



# The Emerging Hydrogen Market

Nordic Energy Day 2024

JOHN WILLIAMS, HEAD OF HYDROGEN

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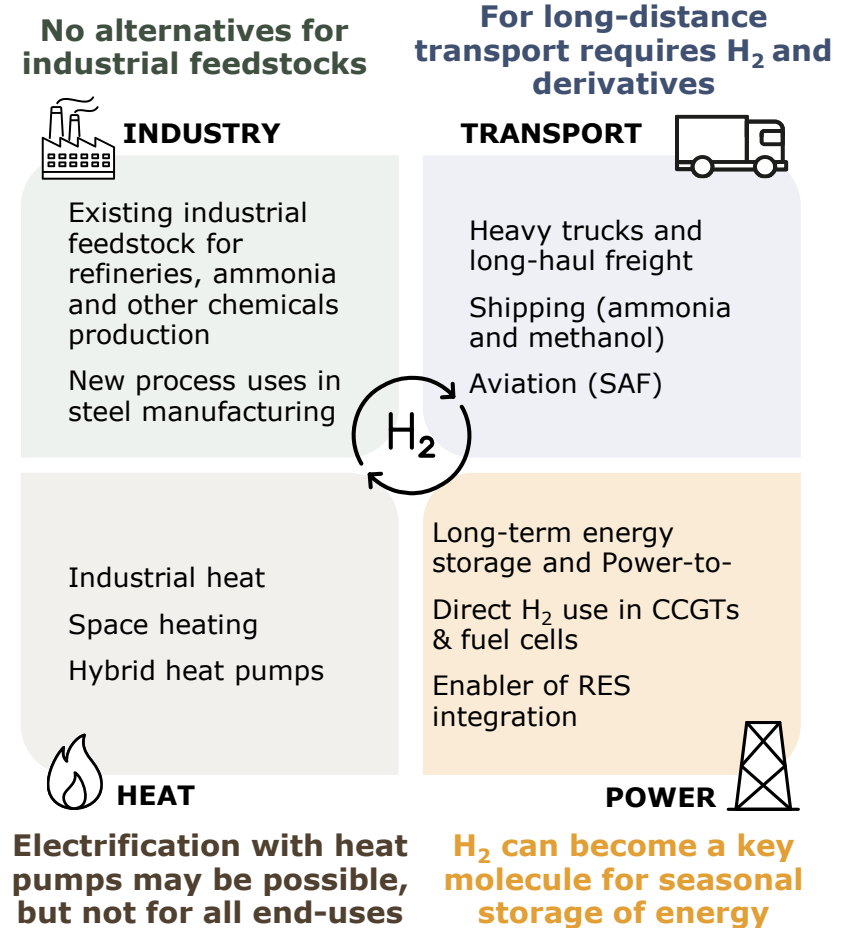
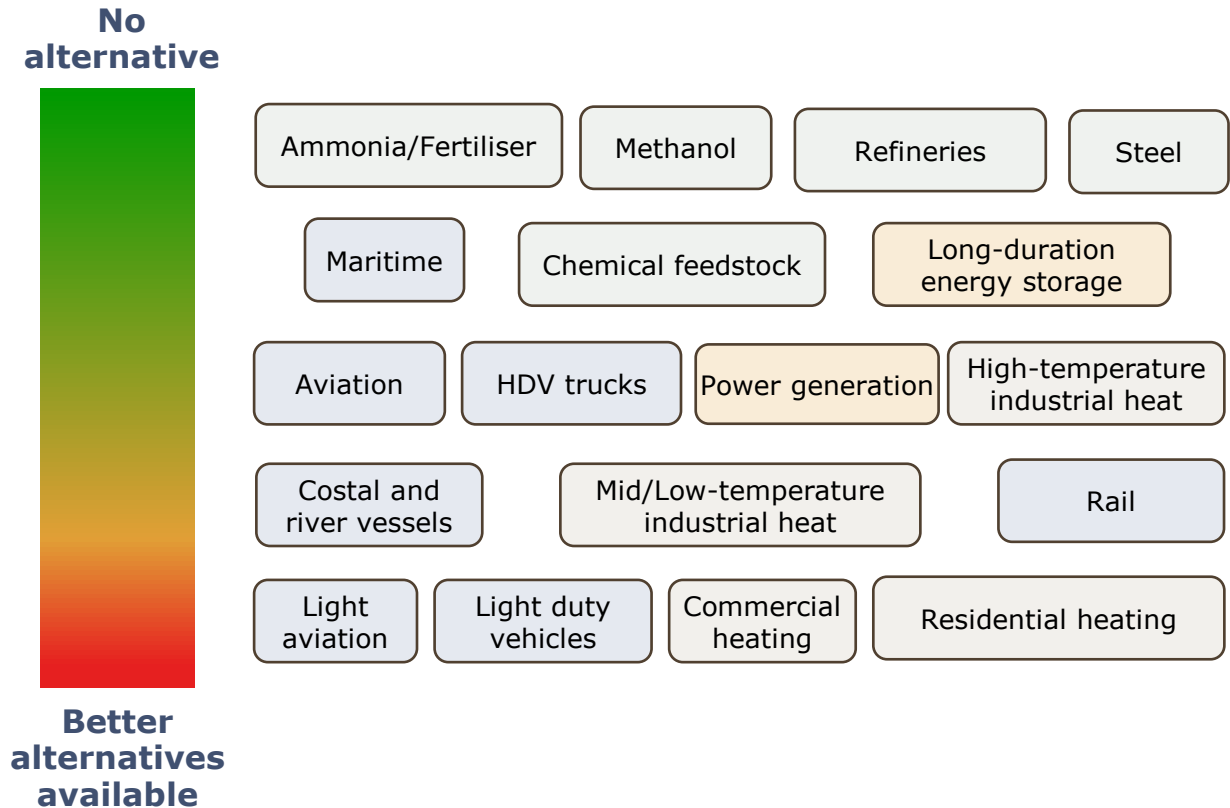
KEY MESSAGES

## The Emerging Hydrogen Market ...

- ✓ Essential in some sectors to achieve Net-zero
- ✓ Market is developing more slowly than anticipated
- ✓ Technical and commercial challenges still prevail
- ✓ Focus on end-use/offtaker incentives is crucial to accelerate developments
- ✓ Nordic markets are well placed to play an important role



# Hydrogen could be crucial to decarbonise hard-to-abate sectors to achieve net-zero, but is not a 'silver bullet'



# Costs remain high and uncompetitive for offtakers - FIDs are being delayed and projects 'shelved'

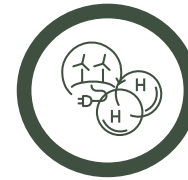
## COSTS

- Costs under-estimated
- High inflation
- Costs of capital
- Supply chain development issues
- Electrolysers are increasing rather than decreasing
- Offtake markets not yet developed
- Projects are being delayed or cancelled



### Policy and Incentives

- Too complex?
- Too restrictive?
- Targeted correctly?



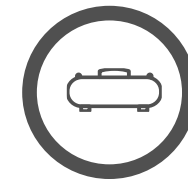
### TECHNICAL/COMMERCIAL

- RES costs and/or PPA costs
- Electrolyser costs high
- Matching intermittency of RES
- Scale of projects is large



### OFFTAKERS

- Long-term offtake contracts required
- Willingness to Pay?
- Competitiveness Vs decarbonisation

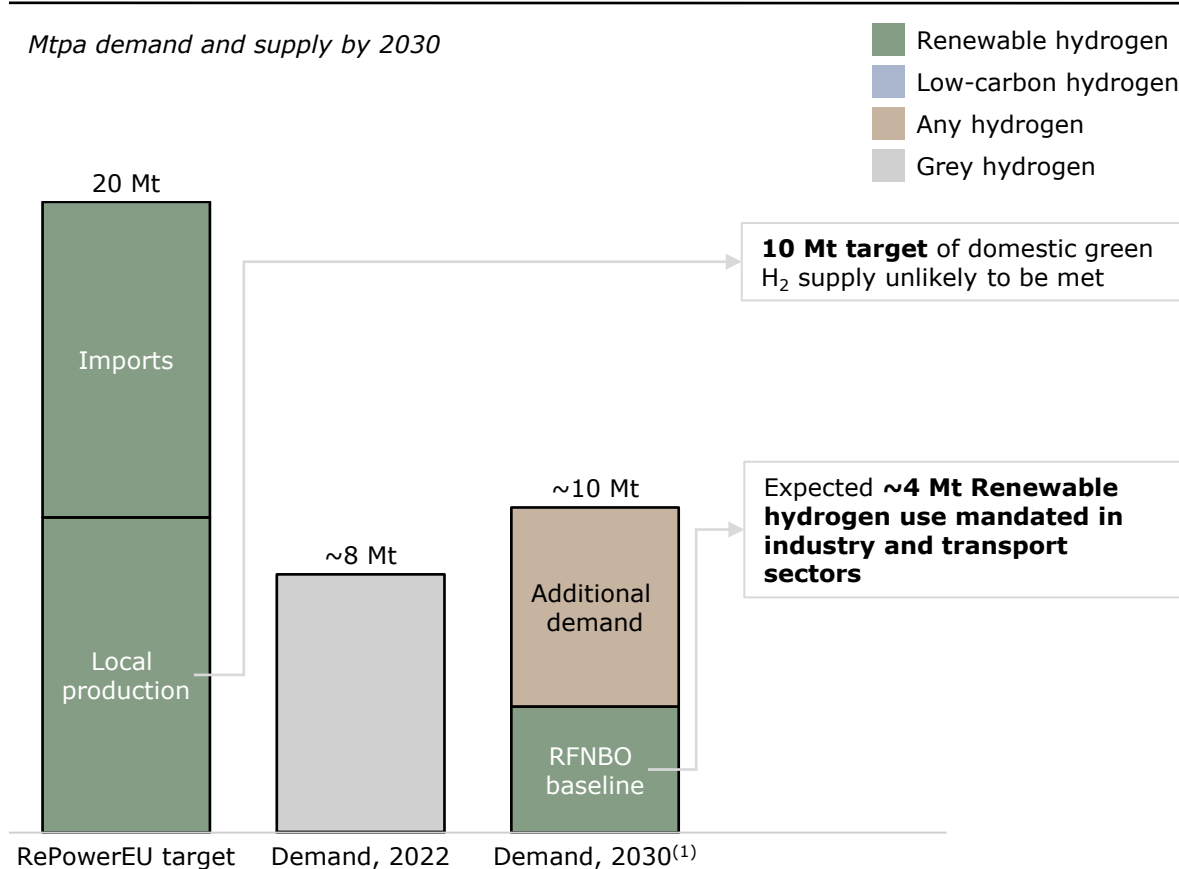


### INFRASTRUCTURE

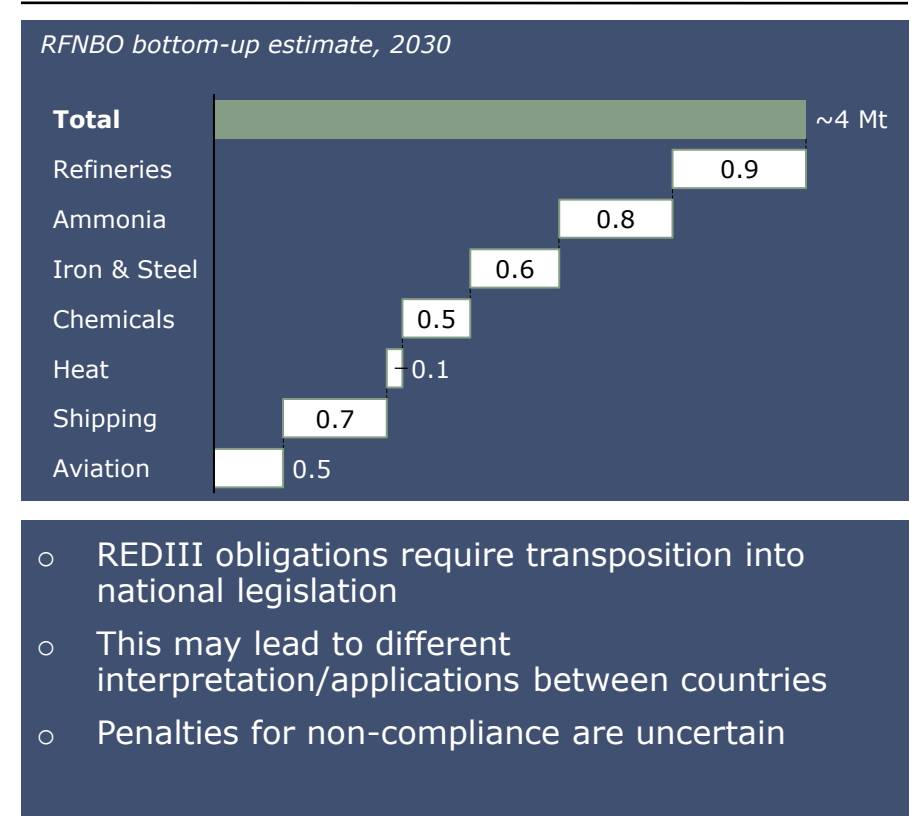
- Power grid capacity availability
- New and repurposed pipelines
- Hydrogen/Ammonia Storage
- Port infrastructure for exports/imports

# REDIII requires adoption of Renewable H2 in industrial and transport sectors but will not reach RePowerEU targets for 2030

## EUROPEAN LOW-CARBON H2 SUPPLY-DEMAND



## CONSERVATIVE H<sub>2</sub> DEMAND BREAKDOWN

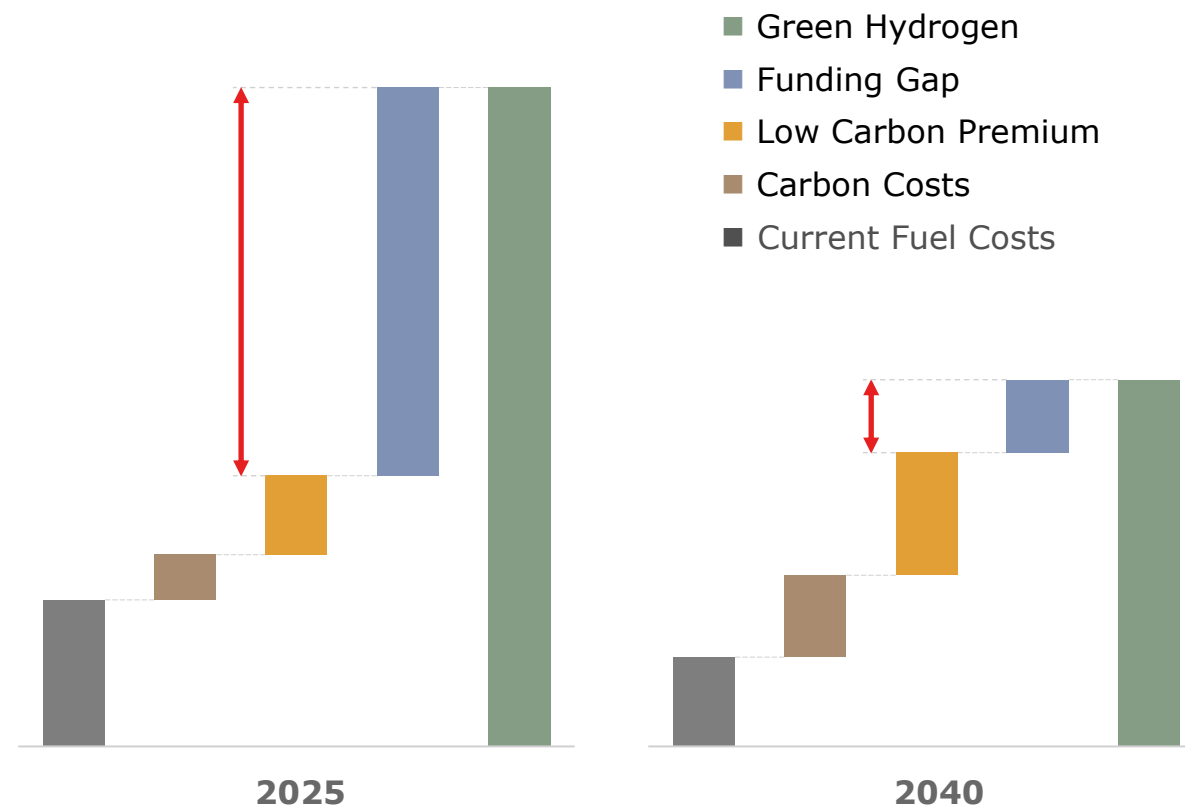


Source: European Hydrogen Observatory (EHO), GlobalData, IEA, Hydrogen Europe, S&P Global | <sup>(1)</sup> Based on median of 22 forecasts compiled by EHO | <sup>(2)</sup> IEA estimates higher FID volumes than GlobalData (but similar FID percentage).

Although some offtake contracts are being signed there exists a wide funding gap between 'willingness to pay' and supply costs

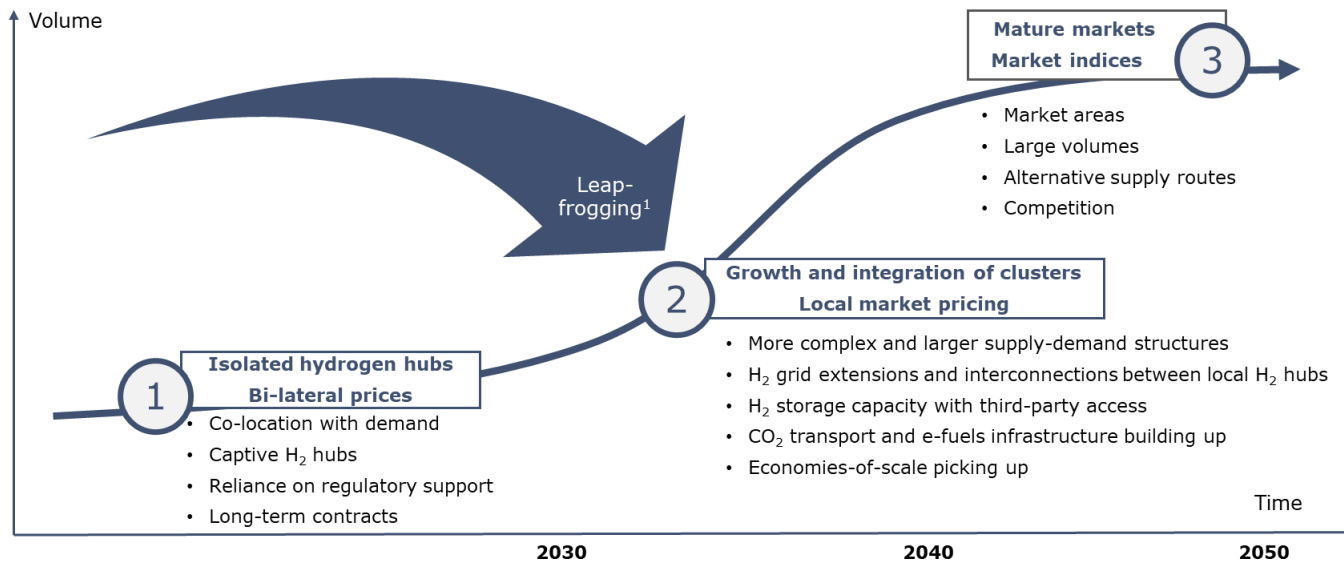
- H2 developers will initially need long-term contracts and subsidies to make the projects bankable
- Offtakers' 'Willingness-to-pay' is much less than supply costs
- REDIII obligations may 'force' adoption, but this will depend on any penalties for non-compliance
- Higher carbon prices would help close the gap

FUNDING GAP REQUIREMENTS REDUCE OVER TIME



A mature market may take some time to develop but policies and support could accelerate the process

**POSSIBLE HYDROGEN MARKET DEVELOPMENT**

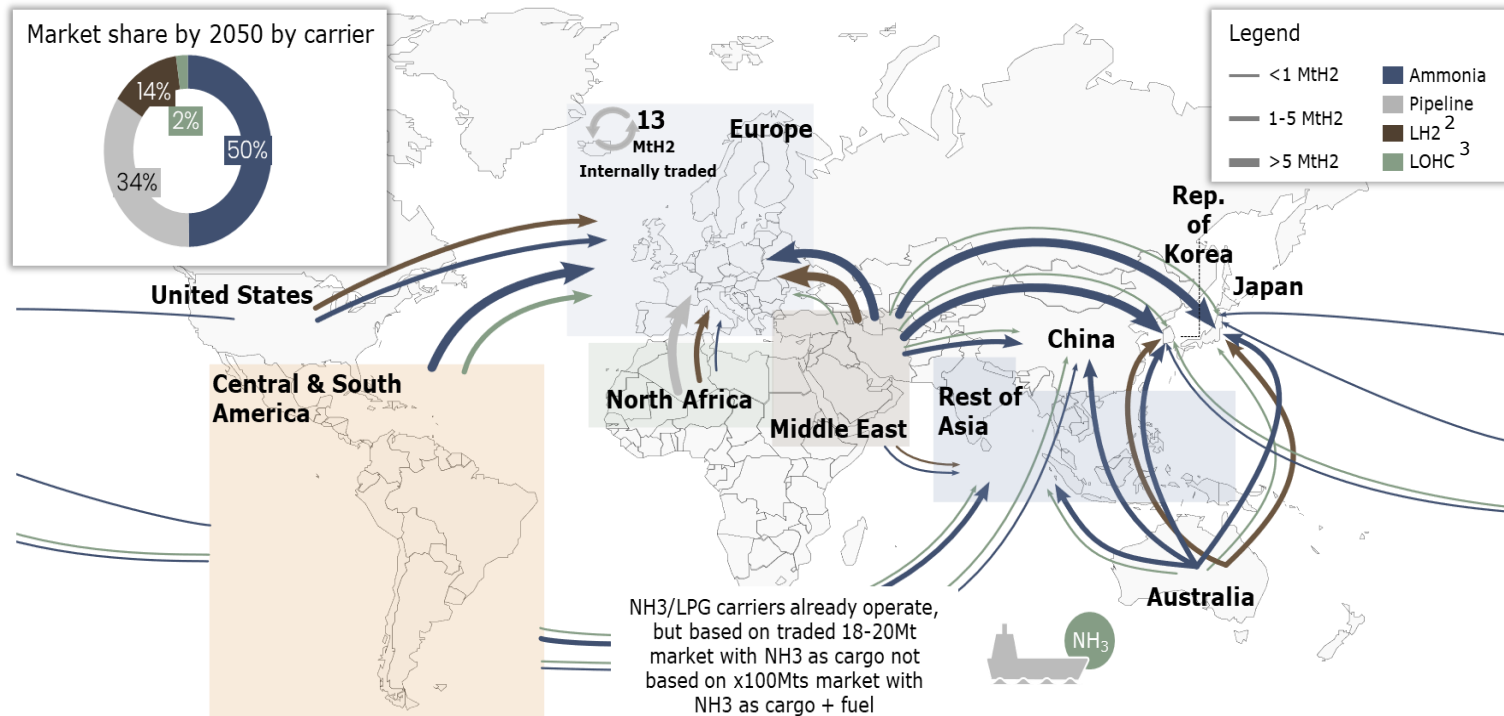


- No real market pre-2035
- Some countries e.g. Germany likely to be reliant on imports and a market could emerge at import hubs
- Ammonia market may be more liquid than a hydrogen market in medium term
- Information will be essential to lead to price information e.g. EU Hydrogen Bank and H2 Global

<sup>(1)</sup> For example, the German government has backed an initial core hydrogen network by 2032 with government advance payments, while the US government will likely offer \$8 billion to build seven regional H<sub>2</sub> clusters.

# AFRY's global trade flow model predicts the emergence of global trade flow routes

## AFRY'S GLOBAL TRADE FLOW MODEL

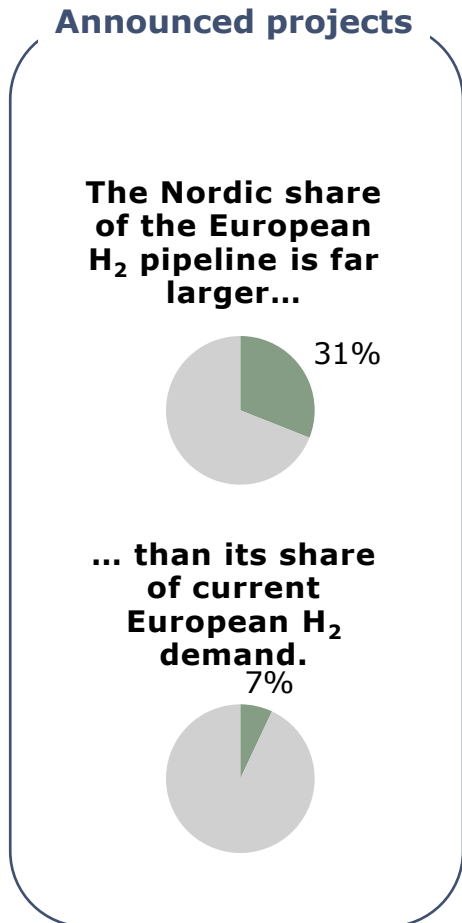


- Trade flows driven by import requirements in Europe and Asia
- Lower cost renewable sources in exporting countries used to produce hydrogen and derivatives
- Infrastructure investment at large-scale is required
- Pipelines are the cheapest transportation option
- Ammonia is likely to be the transport vector for long-distance shipping

Note: Market value estimated considering traded volumes and CAPEX for carriers' conversion and reconversion. 1) Renewable Energy Sources 2) Liquid Hydrogen 3) Liquid Organic Hydrogen Carriers 4) Liquefied Natural Gas

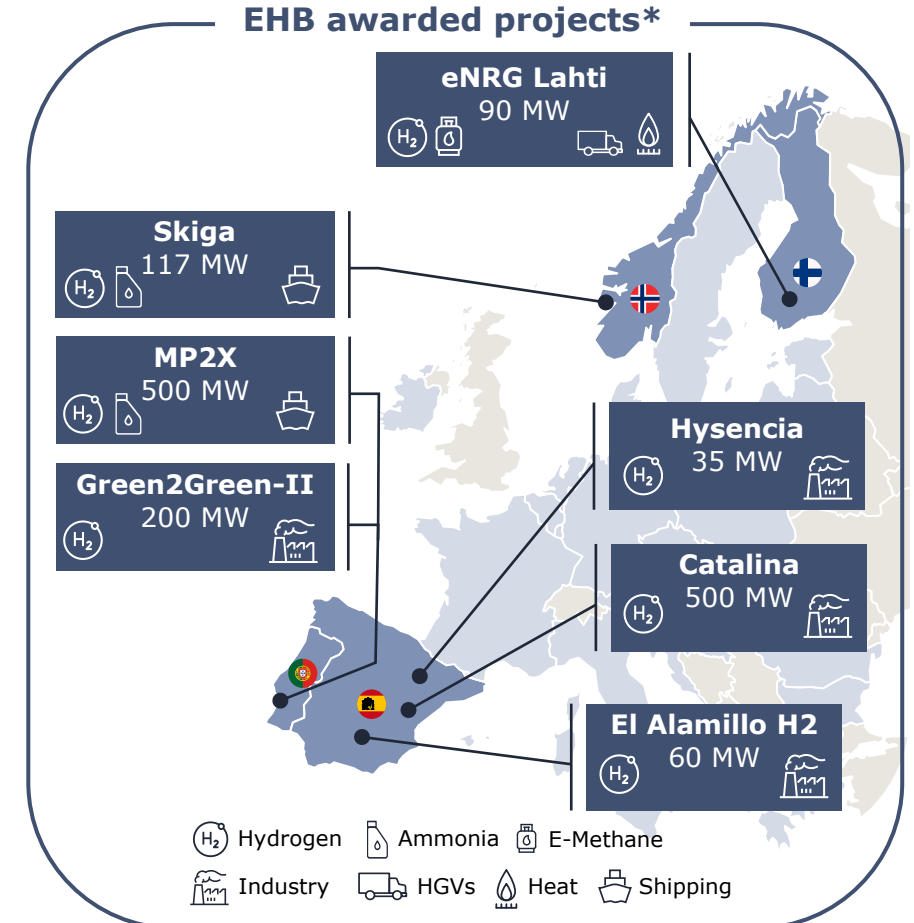


# Nordics has the potential to play a leading role due to power market fundamentals and biogenic carbon availability



### Nordic Advantages

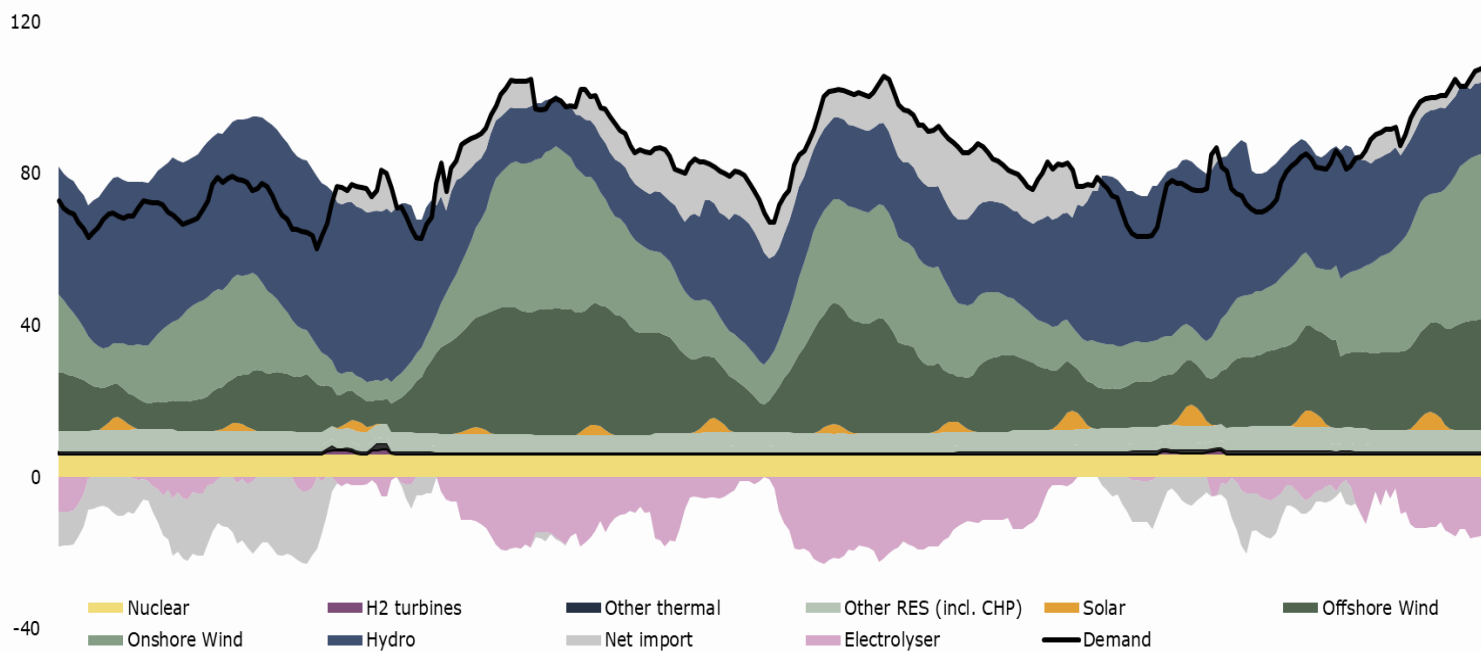
- Cheap power and/or even generation** (Lightning bolt icon)
- Access to low-carbon electricity** (CO<sub>2</sub> cloud icon)
- Ability to source grid electricity** (Sun, wind, and solar panel icon)
- Access to bio-CO<sub>2</sub> for e-fuel production** (Plant and factory icon)
- Water availability** (Water drop icon)



\* Projects awarded a subsidy in the first European Hydrogen Bank Auction 2024

# What impact will electrolysers have on the power market?

**HOURLY GENERATION/DEMAND (GW), 2 WINTER WEEKS IN 2050  
BID3 AFRY CENTRAL SCENARIO\***



- Nordic power market will become more variable due to increased RES penetration, more interconnection and more demand flexibility
- Hydro power provides much of the flexibility to meet increased variability
- More RES results in downward pressure on prices but increased demand leaves overall prices largely unchanged
- Grid connected electrolysers will produce hydrogen in low-priced hours and 'set' the power price
- Electrolyser demand can act to reduce price volatility in future

\* BID3 modelling carried out with 2050 capacity mix with 2003 weather year data

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# Our hydrogen ambition

## OUR AMBITION

To be the leading advisor to the hydrogen and low carbon fuels industry providing advisory services and technical expertise across the whole value chain

Providing a **'One-Stop-Shop'** for our clients at whatever stage of their journey in the energy transition

# Our hydrogen expertise

## KEY FIGURES

- 1 Over 300 projects delivered globally in over 30 countries since start of 2020
- 2 Technical/engineering advisory and design on projects with over 20GW electrolyser capacity
- 3 Expertise covers the entire value chain from production to end-use
- 4 Expertise in Hydrogen, ammonia, e-methanol, e-methane and Sustainable Aviation Fuels
- 5 Experts located globally involved in consulting and engineering projects



AFRY AND HYDROGEN

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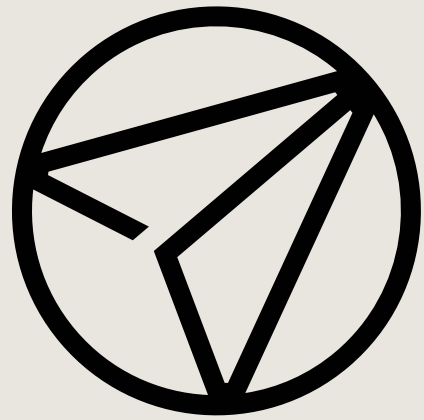
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AFRY