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Hydrogen Conference

LONDON 2024

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AURORA KEYNOTE

THE EMERGING EUROPEAN INVESTMENT LANDSCAPE

Agenda

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A case for optimism?

How can production projects gain a competitive advantage?

What might hinder the development of the market?

At least 4.7 GW of electrolyser capacity has reached FID since mid-2023

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Electrolyser projects reaching FID

Summer 2023

- Yumen Oilfield Renewables Hydrogen Production
- 100MW
- CNPC
- Industry

- Galp electrolyser project
- 100MW
- Galo
- Refining

Winter 2023

- Phoenix Green H_2 Plant
- 80MW
- H_2
- Mobility

- Hydrogen Hub Agder
- Greenstat
- Mobility (maritime)

- 3H2 Helsinki Hydrogen Hub
- 3 MW
- Helen
- Mobility

Summer 2024

- Aberdeen H_2 Hub
- 10MW
- BP
- Mobility

- AM Green Ammonia
- 1300 MW
- AM Green Ammonia
- Industry & others

- Castellón Green H_2 Cluster
- 25MW
- BP
- Refining

- Uxin Banner Wind, Solar and H_2 Storage Integrated Project
- 133MW
- Sinopec

- Clean H_2 Coastline
- 320MW
- EWE
- Industry

- Shenzhen Energy Chifeng Linxi Wind Power H_2 and Ammonia Integration Project
- 2000MW
- H_2 and Ammonia

- OranjeWind
- 795MW
- RWE/Total
- Industry

- REFHYNE 2
- 100MW
- Shell
- Refining

- Project name
- Company
- Project final capacity
- End user

Source: Aurora Energy Research

A clear set of success criteria determine the likelihood of a project achieving a Final Investment Decision

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1. HPA with creditworthy offtaker
2. Off-taker incentivised to switch to low-carbon alternatives thanks to policy levers
3. Power sourcing strategy compliant with regulatory requirements
4. LCOH/HPA prices below WtP
5. Access to transport & storage infrastructure
6. Planning, grid connection, water, and associated environmental permitting
7. Direct or indirect subsidy support
8. Access to finance

Source: Aurora Energy Research

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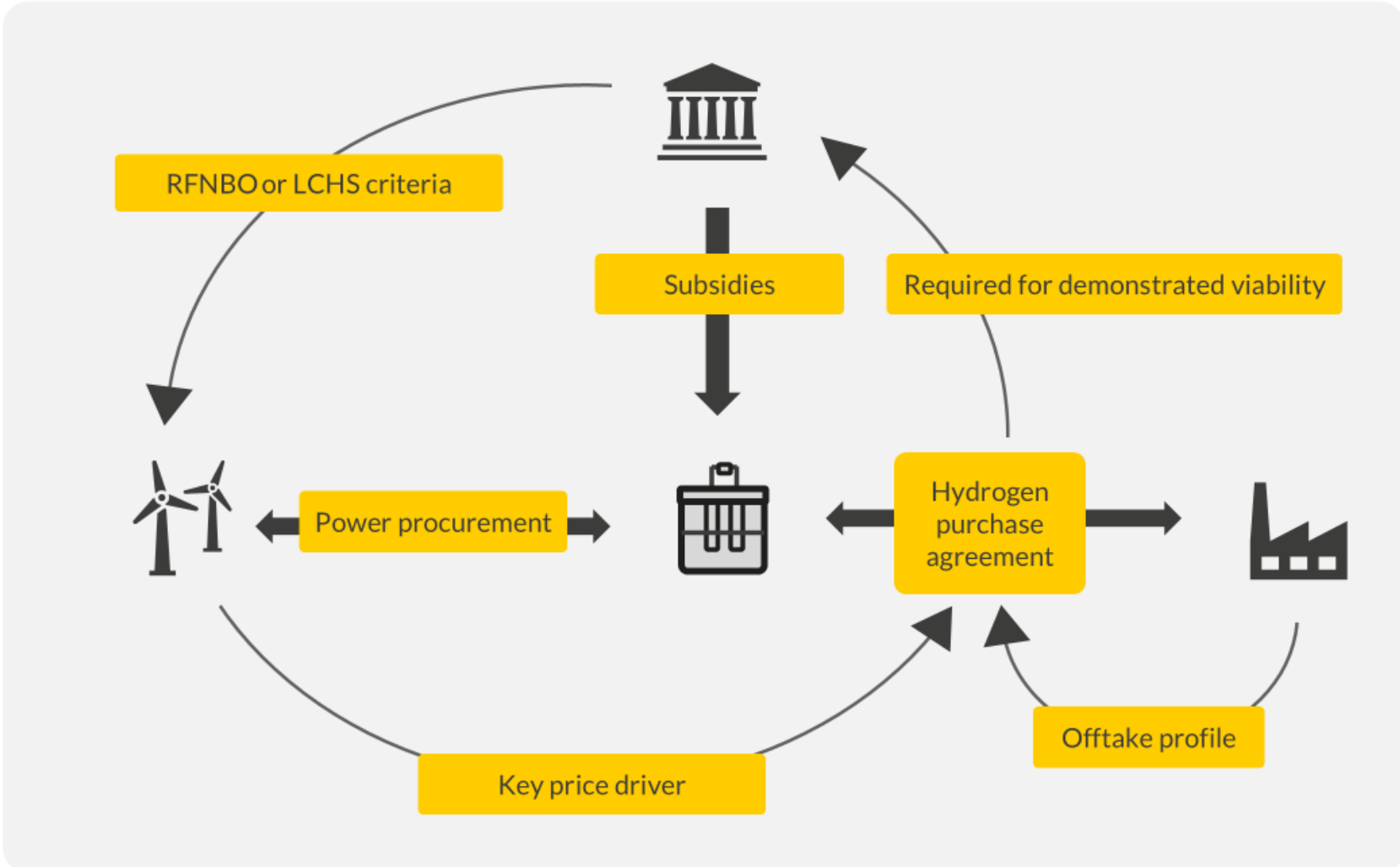
For a hydrogen project to be successful, each step in the chain must be aligned with the others



Source: Aurora Energy Research

The regulatory environment for hydrogen in Europe presents an opportunity for countries with high renewable penetration

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EU's Renewable Hydrogen

- Hydrogen produced from **renewables technologies** such as wind, hydro and solar power assets
- Must meet **additionality, geographical, and temporal correlation criteria**. However, EU's Delegated Act also set out scenarios when certain criteria may be exempt:

Electrolyser **directly connected to a RES** asset

Electrolyser located in a bidding zone where average **RES share in electricity mix >90%**[1]

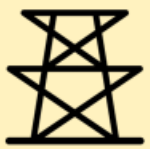
Deep-dive

Electrolyser using power that would have been **curtailed otherwise**

Electrolyser located in zone with average **grid carbon intensity < 64.8 gCO_2/kWh**

Electrolysers located in a bidding zone where average RES share in electricity mix >90% have a wider choice of RED III compliant business models, including the ability to procure power directly from the grid:

Electrolyser can be located closer to H_2 demand



It can purchase power at the spot market, and power is available whenever needed

90%

It can operate at high load factors

Electrolyser operation can follow the offtake profile

11) If the condition is met in the previous calendar year, it is considered to be reached in the following 5 calendar years

Source: Aurora Energy Research

Nordics and Iberian regions are the cheapest regions to produce H_2 in Europe, thanks to RED III compliant grid power and cheap power prices

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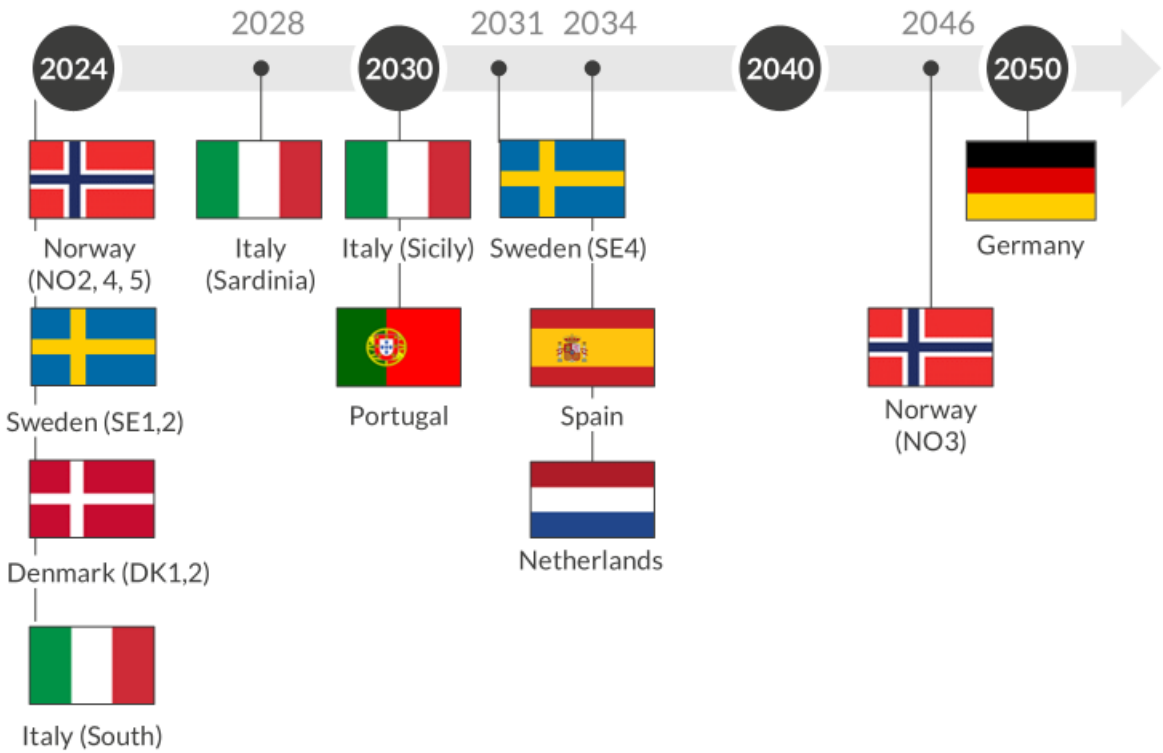
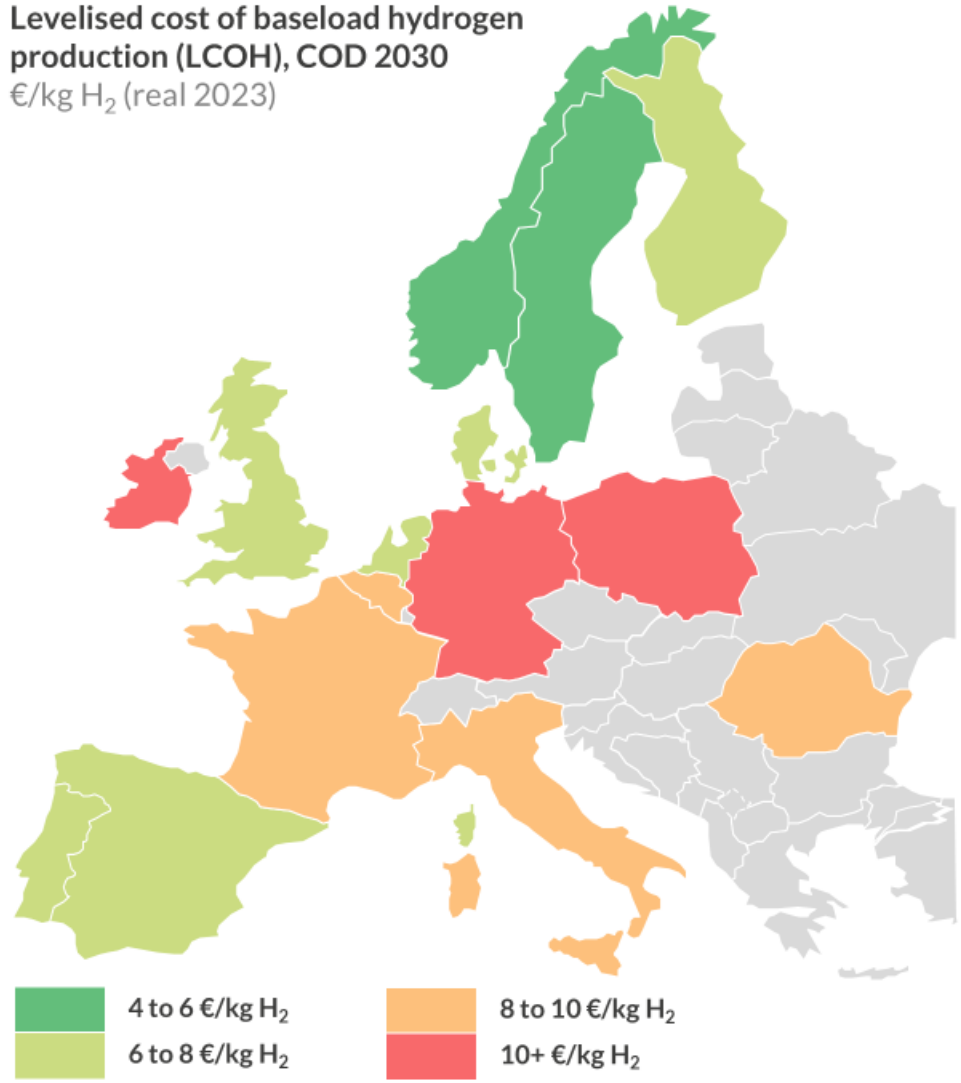
Dates for which regions are expected to reach 90% of renewable power production



Levelised cost of baseload hydrogen production (LCOH), COD 2030
€/kg H_2 (real 2023)



Source: Aurora Energy Research

Countries willing to integrate electrolysers into their power systems, could benefit from lower LCOH, like Germany with its 13K mechanism

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EU's Renewable Hydrogen

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Electrolyser **directly connected to a RES** asset	Electrolyser located in a bidding zone where average **RES share in electricity mix >90%**[1]	Electrolyser using power that would have been **curtailed otherwise**	Electrolyser located in zone with average **grid carbon intensity < 64.8 gCO_2/kWh**

Deep-dive

From October 2024, heat loads and electrolysers can procure previously curtailed renewable electricity at a discounted price under §13k of the EnWG (the Energy Industry Act)

13k Aim	The aim of the new mechanism is to incentivise additional loads to take off electricity from renewable electricity installations that would otherwise have to be curtailed due to grid congestion
Price information	The **13k price** is designed to make technologies participating in the 13k mechanism competitive with alternative fossil-based technologies
Volumes	TSOs determine the hourly generation volumes from renewables installations likely to be curtailed due to grid congestion at the latest 2 hours before the close of the spot market auction on the day before delivery.

11) If the condition is met in the previous calendar year, it is considered to be reached in the following 5 calendar years

Source: Aurora Energy Research

Assuming 13k power is available for 10 years, the LCOH produced via a PPA business model reduces by 12-17%

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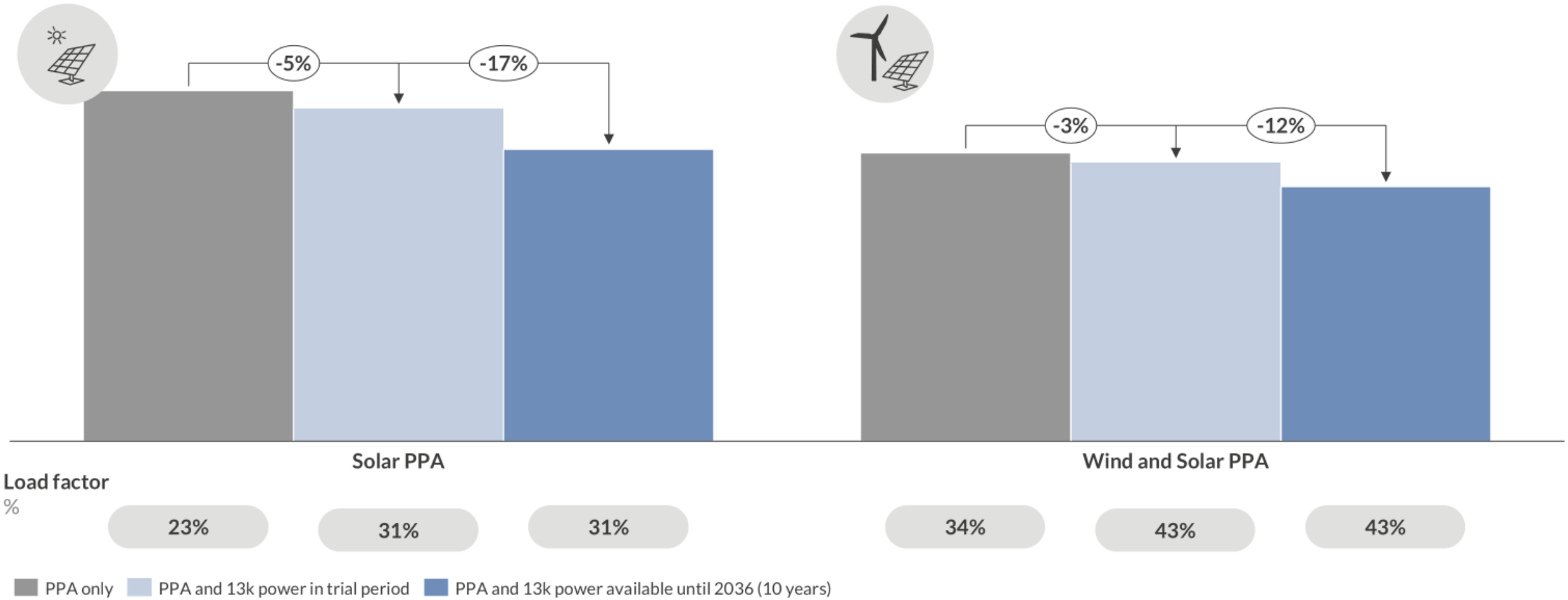
Levelised cost of hydrogen (LCOH)[1], COD 2025
€/kg H_2 (real 2023)



Source: Aurora Energy Research

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In 2030, industry will drive 84% of hydrogen demand, mainly from ammonia and refineries, with Germany being the largest demand centre in Europe

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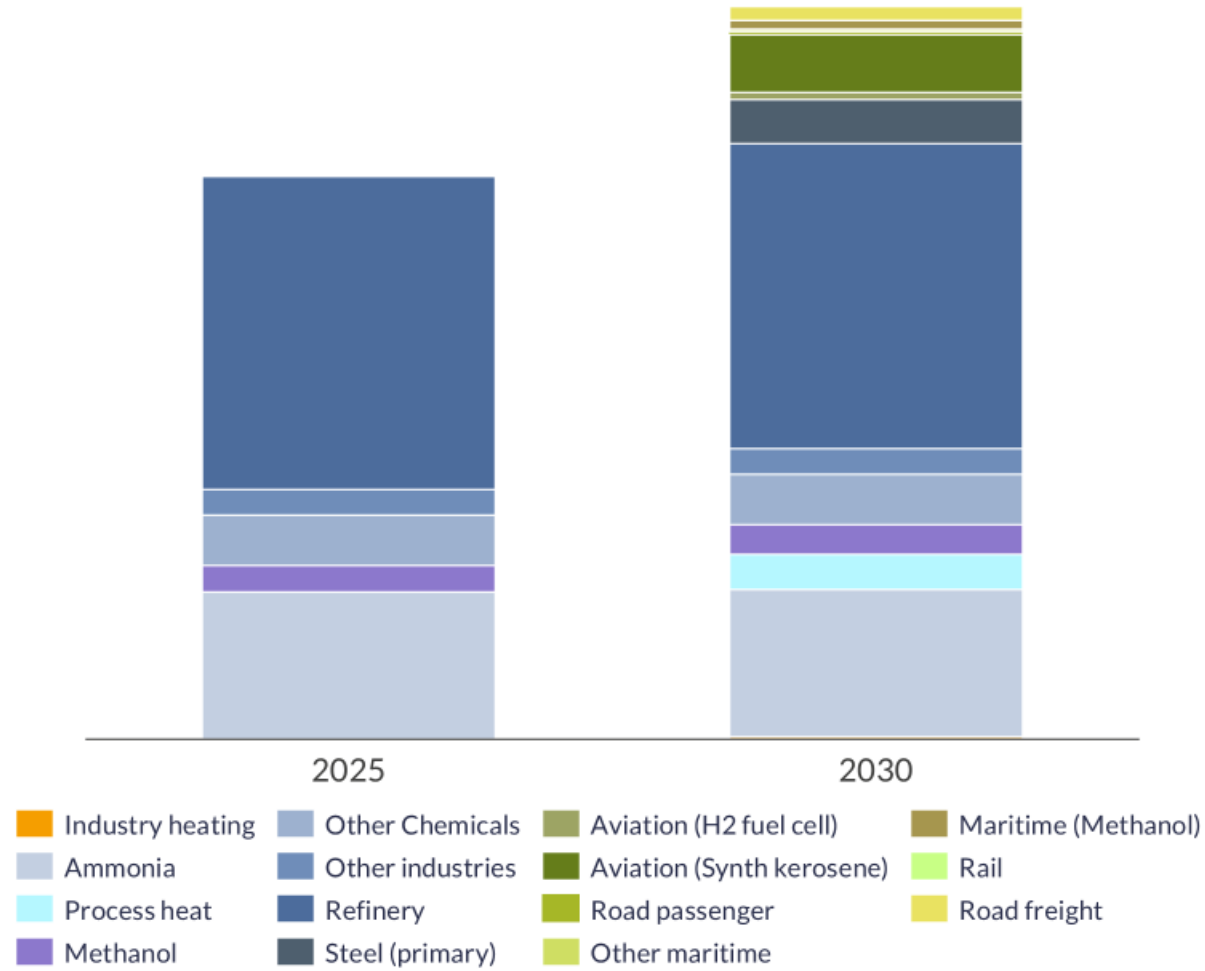
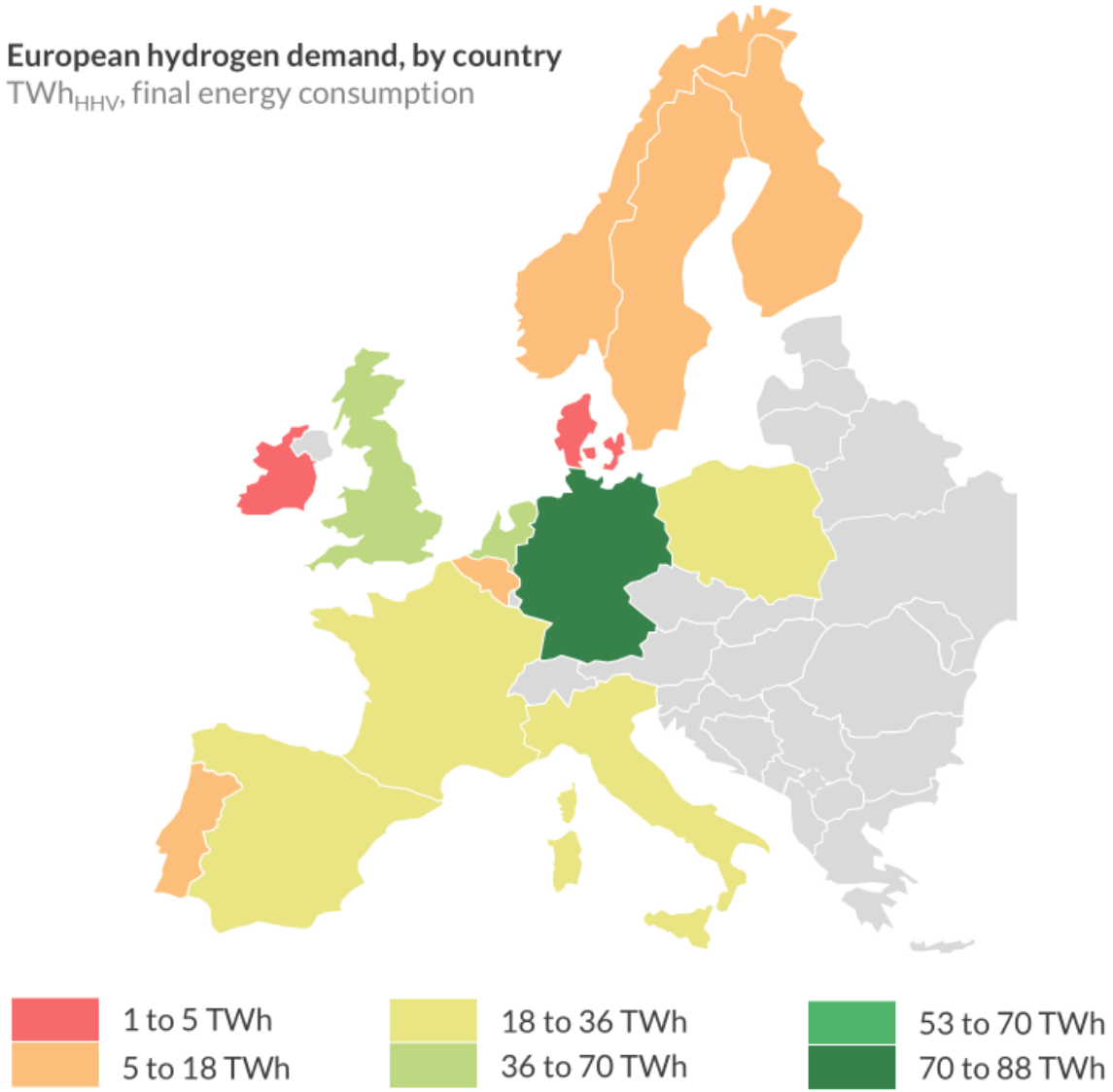
European hydrogen demand, by sector
TWh_{HHV}, final energy consumption



European hydrogen demand, by country
TWh_{HHV}, final energy consumption



Source: Aurora Energy Research

The LCOT comprises 5-11% of the total cost of delivered hydrogen, allowing countries with highly renewable power systems to retain their competitiveness

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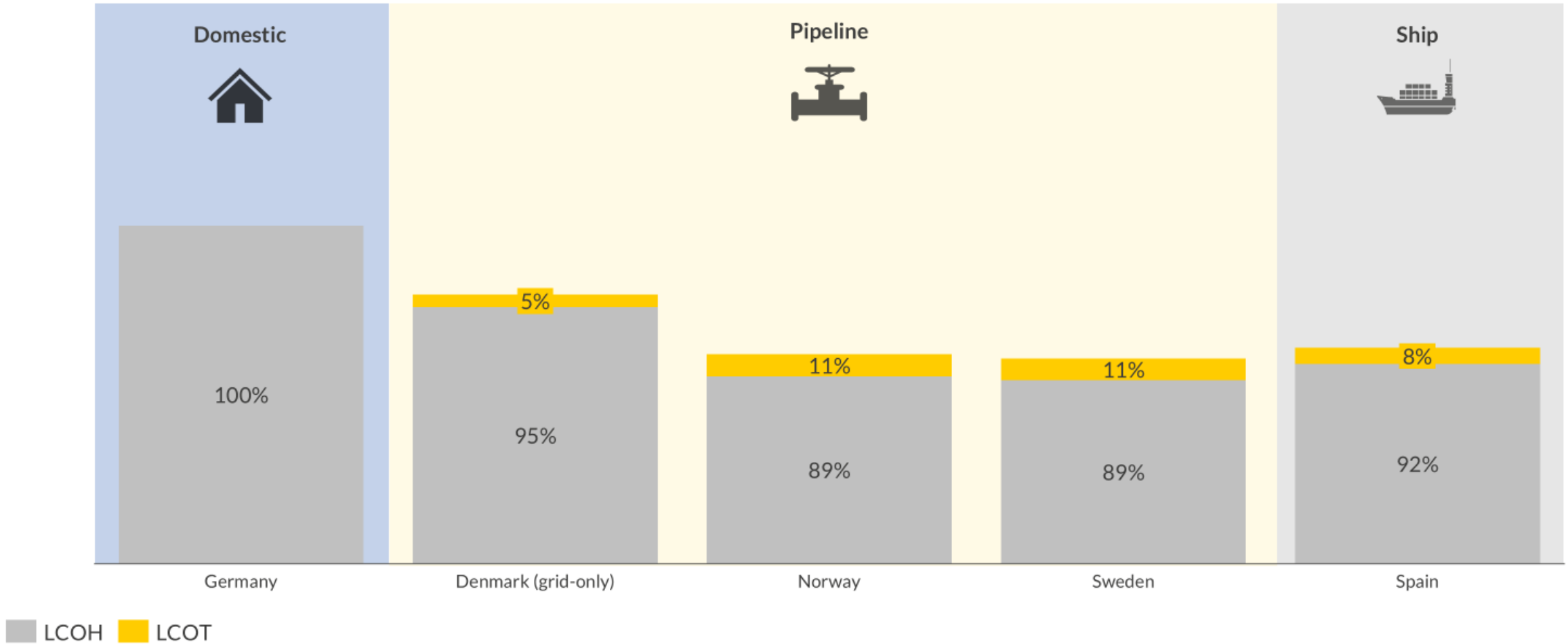
Levelised cost of hydrogen (LCOH), COD 2030
€/kg H_2 (real 2023)



Source: Aurora Energy Research

A robust transport & storage infrastructure network will be required to allow producers to access domestic and EU demand centres

Within the EU H_2 Backbone, TSOs are driving development of the EHB, leading both large-scale coordination efforts and the delivery of T&S projects

European Hydrogen Backbone

Risk category	Risk
Financing	Investment proposition for network operators not sufficiently attractive, yet
Market risk	Hydrogen demand ramp up too slow or not materialising at all
Regulatory framework	Non-economic regulatory risks and permitting delays

High risk Medium risk Low risk

Source: Aurora Energy Research,

Key takeaways

1. **Marked uptick in the number of projects reaching FID** – despite a growing sense of realism in the market on the pace of the development of a clean hydrogen market, some 4.7 GW of electrolyser projects have achieved FID since summer 2023

2. **The regulatory environment for hydrogen in Europe presents an opportunity for countries with high renewable penetration** – electrolyser projects that can produce RFNBO compliant hydrogen from grid electricity have the lowest LCOH's in Europe, whilst allowing producers to adapt to the volume needs of offtakers

3. **Countries willing to integrate electrolysers into their power systems, could benefit from lower LCOH** – the German 13k mechanism could reduce hydrogen production costs by 12-17%, by providing a mechanism by which electrolysers can access power that would otherwise be curtailed

4. **A robust transport & storage infrastructure network will be required to allow producers to access domestic and EU demand centres** – the cost of hydrogen transport makes up just 5-11% of the total cost of delivered hydrogen, which would allow countries with higher renewable penetration to outcompete local producers in Germany. However, there remain significant uncertainties surrounding the wider deployment of infrastructure

Source: Aurora Energy Research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