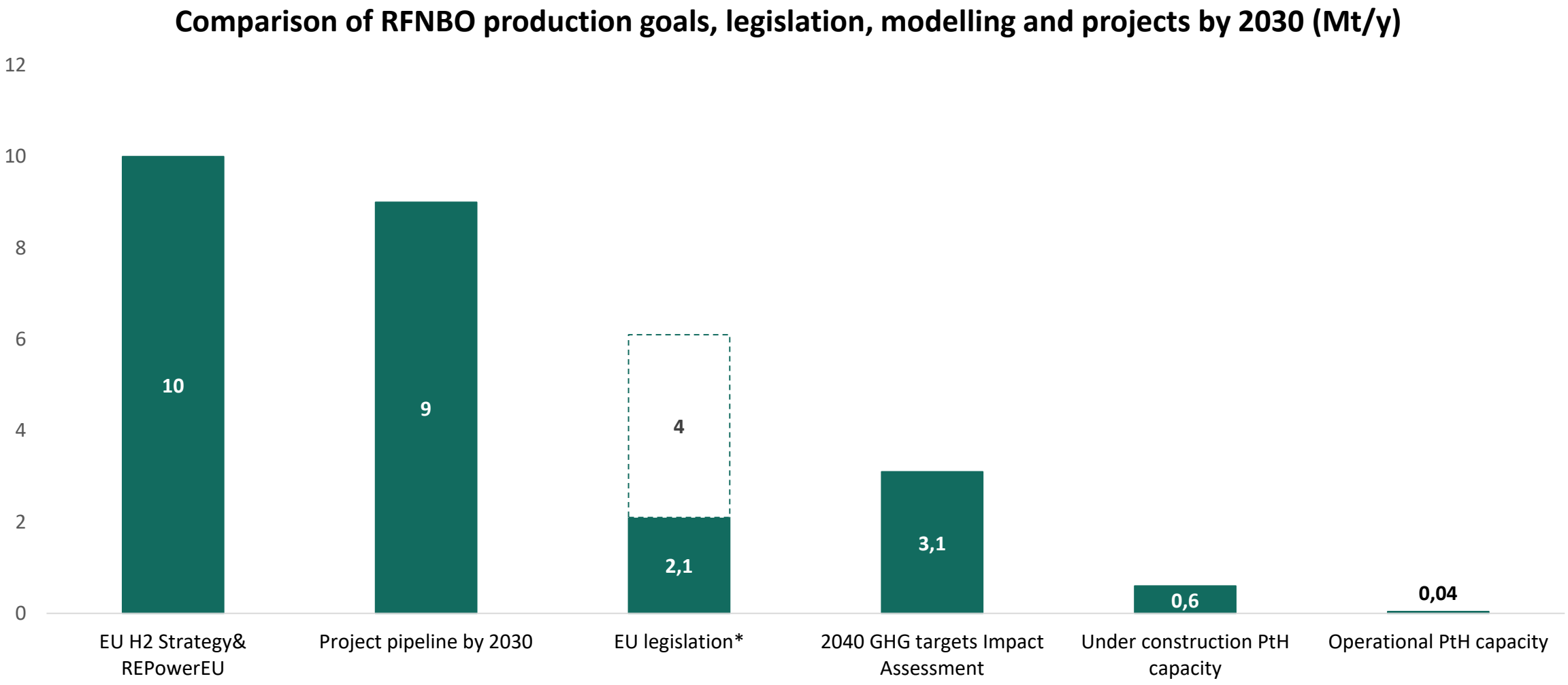
Estimated regulatory RFNBO demand in 2030 if targets are transposed on national levels (Mt)



*1% RFNBO in transport fuels with a x2 multiplier - i.e. effectively 0.5% RFNBO share

Source: Hydrogen Europe

Early goals and objectives are not supported by legislation while current market deployment is lagging behind



Notes: *2.1 Mt estimated RFNBO production required to cover RED III industry and transport targets considering current consumption and potential 4 Mt reflecting the remaining part of the RED III combined targets for RFNBOS and advanced biofuels and use of RFNBO in the steel sector
Source: Hydrogen Europe

A framework to reach demand targets

Regulatory certainty framing the eligible hydrogen-based fuels

Renewable Fuels of Non-biological origin (RFNBO) – Renewable Energy Directive

Additionality

- Additionality from 2028 (36 months rules), derogation until 2038, then unsupported RES generation
- Geographical correlation
- Monthly correlation until 2030, then hourly

Emissions:

<3.4Kg CO2/ Kg H2 (>70% of GHG savings)

Certification schemes already in place

Low carbon H2 (Gas& H2 Directive)

Characteristics

- Non-renewable sources (Natural gas, low-carbon electricity)
- Includes upstream emissions (methane regulation)
- **DEBATE: PPA with low-carbon electricity sources/ timeframe for emissions accounting**

Emissions:

<3.4Kg CO2/ Kg H2 (>70% of GHG savings)

Expected by summer 2024

Different production pathways offer unique benefits from sector coupling to locally based decarbonisation

Hydrogen Europe

	Water electrolysis	Reforming with carbon capture	Methane splitting	Biowaste-to-hydrogen	Non-biological waste-to-hydrogen
Main feedstock or energy input	Electricity	Natural gas	Natural gas	Biowaste	Non-biowaste
Technology	Water electrolysis	Reforming with carbon capture	Pyrolysis	Gasification/pyrolysis	Gasification/pyrolysis
Unique technology benefits	- Coupling electricity and gas sectors - Grid flexibility - Delivering renewable electricity to hard to electrify sectors - Unleashing stranded renewable energy and transport it between regions	- Large scale - Available feedstock supply - Mature technology allows rapid delivery of low-carbon hydrogen for decarbonisation	- Large scale potential; - Available feedstock supply - Zero direct emissions without need for additional infrastructure - Supply of solid carbon.	- Utilising available local biowaste feedstocks; -Abating otherwise unabated emissions; - Carbon removal potential; - Promoting locally based decarbonisation	- Availability of local non-recyclable waste; - Promoting locally based decarbonisation - Contribution to waste management

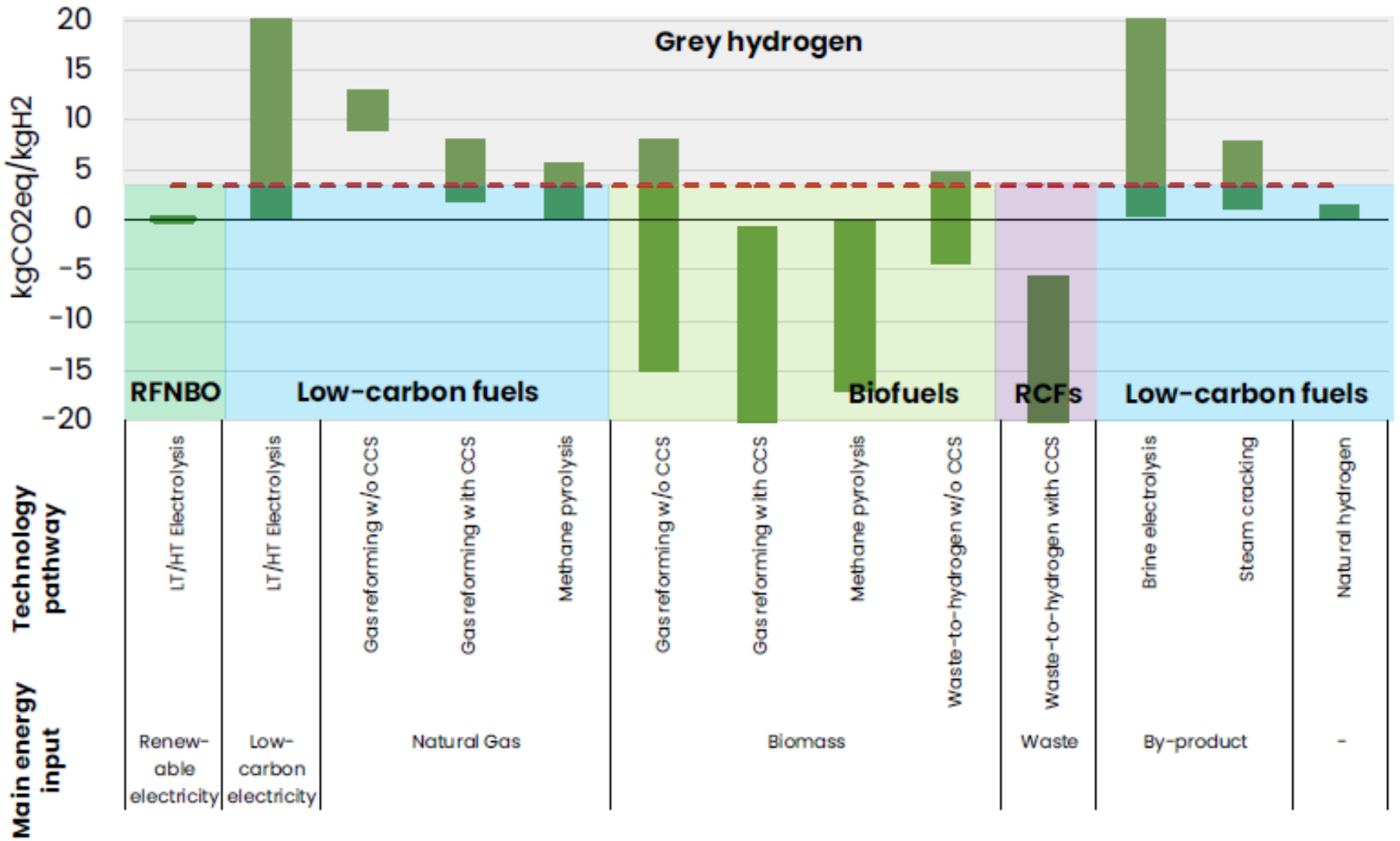
All analysed production pathways can have a substantial positive contribution towards climate change mitigation

All of the pathways can produce hydrogen with a carbon intensity below 3.4 kgCO2/kgH2 – in line with EU sustainable finance taxonomy and the Fit-for-55 package definitions.

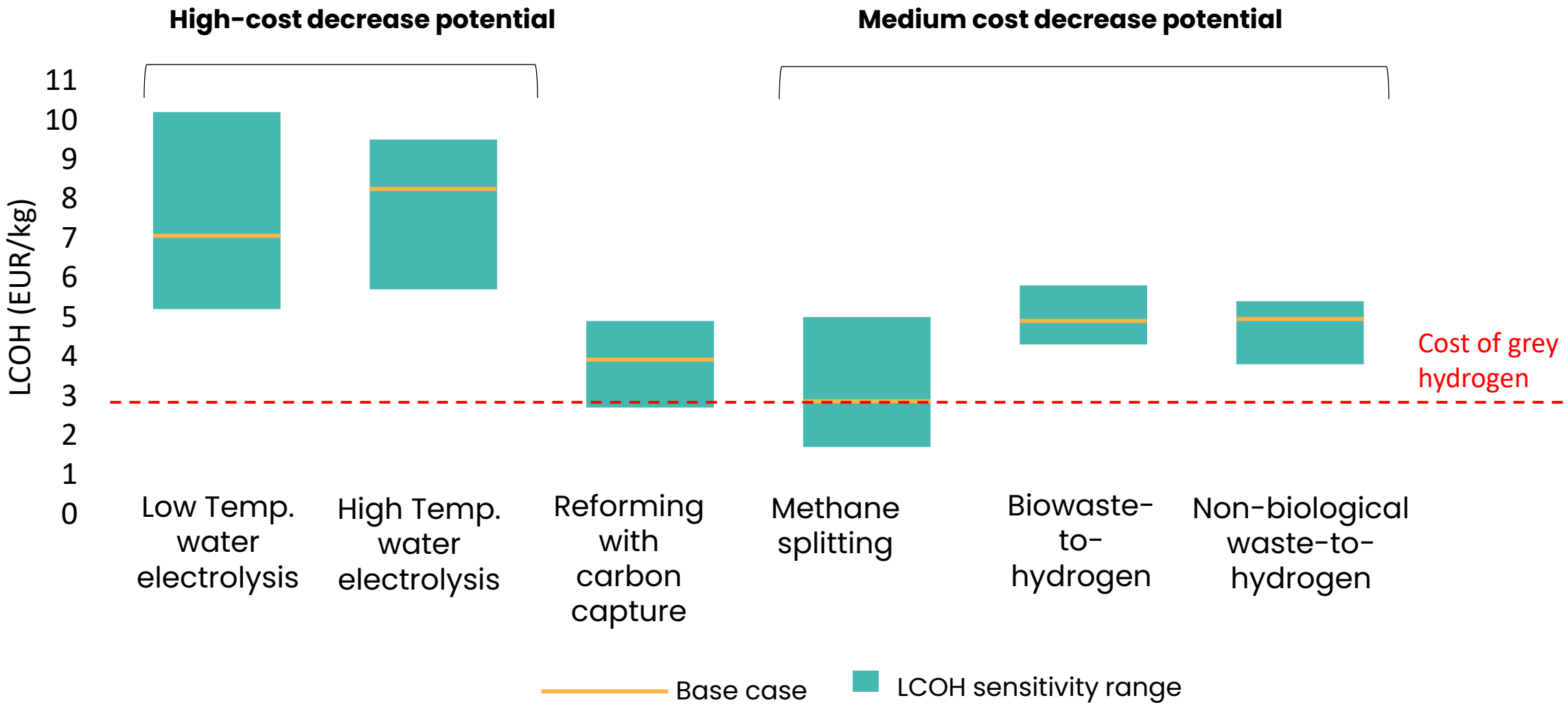
Waste and biomass feedstocks can even lead to negative emissions.

BUT for some pathways the emission intensity can be significant – even exceeding emissions from unabated natural gas reforming (i.e. grey hydrogen).

It is therefore of utmost importance to design a strong regulatory framework, which would promote sustainable solutions, while, at the same time, not create unnecessary investment barriers – as has happened with renewable electrolytic hydrogen.



Clean hydrogen production costs are between 1.7 and 10.2 EUR/kg. Water electrolysis is most expensive pathway today but presents largest cost reduction potential



Note: LCOH stands for Levelized Cost of Hydrogen

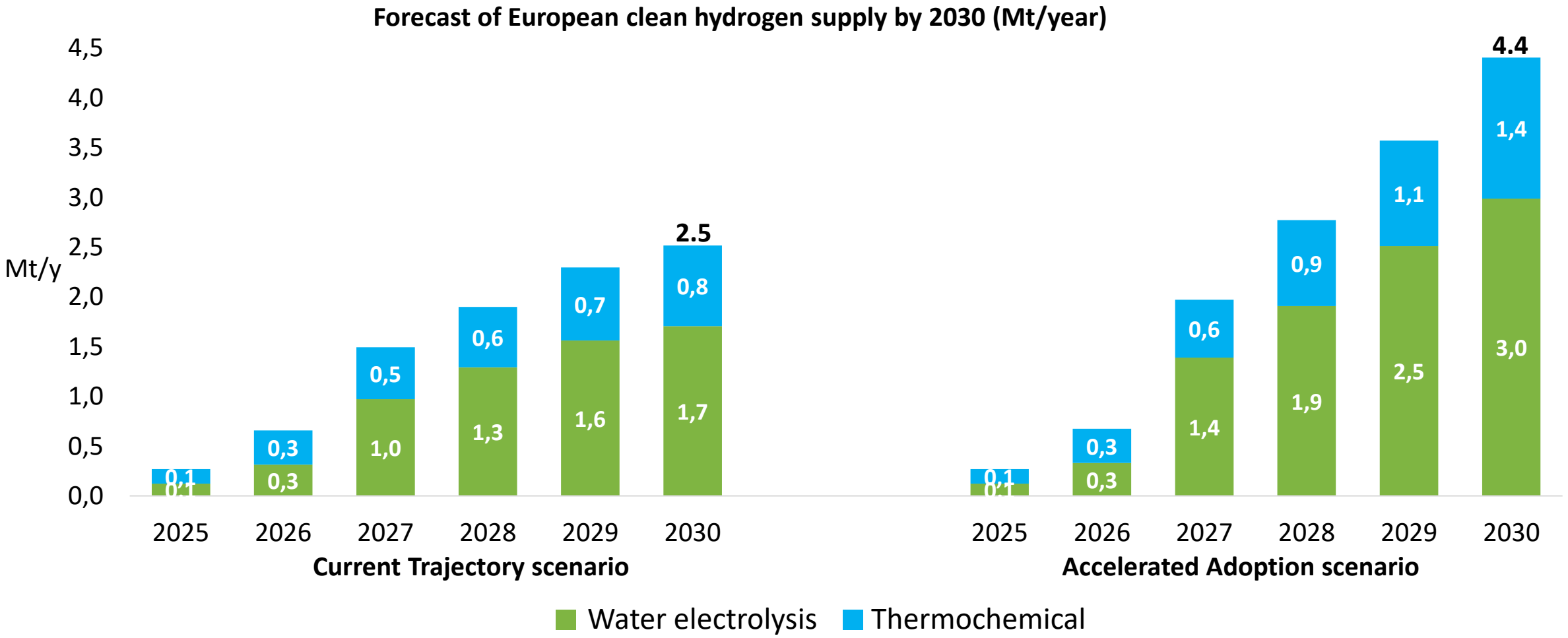
RFNBO hydrogen is currently prioritised by EU policy and funding schemes

Hydrogen Europe

Clean hydrogen fuels play different roles depending on each regulation and target. RFNBOs enjoy highest priority and dedicated targets across all sectors. Fossil-based low carbon fuels can only contribute to maritime sector

	RED transport targets				RED industry targets	RefuelEU Aviation targets		FuelEU Maritime targets	
	1% RFNBO target	5.5% sub-target with advanced biofuels	Overall RES target (29%)	GHG reduction target	42% RFNBO target	Synthetic aviation fuels (1.2% by 2030)	SAF (6% by 2030)	RFNBO (1% by 2030)	GHG reduction target
RFNBO	x2 multiplier x1.5 multiplier for aviation and maritime			YES	YES	YES	YES	YES	X2 multiplier until 2033
Bio-hydrogen (advanced)	NO	YES	YES	YES	NO	NO	YES	NO	YES
Bio-hydrogen (1st gen)	NO	NO	YES (limited)	YES	NO	NO	NO	NO	NO
Low-carbon	NO	NO	NO	NO	NO	NO	NO	NO	YES
Low-carbon non-fossil	NO	NO	NO	NO	NO (but can reduce the target)	YES	YES	NO	YES
RCF	NO	NO	YES (if the MS choses to do so)	YES (if the MS choses to do so	NO	NO	YES	NO	YES
By-product	NO	NO	NO	YES (if low-carbon)	NO (but reduces the target)	NO	YES (if low-carbon)	NO	YES (if low-carbon)

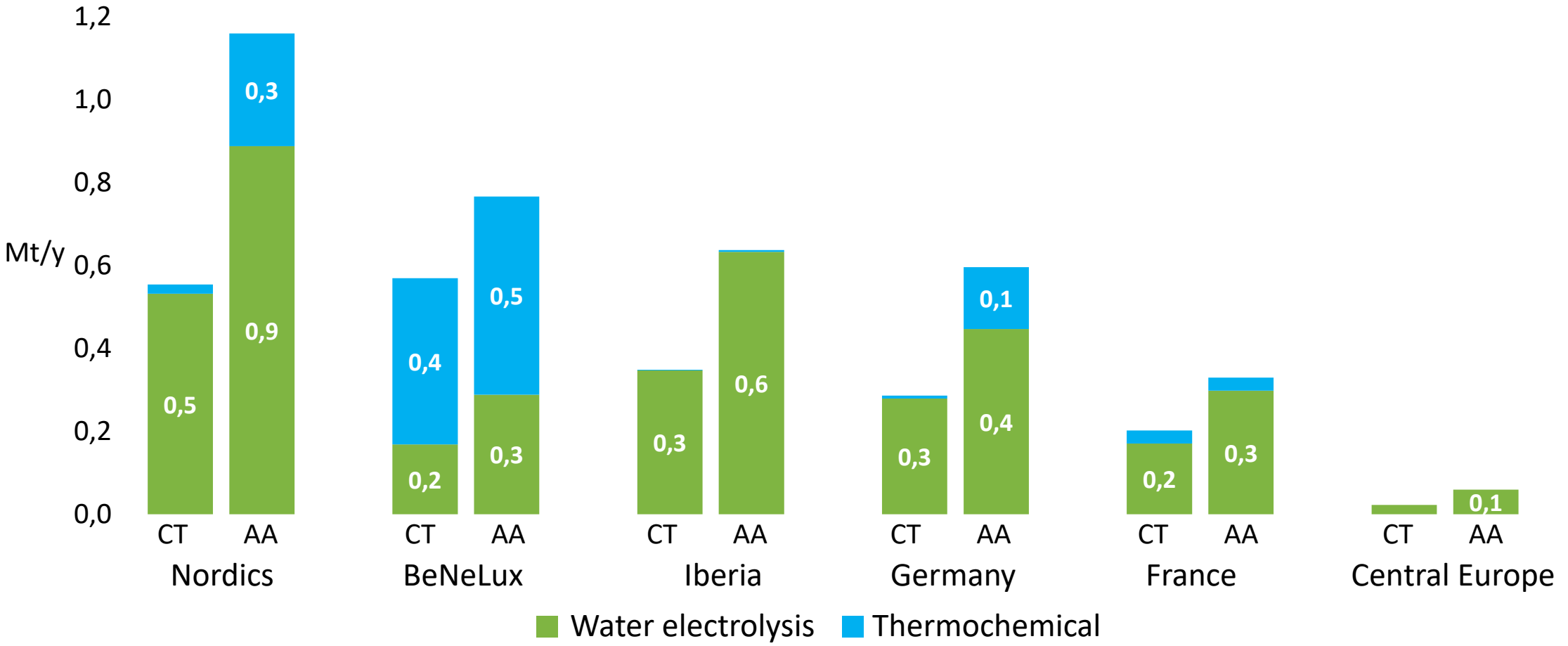
Europe can expect a supply of 2.5 to 4.4 Mt of clean hydrogen by 2030, driven by regulatory demand but highly dependent on regulatory constraints, access to funding, and the development of pan-European infrastructure



Notes: Methodology and terminology explanations can be found in the Clean Hydrogen Monitor 2024 report.

Nordics and Iberia lead the supply of electrolytic hydrogen by 2030 in both scenarios while most thermochemical volumes are expected in BeNeLux and UK

Clean hydrogen supply by 2030 in selected regions under Current trajectory (CT) and Accelerated Adoption (AA) scenarios

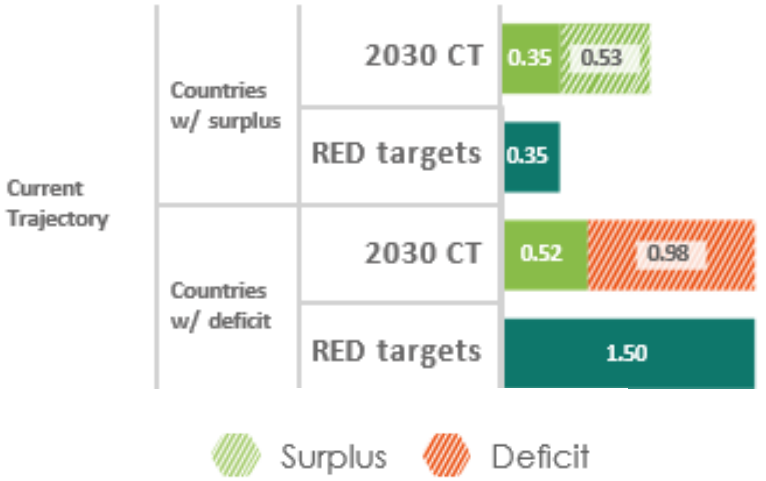


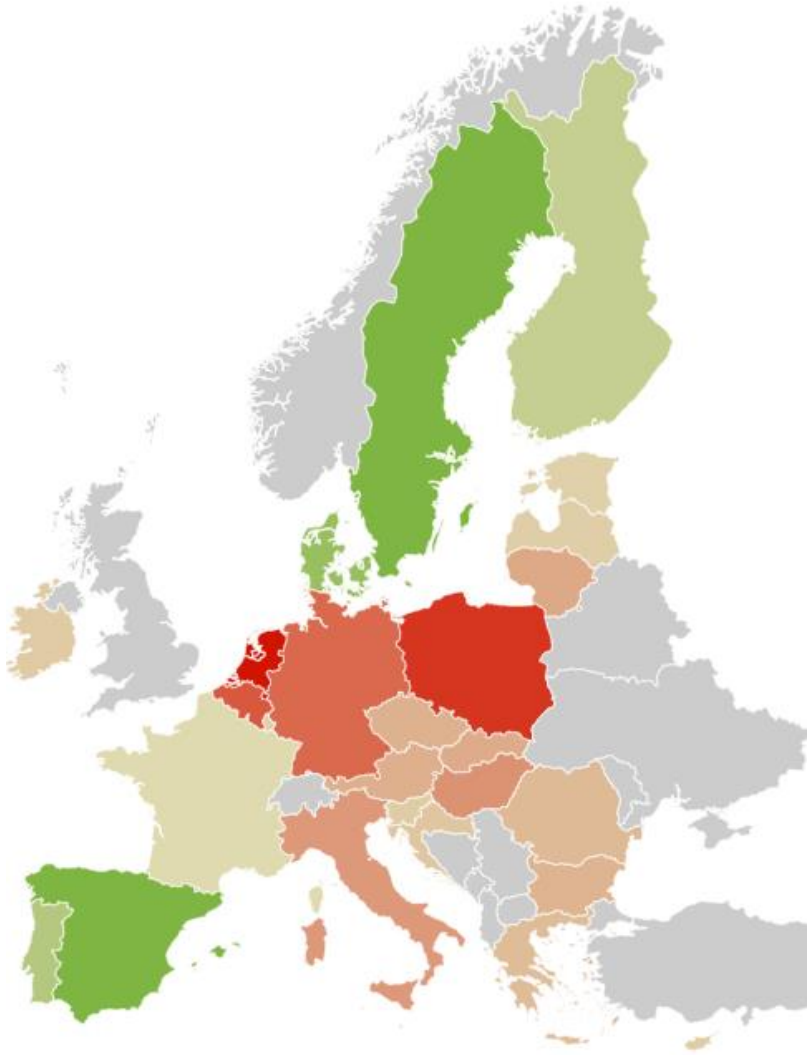
Notes: Nordics includes Denmark, Finland, Norway, and Sweden; Iberia includes Spain and Portugal; Central Europe includes Poland, Czechia, Slovakia, Hungary

Hydrogen trade could enable achieving Europe's 2030 RED3 targets if the infrastructure is built on time to support trade flows from within and outside Europe

- Compliance with **RED3** could require around **1.85 Mt of RFNBO by 2030**.
- However, targets must be met at Member State level and results show varying progress across countries.
- Infrastructure is key
- Imports are key

Hydrogen supply deficit and surplus relative to the minimum RED3 targets. The map shows results for the Current Trajectory scenario (Mt/year)

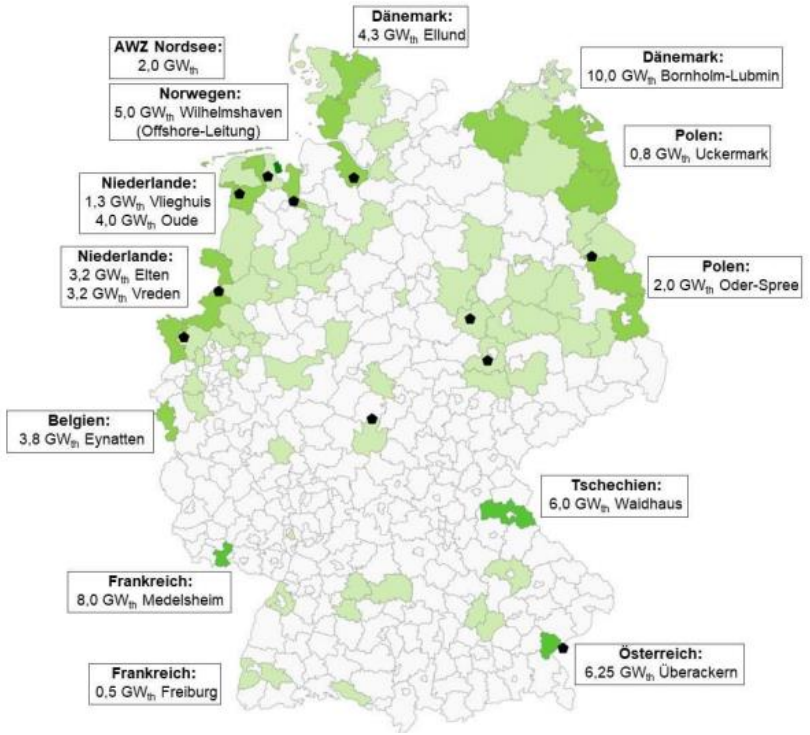


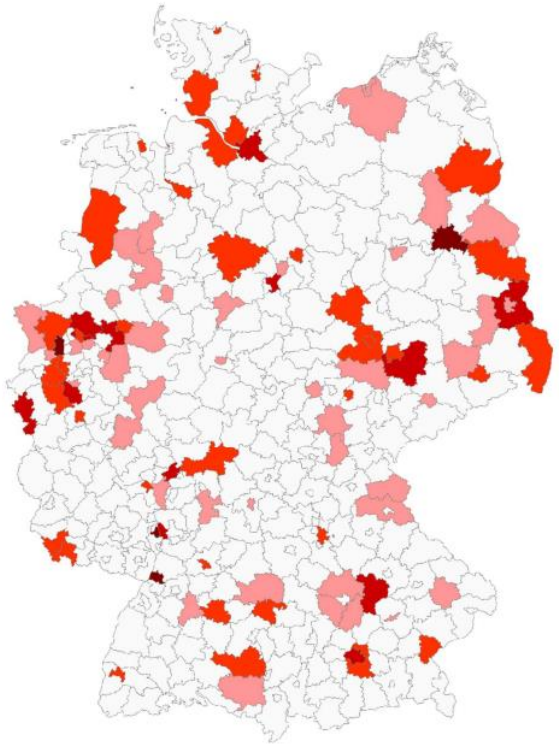


Notes: RED3 targets are calculated based on 2023 consumption and do not omit any volumes from the target due to specific exclusions. For the purposes of this calculation, electrolytic hydrogen supply from the two scenarios equals RFNBO hydrogen supply.

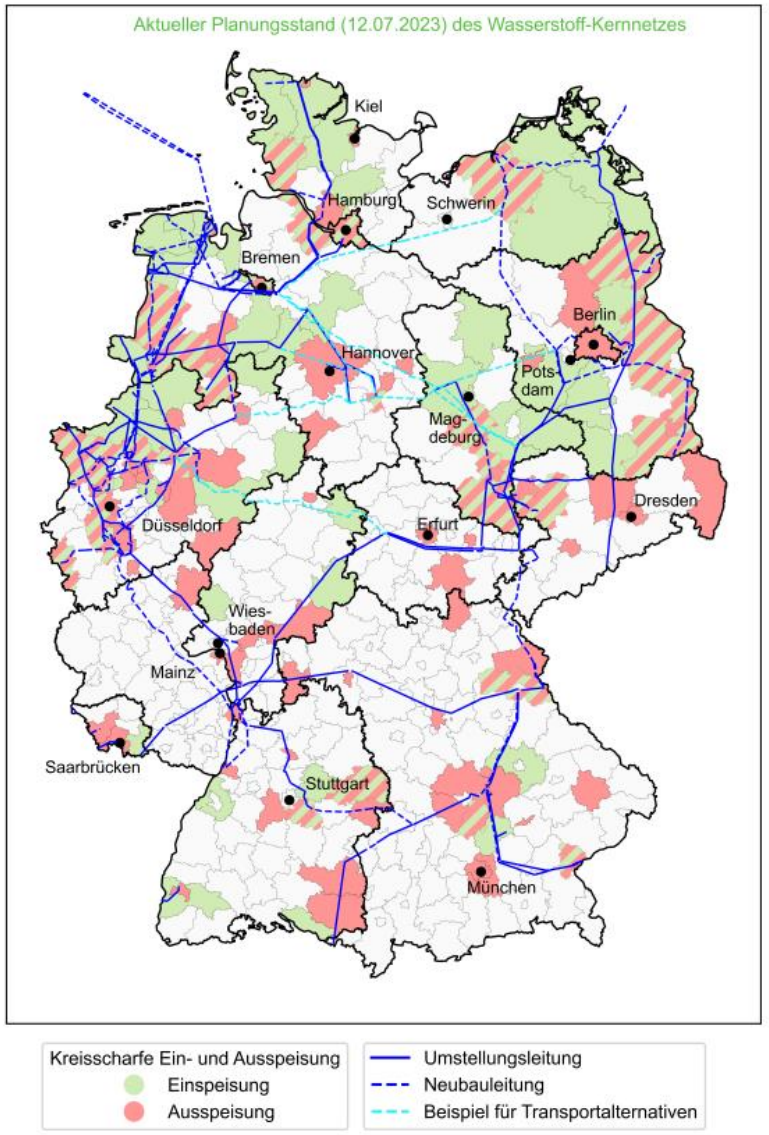
The German CORE hydrogen network

Planning status of the CORE network





Supply vs demand centers

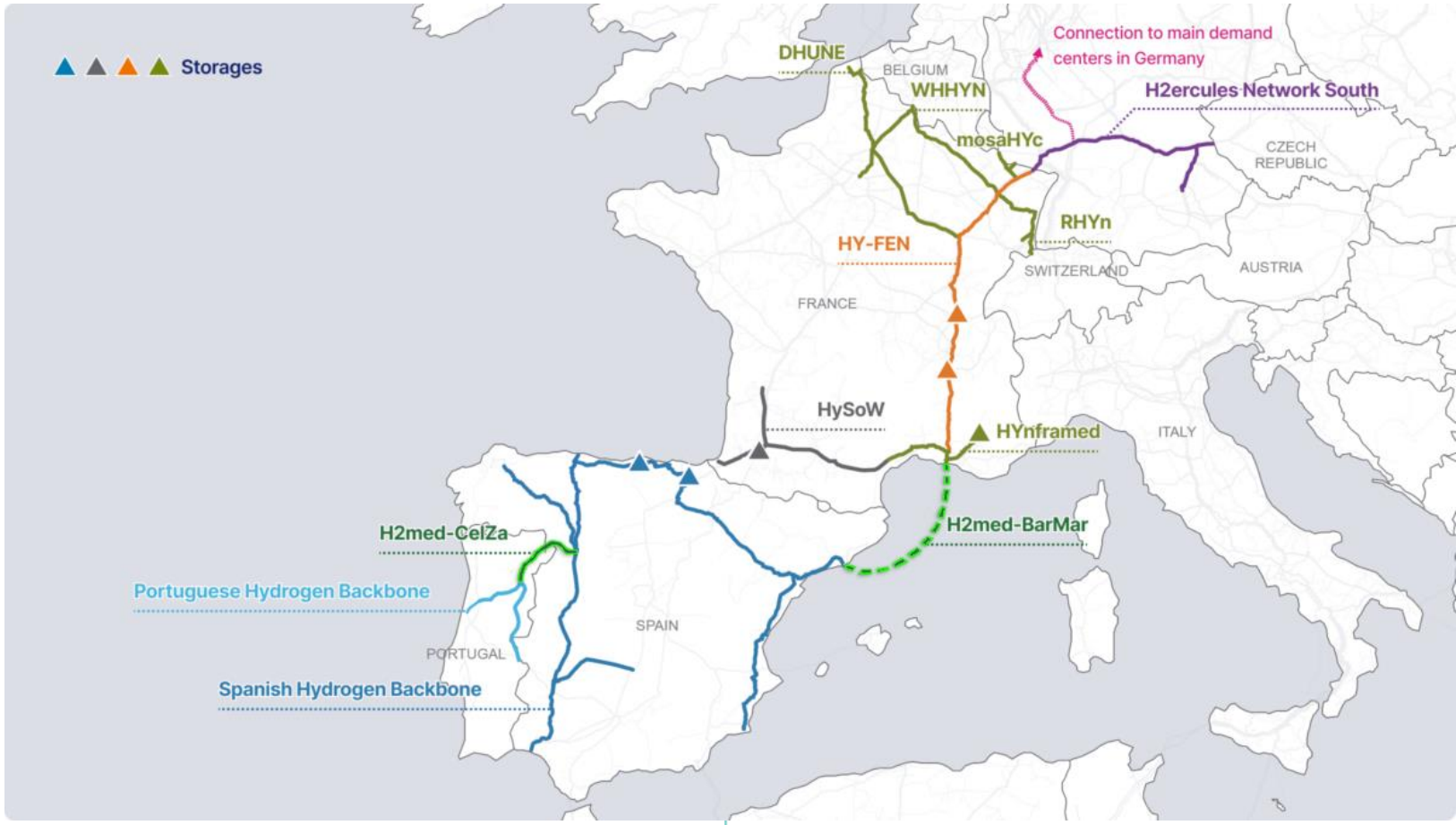


- **11.000 km** network length
- 60 % to be **repurposed**, 40 % to be constructed newly
- Total feed-in capacity of 101 GW, total exit capacity of 87 GW

Planning a Pan-European Hydrogen network

- Strong outcomes from the Call for Interest
- Support received as Project of Common Interest
- Challenges remain regarding the transposition of the Gas package, and coordination among countries/ funding design

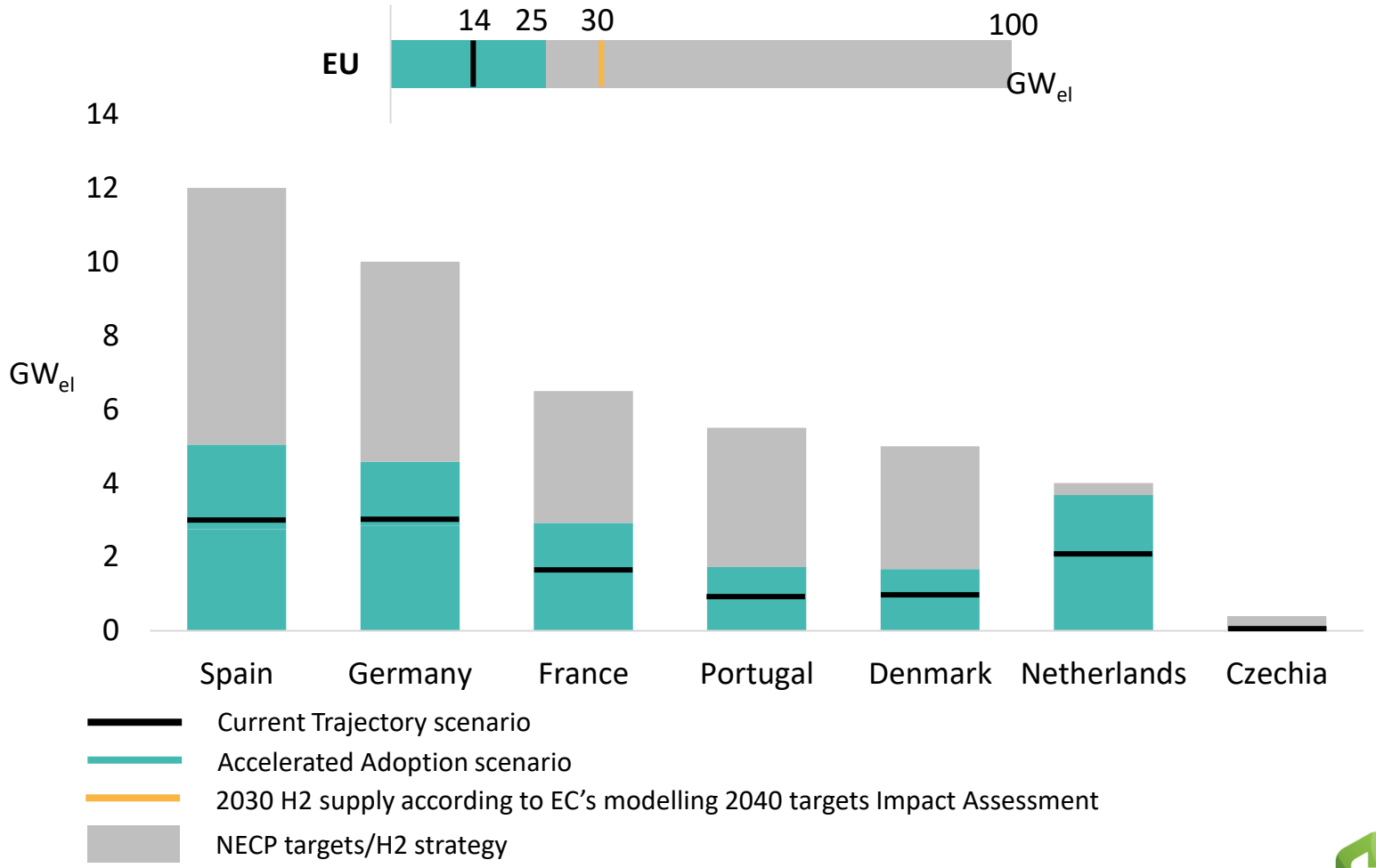
H2MED Project



The supply outlook across the EU is far from reaching national and EU ambitions, more efforts are needed to ramp-up the clean hydrogen market

Comparison of NECPs, EU Hydrogen Strategy, and electrolytic supply scenarios by 2030

- most countries' NECPs have significantly higher objectives than what is likely to be deployed.
- Ambitious goals are set, and this is very positive, but existing market and regulatory conditions are not sufficient to trigger the needed investments in clean hydrogen.
- Most countries will likely achieve only 30–40% of their NECP ambition by 2030.

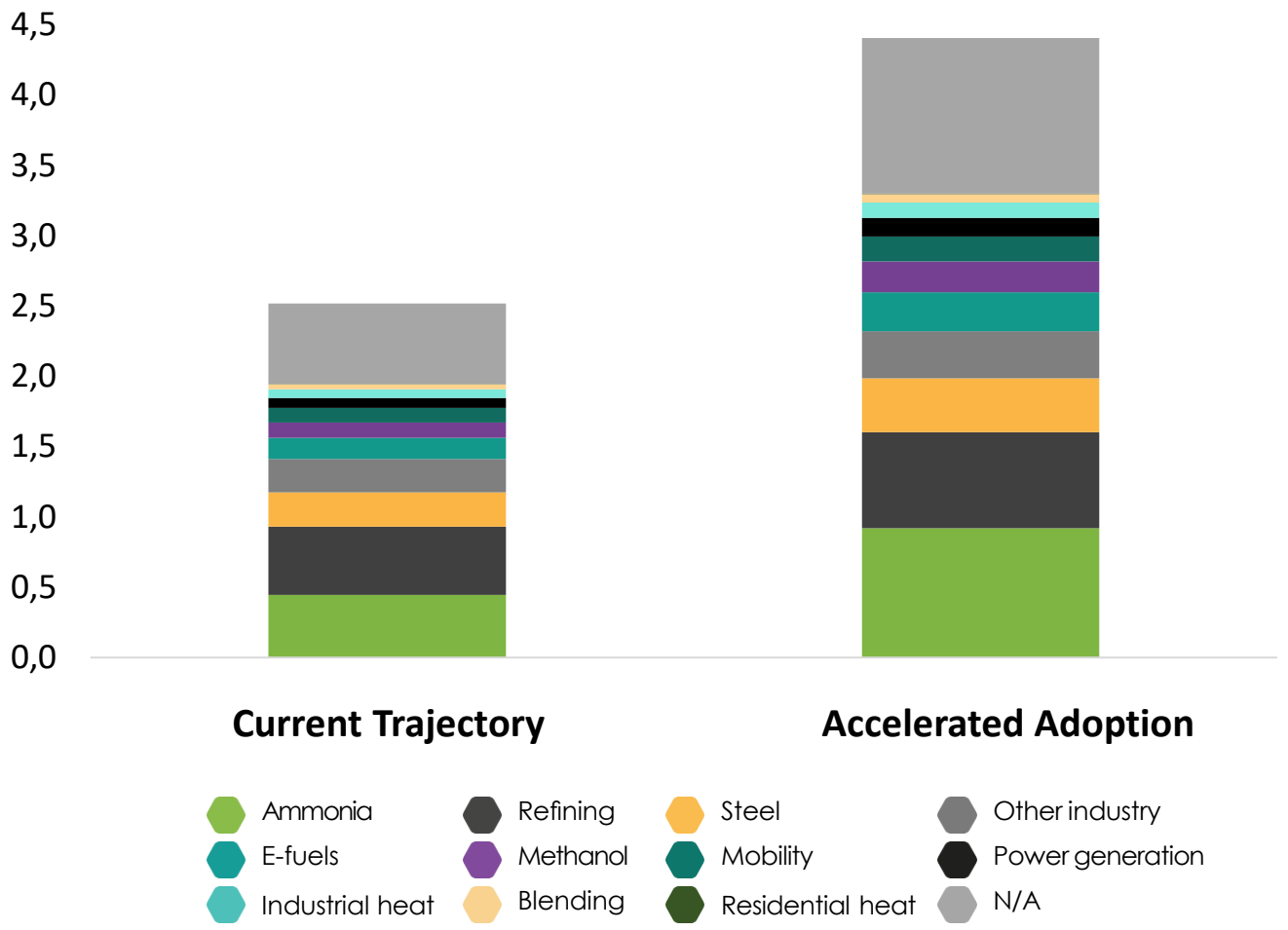


Notes: Europe's 2040 climate targets document refers to the "Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society" communication. The European Commission's modelling forecasts 3.15 Mt per year of renewable hydrogen supplied by 2030, for which this report assumes 30 GW_{el} of installed electrolyser capacity to be needed. The EU Hydrogen Strategy calls for the supply of at least 40 GW in hydrogen output and up to 10 Mt by 2030, for which 100 GW_{el} of installed electrolyser capacity would be required.

Ammonia, refining, and steel constitute ~45% of the declared end-uses in the two supply scenarios

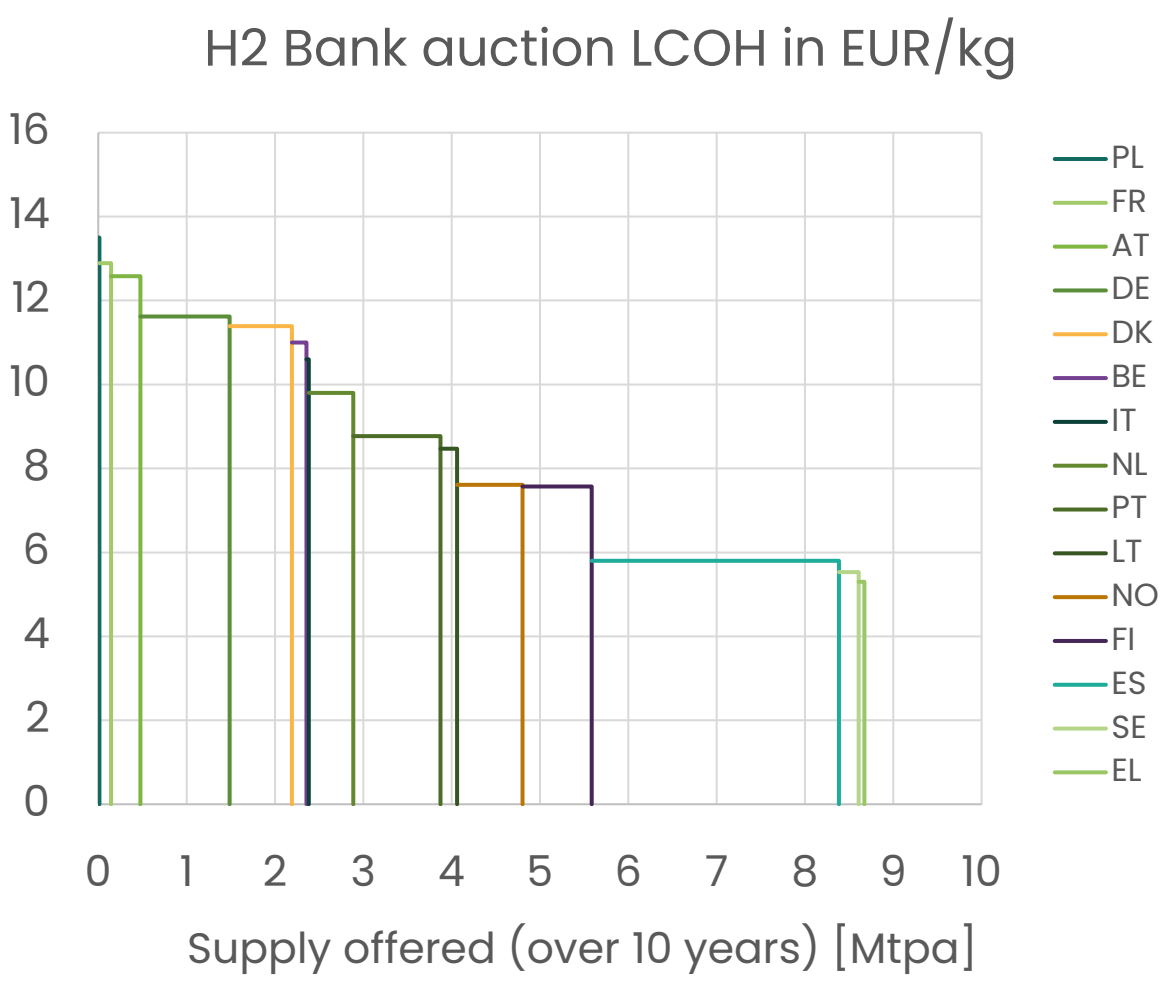
Intended end-uses of the two clean hydrogen supply scenarios by 2030

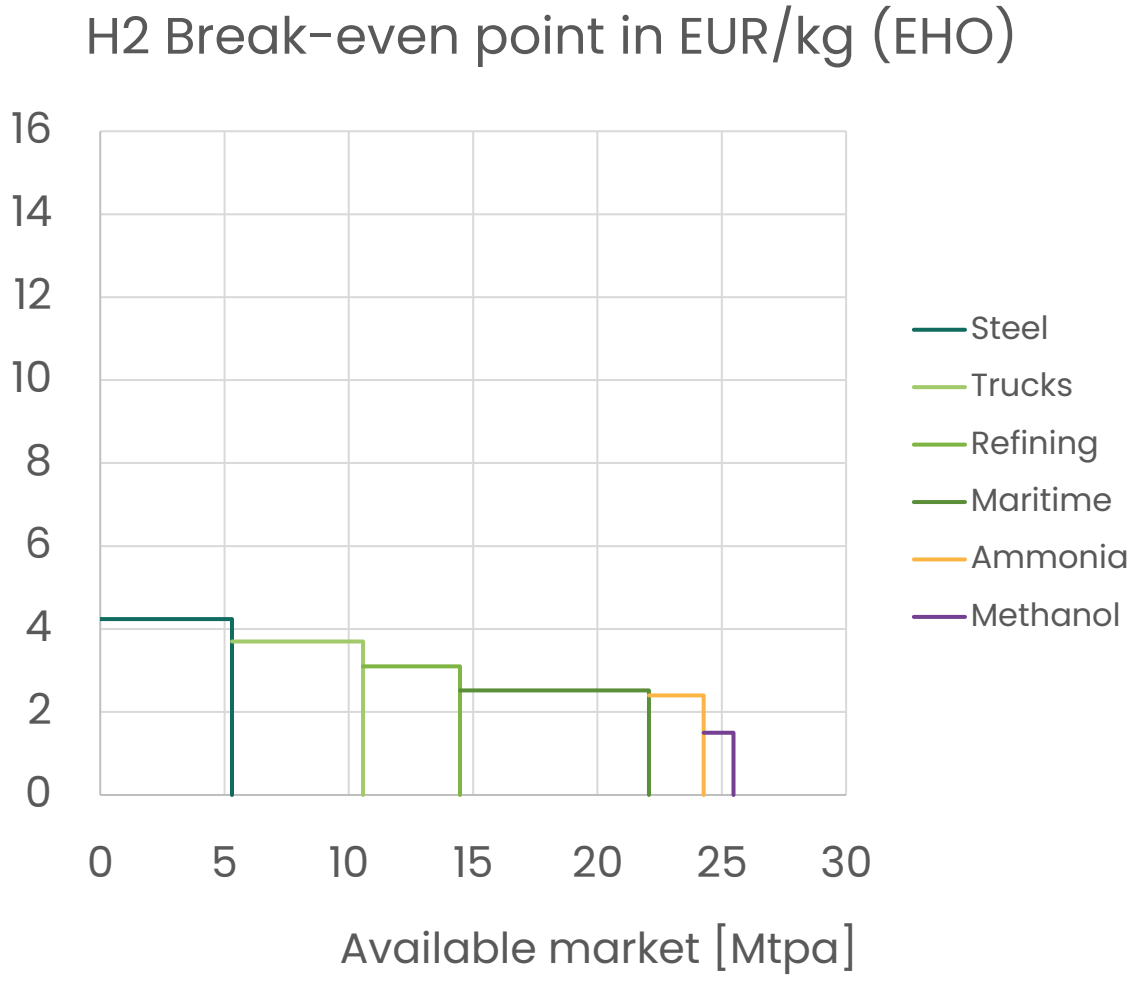
- Under the Accelerated Adoption scenario, around 0.92 Mt of hydrogen is expected for **ammonia** production by 2030, with 0.6 Mt coming from electrolysis, insufficient to replace the 0.84 Mt from RED3 industry target.
- **Refineries**, the largest current hydrogen consumer will be key offtaker of clean hydrogen by 2030 with 0.5-0.7 Mt in the two scenarios.
- **Clean methanol** demand will be driven mostly by shipping.
- Only 10% of hydrogen supply has been announced for **e-fuels and mobility**, with more volumes expected post-2030. However, securing long-term e-SAF offtaker agreements remains a challenge.
- **Steel** could decarbonize around 6% of the sector with the 0.4 Mt/year of hydrogen in the AA scenario.



Notes: No assumptions regarding how much hydrogen supply will be assigned to a specific end-use were made by Hydrogen Europe. End-uses for the Current Trajectory and Accelerated Adoption scenarios are based on the announced projects' end-uses. See methodological notes for more details

H2 production costs vs break-even costs





* H2 BEP based on European Hydrogen Observatory and BNEF 2024, the indicated cost break-even point is at delivery (so including costs of H2 transportation and storage).

The Clean Industrial Deal considers Hydrogen of strategic importance

Regulatory Certainty	• Adoption of Delegated Act on Low-Carbon Hydrogen, planned for this year. • Ongoing assessment of RFNBO framework
Financing	• Planned Third call for Q3 2025, with a budget of EUR 1 Billion. • H2 bank 3rd auction and platform to pool resources ('auction-as-a-service').
Market Creation	• Creation of **lead markets** for Steel, Cement, Chemicals, and more. • **Non-price criteria** in public procurement and private purchase incentives • Launch of the Hydrogen Mechanism, connecting producers and offtakers.
International Dimension	Promotes global cooperation on standards, trade, and regulatory alignment for hydrogen-based fuels.

→ Legislative measures to achieve this include:

- Industrial Decarbonisation Accelerator Act (Q4 2025)
- Simplification of State Aid Rules by Q3 2025
- European Grids Package (Q1 2026)
- Revision of the Public Procurement Directives (Q4 2026)

1. Lead markets

Fertilisers

Refineries

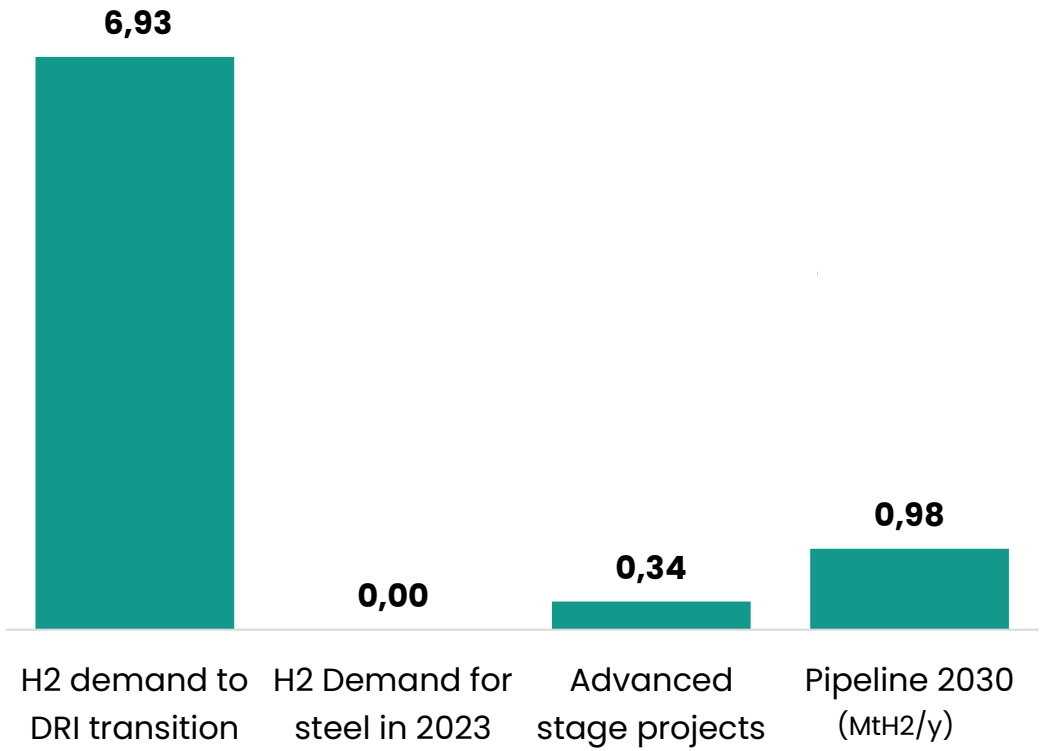
Steel

Stéphane Séjourné

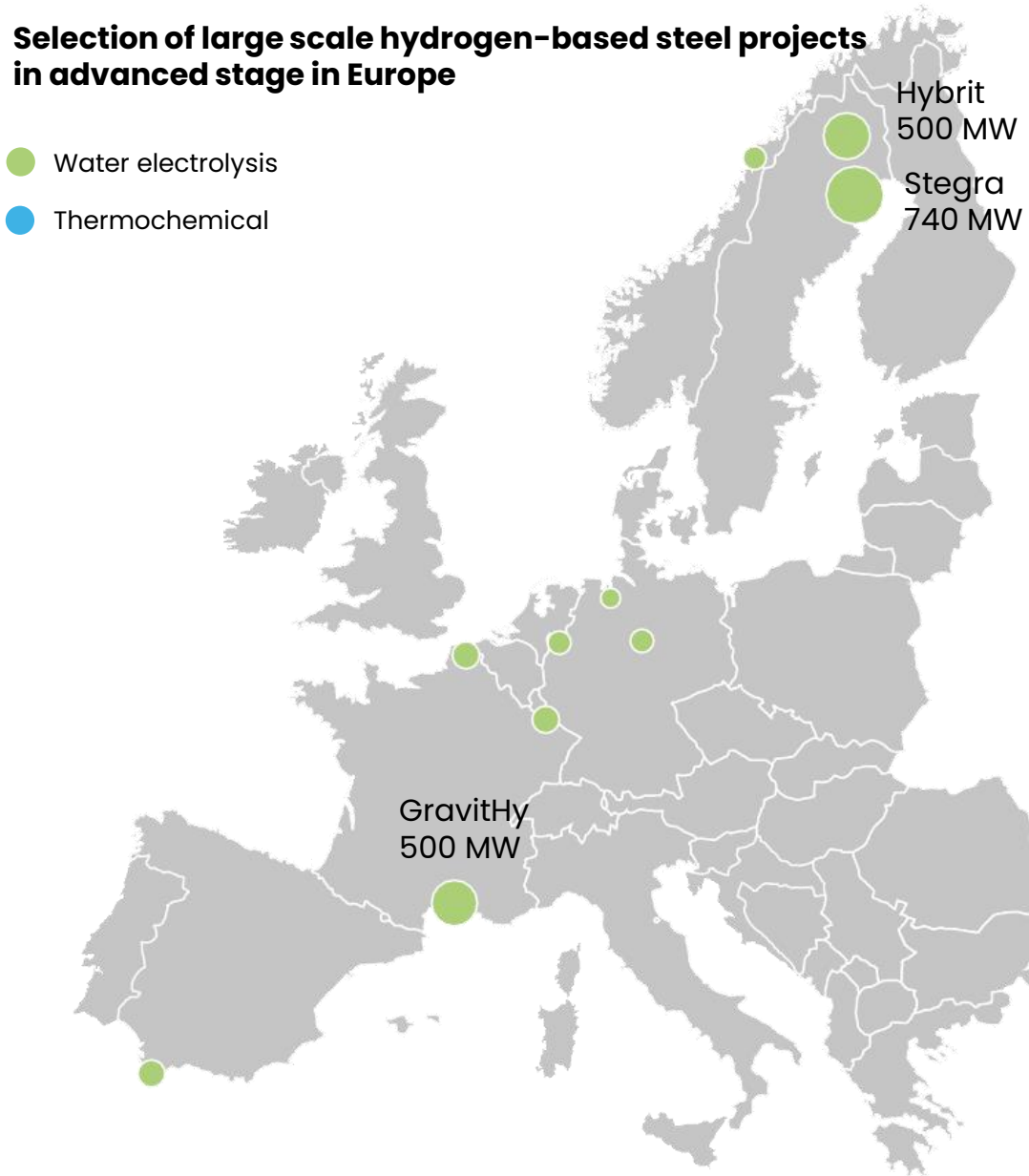
Teresa Ribera

Announced clean steel projects could help replace 18 Mt (14%) of current primary steel production by 2030

- Although there is no hydrogen demand in the steel sector today, the main zero-emission alternative is expected to consume large volumes
- Advanced stage building of new production is heavily focusing on the **automotive sector as an offtaker**:

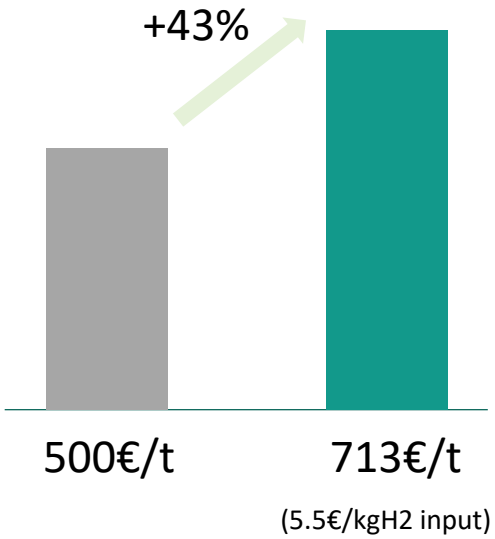


Selection of large scale hydrogen-based steel projects in advanced stage in Europe



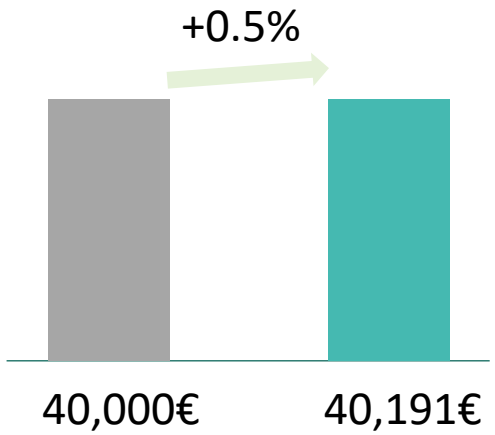
Negligible impact for green steel car buyer, but considerable for a ship manufacturer

Steel



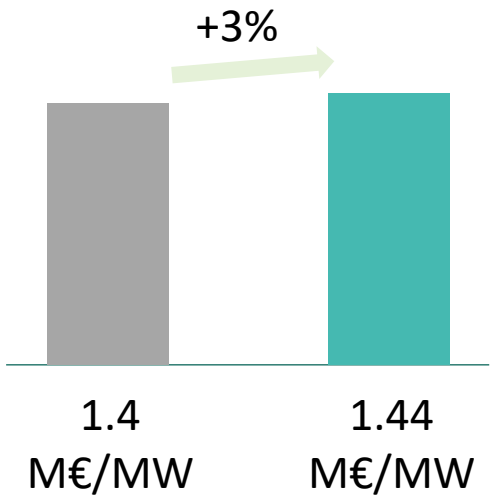
Car

+191 € for a car



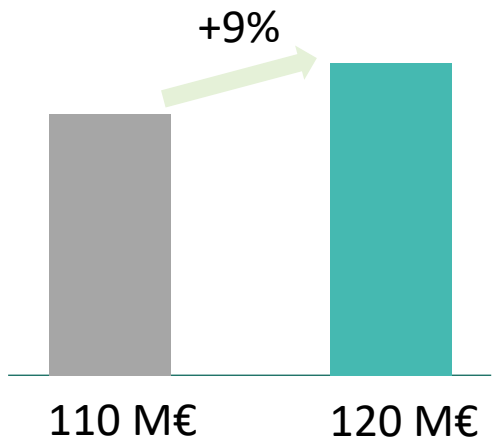
Wind turbine

+38 k€ for a MW



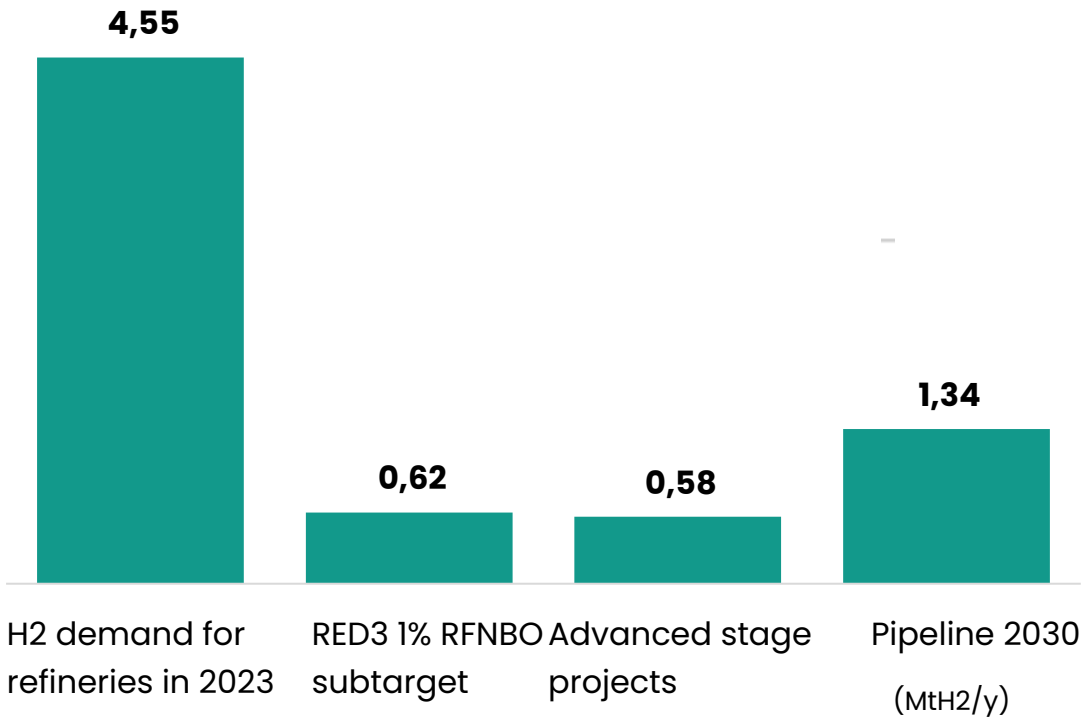
Ship manufacturing

9.8 M€ for a ship

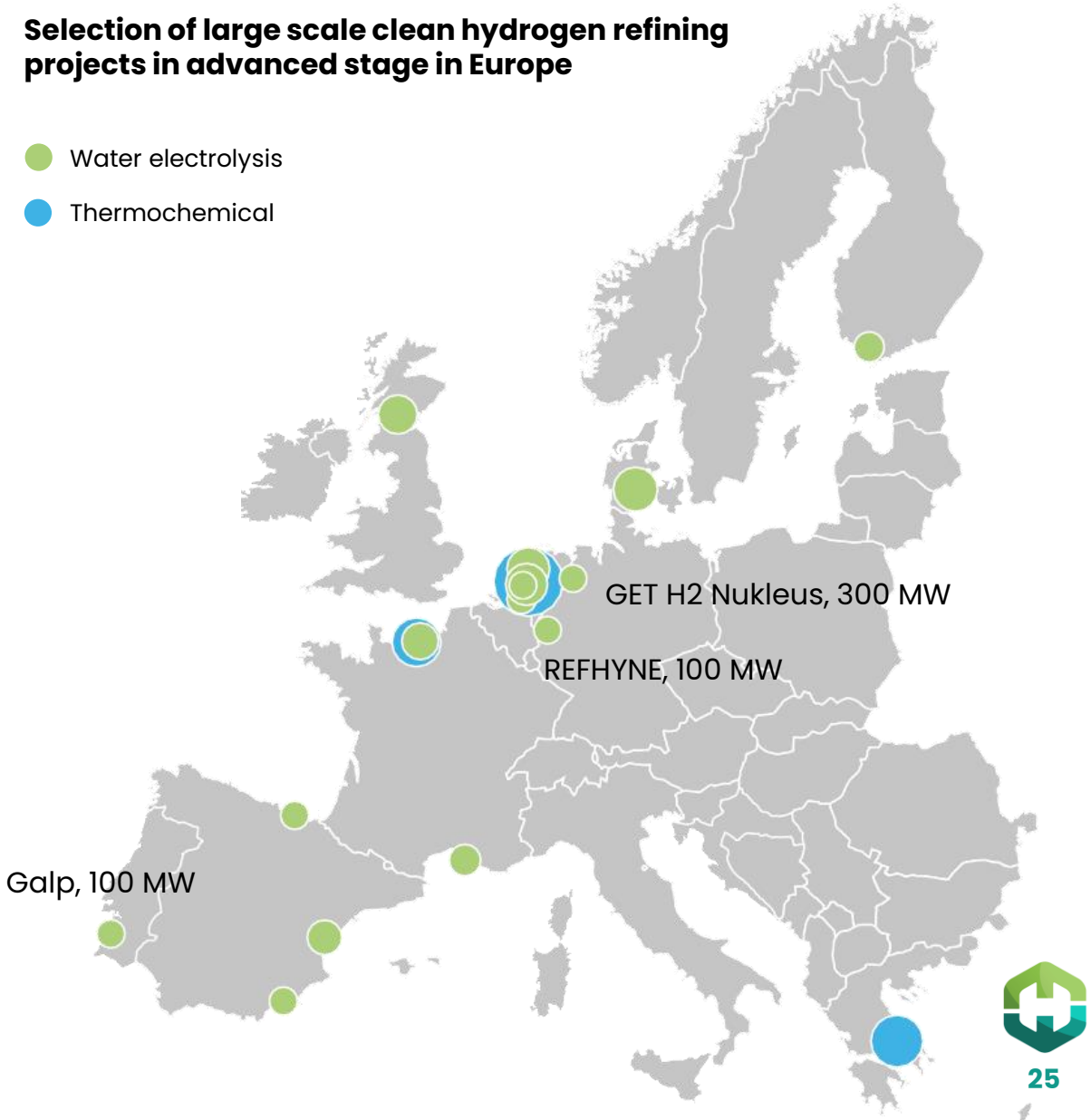


Refineries have announced projects for the consumption of 1.34 Mt of clean hydrogen, 29% of current demand in the sector

- 50% of the clean hydrogen volumes announced by refineries and at an advanced stage of development are based on water electrolysis.

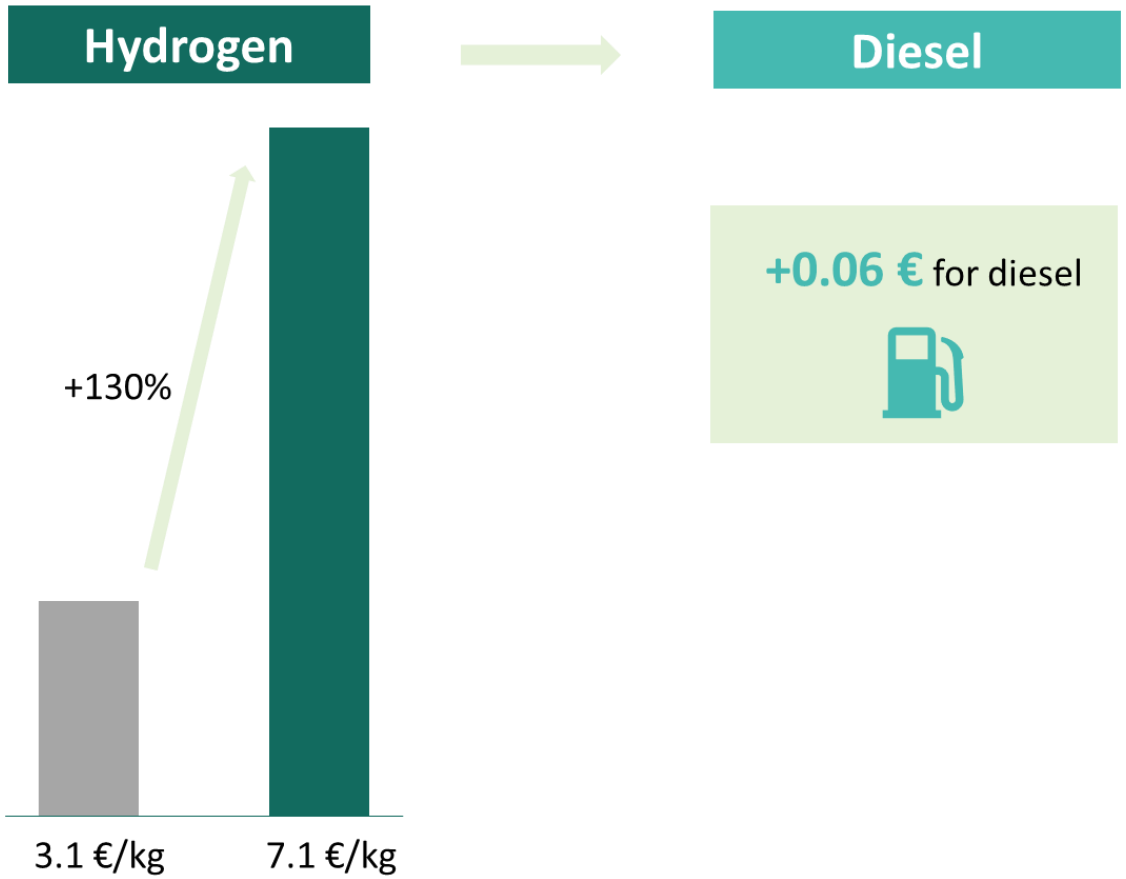


Selection of large scale clean hydrogen refining projects in advanced stage in Europe



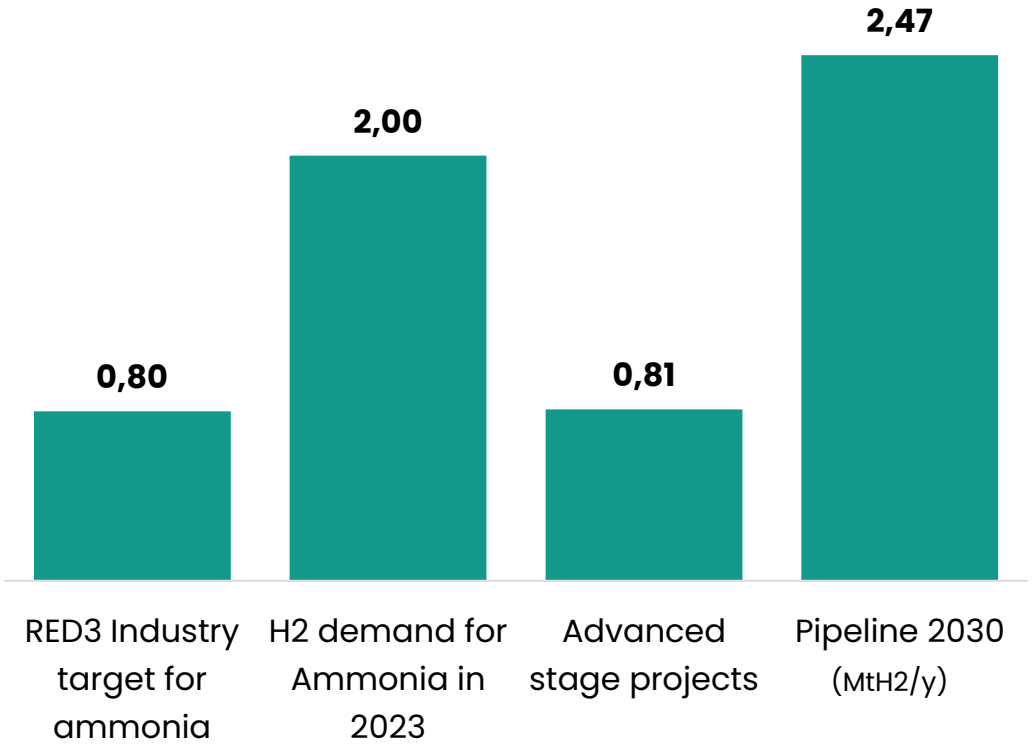
Production costs of conventional fuels would rise significantly if renewable hydrogen would be used as intermediary … But would still be an attractive RED3 compliance option

- Replacing grey hydrogen as internadiary in conventional fuel production would add significant costs but …
- Replacing a limited amount of grey hydrogen production can be achieved with limited disruption to existing procesess
- The RE variability (+RFNBO temporal correlation) can be managed with a relatively small buffer storage
- Costs could potentially be transferred to end-consumers anyway
- No need to build a new market from scratch as is the case with other RED3 compliance options
- **Use of RFNBO as intermediaries is one of the most attactive RED3 compliance options**

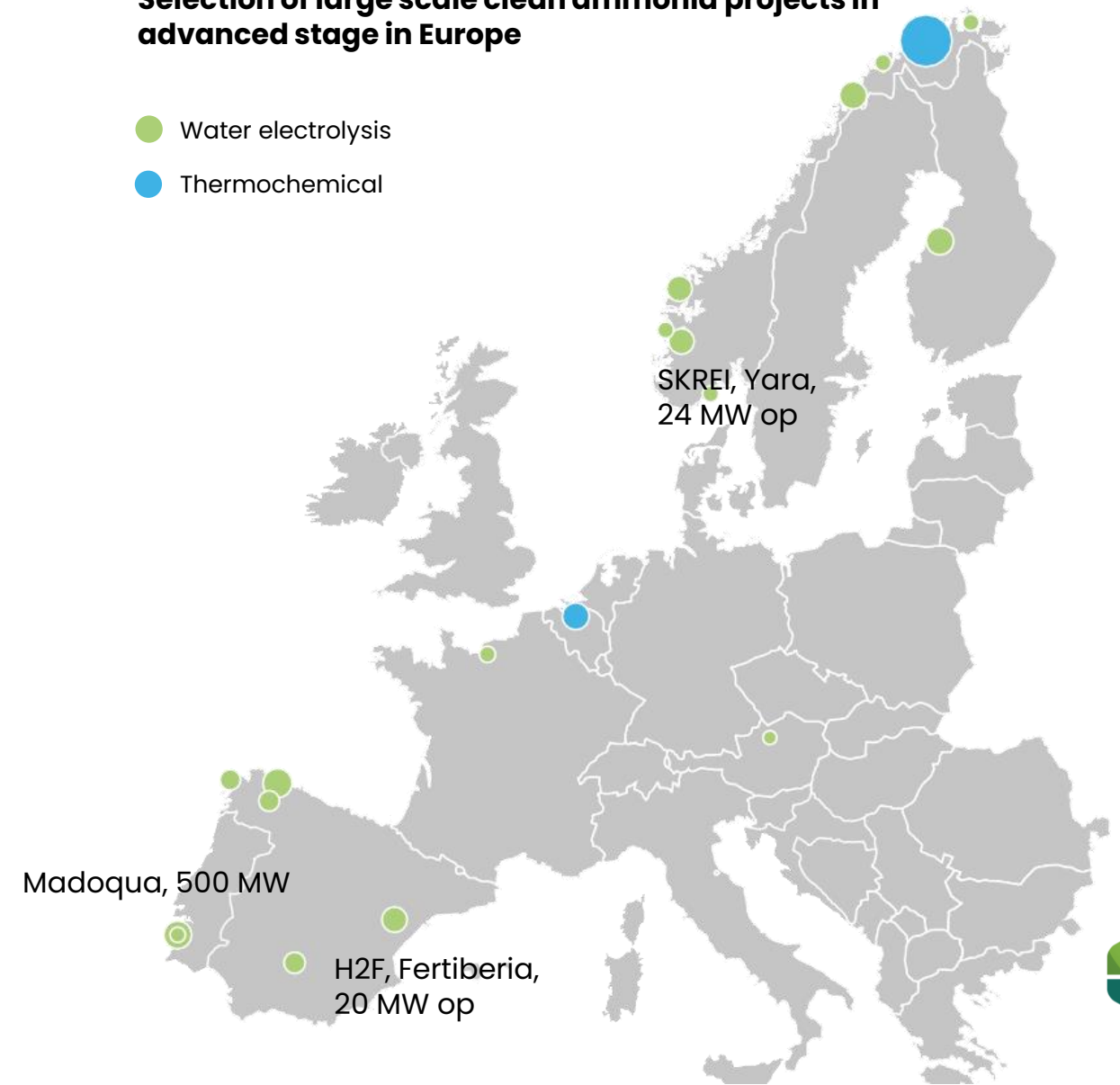


Ammonia projects concentration in Iberia and Nordics is driven by low renewable electricity prices and orientation towards exports

- Current ammonia production is at 17.7 MtNH3/y. Besides decarbonising existing plants, projects are building new ammonia production, likely destined for exports.

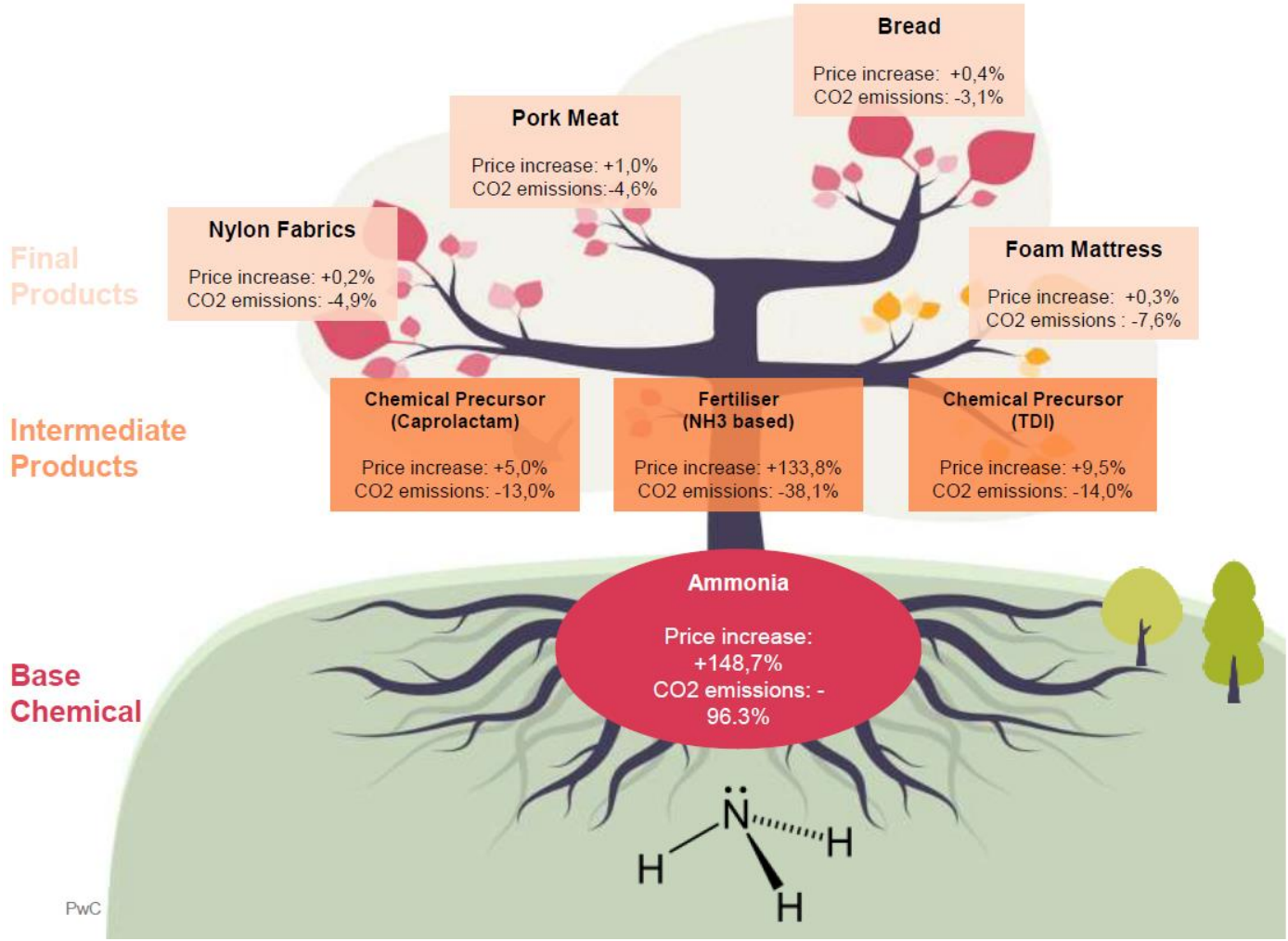


Selection of large scale clean ammonia projects in advanced stage in Europe



Ammonia decarbonisation via renewable hydrogen is one of the most challenging applications as H2 is a key business cost driver and due to limited offtakers willingness to pay

- Break even point is for RFNBO H2 is similar to the refining sector, however
- The willingness to pay is not there (at least on the existing ammonia markets)
- **Focus on products further downstream from ammonia could be a solution as the price impact on end-products is limited**



Source: PWC

2. Resilience: More than Strategic Autonomy

The CID aims to merge competitiveness and decarbonisation strategies with three main objectives:

- **Securing affordable energy**, reducing energy costs, further electrification, and expanding the energy infrastructure.
- **Boosting EU production**, increasing the share of domestically-produced clean-tech components with a 40% target by 2030.
- **Ensuring resource security and reducing dependencies**.

We came a long way on resilience for the electrolyser supply chain

Hydrogen Bank Terms & Conditions 2nd call v2

Sept 2024

Net-Zero Industry Act consultation on resilience

February 2025

1. Diversification of European supply chains

Max 25% sourcing of electrolysers stacks from China, including:

Surface treatment

OR

Cell unit production

OR

Stack assembly

Reporting: double check of compliance at Financial Close and Entry into Operation of project + reporting during project life

Penalties: reduction of grant or termination

DRAFT

Resilience will always apply to ELYs, and to at least 75% of ELYs in object of the auction

Trigger overreliance criterion. Bids shall not contain:

Electrolyser and more than 2 main essential components CANNOT originate or assembled in China	**The stack cannot originate from China**

Reflections

Things are a little lower than anticipated, but the fundamentals are there and hydrogen remains a key pillar of the Energy transition.

National transposition of the RED3 for transport and industry is key. EC and goverments needs to stay the course and focus on implementation.

To unlock more clean hydrogen supply in Europe and meet EU targets, production framework should be simplified, allowing more competitive renewable hydrogen.

Its key to continue developing regional/valleys project, creating positive environments to multiple stakeholders. Staking offtake uses (mobility, industry) can support greatly viability of projects.

Governments needs to be bold on supporting the deployment of hydrogen infrastructure, providing anticipatory investments and derisking projects.

Thank You

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