

# CLEANTECH REALITY CHECK



# REFINERIES

## Renewable H2 for refineries: Getting pumped

### • What is renewable hydrogen (H2)?

Renewable hydrogen (RFNBO-aligned: renewable fuel of non-biological origin) is produced through electrolysis using renewable electricity and water. Hydrogen in oil refining is largely used to hydrocrack and treat heavy crude oil into transport fuels and industrial feedstock. Most hydrogen today is produced on-site from natural gas or as a byproduct from refinery processes. Refinery emissions, with a notable contribution from on-site H2 production, currently represent ~46% of scope 1 and 2 CO2 emissions from oil and gas production.

### • Key take-aways

- Renewable hydrogen use by refineries could prove to be one of the catalysers of the European Hydrogen Economy, with more than 60 projects announced (accounting for ~2.2 Mt) with potential refinery off-take, and more than 20 projects (~0.2 Mt) beyond FID (Final Investment Decision).
- Faster scale-up is needed when comparing to the current 4.5 Mt of hydrogen used by the refinery sector (mainly fossil-based), or the EU's overall target of 10 million tonnes (Mt) renewable hydrogen.
- The main barriers include insufficient demand mobilisation from policy targets, complicated and suboptimal public funding mechanisms, and fragmented infrastructure development.

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### STRATEGIC IMPORTANCE FOR EUROPE

- > The refining sector, while undergoing deep transformation to meet Europe's net zero goals, could prove to be one of the catalysers of the European Hydrogen economy, as it currently is a significant driver of the EU's renewable H2 demand.
- > Europe is leading significantly in the globally announced project pipeline when it comes to renewable hydrogen intended for refining. Maintaining competitiveness on cost and technology is key, especially with Chinese H2 development subsidies creating an uneven playing field.
- > The EU recognises renewable energy's importance in transport and industry through targets in the Renewable Energy Directive III and RePowerEU, however these targets are less constraining than the regulations in other sectors like aviation (REFuelEU).

### CURRENT PROGRESS OF RENEWABLE H2 WITH REFINERY END-USE IN THE EU

OFF-TRACK

H<sub>2</sub>

ON-TRACK

**Status: SIGNS OF PROGRESS** Although the use case for renewable H2 in refineries is clear, and recent renewable H2 projects FIDs show signs of progress, sustained impetus of renewable H2 development is slowed as policy targets are yet to mobilise refinery demand, funding is complicated to access for H2 projects, and lowest-cost renewable power is yet to be leveraged across the EU H2 economy.

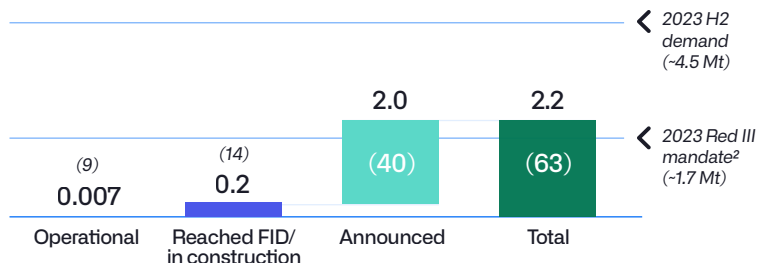
**63** projects announced to be operational by 2030

**23** projects having reached FID or operational in EU as of Q3 2024

### RENEWABLE H2 PRODUCTION CAPACITY BEYOND FID ONLY ACCOUNTS FOR 5% OF REFINERIES' H2 DEMAND

- > The EU's announced and operational production capacity for renewable hydrogen earmarked for refinery end-use represents 66% of the globally announced and operational capacity for refinery end-use, but only 22% of the targeted overall 10 Mt H2 domestic production under Fit For 55.

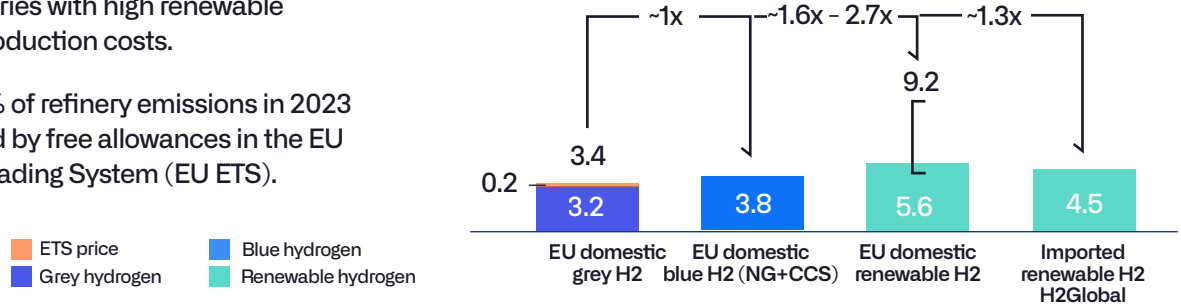
- **Announced renewable H2 production capacity for refineries commissioned by 2030 (Mt)<sup>1</sup> (# projects)**



### EU RENEWABLE H2 CANNOT YET COMPETE WITH GREY, BLUE, OR IMPORTED H2

- > More than 40% of Europe's refining capacity falls in countries with high renewable hydrogen production costs.
- > Roughly 70% of refinery emissions in 2023 were covered by free allowances in the EU Emissions Trading System (EU ETS).

- **Levelised Cost of H2 2024<sup>3</sup> (€/ kg H2)**



<sup>1</sup> Does not include concept or demonstration projects

<sup>2</sup> Estimated Renewable H<sub>2</sub> use target for refineries based on the 2030 RED III mandate which states that 42% of H<sub>2</sub> for industry must be renewable and 1% of all energy supplied to the transport sector must be fuels of RNFBO origin, assuming here that all RNFBO fuels supplied to transport market will originate from refineries. This target could also be met by other e-fuels.

<sup>3</sup> Grey and blue LCOH<sub>2</sub> averaged over 4 EU countries with largest refinery capacity (Germany, Spain, France, Netherlands), domestic renewable H<sub>2</sub> low-end represents Spain, high-end represents Germany, imported renewable H<sub>2</sub> based on H2Global and FertiGlobe's e-ammonia landing price at €1000/ton.

Sources: Analysis by Systemiq undertaken for Breakthrough Energy and Cleantech for Europe. Analysis based on prior completed analysis by Systemiq for MPP relating to EU PtX LOCX, IEA H2 project database, Clean Hydrogen Observatory 2023, ETC 2023 Fossil Fuels in Transition; EU ETS emissions viewer.

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## RENEWABLE H2 FOR REFINERIES: GETTING PUMPED

### 😊 ENABLERS – WHAT IS GOING WELL

#### FIRSTMOVER OFFTAKER ENABLING EARLY SCALING

Europe leads renewable H2 project pipeline for refineries, leveraging their willingness to pay, and existing grey demand (57% of Europe's H2 use today) to reach FID. Co-locating with refinery projects (~25% of refinery H2 demand) and low-tech integration costs both reduce barriers to entry for refineries and thus refineries play key role to scale first volumes.

#### COMPREHENSIVE POLICY FRAMEWORK ESTABLISHED

The Renewable Energy Directive (RED) has set the overarching framework through mandated renewable H2 use targets for industrial feedstock products (42%) and national shares of RFNBO's supplied to the transport sector (1%) by 2030. EU has led high integrity RFNBO definition giving industry clarity, and EU Hydrogen Bank critically provides a framework for supporting both OPEX and CAPEX support (first auction enabled bankability with ~85M for refinery renewable H2).

#### OIL & GAS COMPANIES ABSORBING PROJECT RISK

Whereas other e-fuel segments such as e-SAF for aviation struggle to finance capital-intensive projects, renewable H2 plants benefit from the presence and interest from O&G companies, thereby being able to leverage their existing infrastructure and sizeable balance sheets for favourable capital costs and risk-taking ability.

### ☹️ BARRIERS – WHAT IS NOT GOING WELL

#### POLICY TARGETS YET TO MOBILISE DEMAND

Uncertainty exists around various topics surrounding Member State implementation of RED III (e.g. on target compliance schemes, RFNBO multipliers), halting clarity on the business case for using renewable H2 in refineries. The absence of RED targets beyond 2030 disincentives high ambition and/or long-term investment.

#### COMPLEX AND SUB-OPTIMAL FUNDING

The multitude of EU H2 funding pools increases complexity, delays funding and cannot be stacked, whereby funding granted 2-3 yrs ago proves insufficient in new macro-economic environment without indexing. Much EU funding goes to first-of-a-kind demonstration projects, and requires wider embedded guidelines on sourcing EU-made equipment.

#### DISPARATE DEVELOPMENT OF INFRASTRUCTURE

Pan-EU coordination is essential to leverage competitive renewable power across the EU H2 economy. However, ongoing H2 infrastructure developments so far are driven mainly by national gas network operators, with too little institutionalized EU coordination required to ensure the optimal build-out of renewable power and H2 infrastructure.

### 📅 ACTION AGENDA – WHAT NEEDS TO BE DONE

#### 1 Establish long-term regulatory certainty around set-out policy targets

Set effective measures for Member States to implement RED III into national legislation before the set-out deadline, providing regulatory certainty for various topics surrounding national compliance schemes on both RFNBO's supplied to the transport sector and refineries' use of renewable H2 for industrial products. RED targets could also be extended beyond 2030.

#### 2 Strengthen public funding to support longer term scale-up of the EU H2 economy

This could take the form of increased funding to the EU Hydrogen Bank for auctions specific to end-uses, and financial guarantees through the EIB. To further bridge the green cost gap, enable funding flexibility to allow funding stacking by projects recognised by Member States or Important Projects of Common European Interest (IPCEI), align state aid rules with the EU's next Multiannual Financial Framework budget and existing funding, and index funding to the macro-economic environment. Set the policy framework to ensure EU-funded projects source EU-made H2 equipment, and for the EU Hydrogen Bank to operate as green market maker like Hintco and H2Global.

#### 3 Guide pan-EU coordination to streamline ongoing H2 infrastructure development

Guide the development of the European Network of Network Operators of Hydrogen (ENNOH), aiming at regulatory clarity on implementation of intertemporal and cross-border tariff allocation, H2 purity standards, equitable market entry for all H2 developers, and a development plan for H2 infrastructure planning aligned with the renewable electricity sector, energy industry, renewable H2 developers, and overall EU targets.

Solving the climate change challenge while maintaining competitiveness on a global scale will require partnerships between governments and industries. The European Union could support this effort by reducing complexity around incentives, providing additional regulatory certainty and also ensuring a level playing field to bolster the European clean fuels economy.

Amy Chiang, Chief Sustainability and External Affairs Officer, Topsoe

# REFINERIES

## RENEWABLE H2 FOR REFINERIES: GETTING PUMPED

### 60+ ANNOUNCED RENEWABLE H2 PLANTS (~2.2 MTPA) IN EUROPE

(as of October 2024)

**HySynergy, (phase 1), (phase 2), (phase 3), (2024), (2007), (2030)**

**SHARC (phase 1), (phase 2), (phase 3), (2026), (2026), (2029)**

**Legend: Capacity, kilotonnes of H2 per year**



**Port of Rotterdam BP refinery - H2-Fifty**

**Oranjewind (2028)**

**RWE Eemshydrogen (2027)**

**Multiphly (2023)**

**NorthH2 (phase 1), (2030)**

**Deltaurus 1 (2026)**

**Holland Hydrogen (phase 1), (phase 2), (2025), (2027)**

**Zeeland Refinery - H2ero (2026)**

**El-H2 - Aghada (2026)**

**H2 Pilotanlage Lingen, (phase 1), (phase 2), (2024)**

**Lingen Green Hydrogen (LGH2) (phase 1)**

**Abanto Technology Park (2023)**

**BP Castellon refinery, (HyVal) (phase 1), (phase 2), (2027), (2030)**

**Repsol Bilbao port synfuels project (2025)**

**GreenH2Atlantic (2028)**

**Grey2Green (phase 1), (phase 2), (2025), (2027)**

**Carteia Project (phase 1) (2028)**

**Tecoil (2020)**

**H&R Ölwerke Hamburg-Neuhof (2017)**

**Norddeutsches Reallabor (2026)**

**Bad Lauchstädt energy park (2025)**

**BayH2 (2027)**

**GET H2 Nukleus, (phase 1), (phase 2), (phase 3) (2025, 2027)**

**Grupa Lotos refinery (2027)**

**Trzebinia refinery (2021)**

**GreenHydroChem**

**HySCALE 100 (2026)**

**Hydrogen Eagle (Litvinov) (2028)**

**Rehfyne I, Rehfyne II (2021, 2027)**

**UpHy (2024)**

**Smartenergy Porto Torres, phase 3 (2030)**

**Szazhalombatta refinery (2024)**

**H2V Marseille - Fos (Σ(phase 1), (phase 2), (phase 3), (phase 4), (phase 5)) (2026), (2027), (2028), (2029), (2030)**

**Onuba Project (phase 1) (2026)**

**Repsol Tarragona (phase 1), (2028)**

**Puertollano HyDRIC project (phase 1), (2026)**

**Normand'Hy - Air Liquide (2026)**

**Repsol Cartagena, (phase 1), (2027)**

Notes: Map excludes projects in feasibility stage smaller than 5kt H2 output, projects are placed in respective countries but not always on their respective location.

Source: IEA H2 projects database

In order to make the European Hydrogen Economy thrive, we must implement offtake incentives, improve funding, financing and guarantees for first movers, and introduce resilience criteria in auctions to safeguard European competitiveness.

Anne-Laure de Chammard, Executive Board Member & Group Executive Vice President, Siemens Energy