



# KGAL RESEARCH

## GREEN HYDROGEN



## EU SETS PACE IN GREEN HYDROGEN RACE

*The US and Europe are the regions most committed to promoting a clean hydrogen economy. Europe is taking the more promising approach, focusing on supply AND demand.*

Clean hydrogen is a vital tool in the decarbonisation of the economy. It can be used as a renewable fuel or feedstock in all major CO<sub>2</sub>-emitting sectors, including those where direct electrification is not possible. In addition, with clean hydrogen renewable energies become easier to store and to transport. However, policy support will be needed to ensure clean hydrogen can compete with fossil fuels and other low-carbon alternatives.

To be able to decarbonise their economies, 52 countries have released a hydrogen strategy to date, with many setting megatonne (Mt) production targets. Nearly half of the markets with established strategies have set electrolyser capacity targets, amounting to a combined total of 119 gigawatts (GW) by 2030.<sup>1</sup> Global clean hydrogen production projects are multiplying rapidly, with electrolyser shipments doubling every year since 2020.<sup>2</sup>

However, clean hydrogen demand is lagging behind supply. Based on initiatives announced, the US and the EU are most committed to promoting a clean hydrogen economy, but Europe stands out as a global leader by offering more incentives to align supply with demand. Twenty EU member states have adopted hydrogen strategies, with electrolyser capacity targets totalling 59 GW by 2030 – half of the global total.<sup>3</sup> In addition, EU hydrogen quotas, the EU Innovation Fund and the EU Emissions Trading Scheme (ETS) are the strongest clean hydrogen demand drivers worldwide.

Global government funding for hydrogen reached \$351 billion in 2023 – around 46% higher than in 2022 – largely due to funding from Europe and the US. Outside Europe, most funding programmes support clean hydrogen production.<sup>4</sup> On the following pages we compare the US and EU hydrogen strategies.

### THE AUTHORS



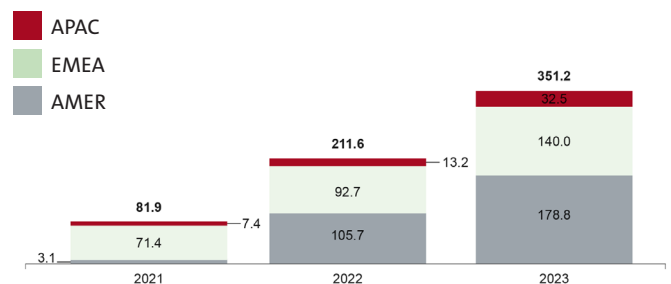
**BRITTA  
RODEN**  
Head of Research  
at KGAL



**FELICIA  
OJINJI**  
Infrastructure Research Analyst  
at KGAL

### GREEN HYDROGEN FUNDING

\$ billion (2022 real)



Source: BloombergNEF; January 2024

<sup>1</sup>BloombergNEF 2H 2023 hydrogen Market Outlook, October 2023. <sup>2</sup>BloombergNEF 2H 2023 hydrogen Market Outlook, October 2023. <sup>3</sup>BloombergNEF 2H 2023 hydrogen Market Outlook, October 2023. <sup>4</sup>BloombergNEF Electrolyzer Industry in 2024 - World Electrolysis Congress - Full Report.

## THE UNITED STATES

The growth in US government funding for hydrogen is driven by the clean hydrogen production tax credit (PTC), created under the Inflation Reduction Act (IRA).

**The Inflation Reduction Act (IRA):** The IRA, approved by the US Congress in August 2022, aims to reduce domestic inflation and combat climate change. Key goals include cutting national carbon emissions by 40% by 2030.<sup>5</sup> The act allocates around \$370 billion for initiatives promoting cleaner alternatives for energy, transportation, buildings and manufacturing in the US. These include grants, loans, tax incentives and other measures to accelerate the adoption of sustainable practices.<sup>6</sup> The clean hydrogen PTC was introduced as part of the IRA.

**The clean hydrogen production tax credit (PTC):** The PTC provides a 10-year incentive of \$0.6–\$3 per kilogram of clean hydrogen produced in the US. The value of the tax credit depends on the carbon intensity of the production method, with the maximum credit granted to a production pathway with 0-0.45 kg of carbon dioxide equivalent (CO<sub>2</sub>e) per kilogram of hydrogen produced and the minimum credit for 2.5-4 kg CO<sub>2</sub>e. Projects must commence construction by 2033.<sup>7</sup>

The goal is to make clean hydrogen more competitive than grey hydrogen produced with natural gas. The production cost of clean

hydrogen ranges from \$2.5 to \$5.2 per kilogram while that of grey hydrogen ranges from \$1.14 to \$1.45 per kilogram in the US.

## EUROPEAN UNION

The European Hydrogen Bank, financed by the EU Innovation Fund, drives the expansion of green hydrogen subsidies.

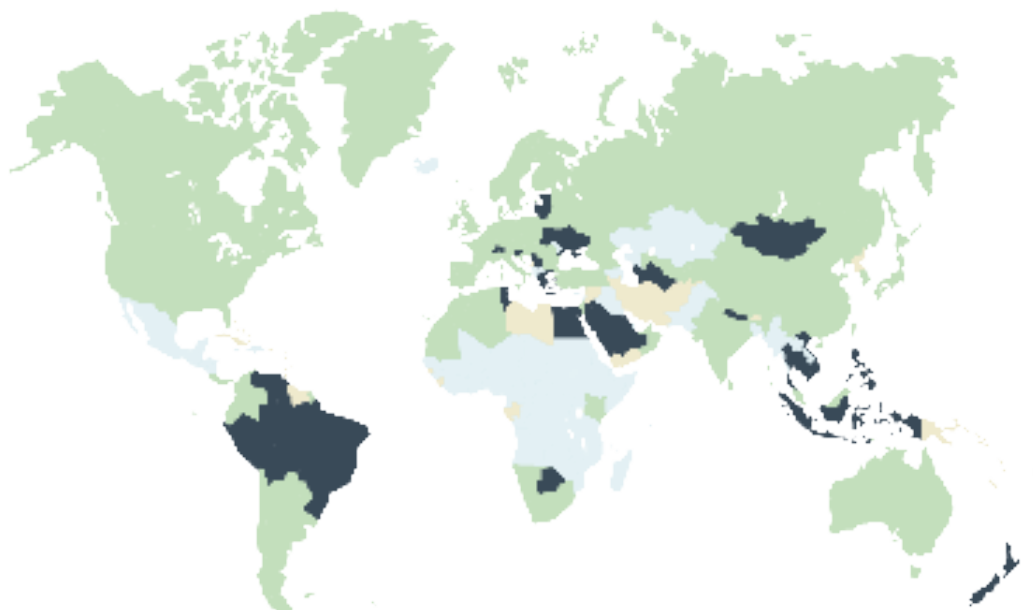
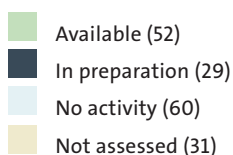
**European Hydrogen Bank:** In 2022, the European Commission initiated the establishment of the European Hydrogen Bank to foster investment stability and cultivate business prospects for renewable hydrogen production, both in Europe and globally.



### The EU hydrogen bank is set to offer subsidies of up to €4.5/kg, outcompeting the US clean hydrogen PTC

With an initial budget of €800 million (\$859 million) from the EU Innovation Fund, the Hydrogen Bank is set to offer subsidies of up to €4.5/kg (\$4.8/kg), outcompeting the US clean hydrogen PTC.<sup>9</sup> The Hydrogen Bank aims to reduce the cost gap between green and fossil-based hydrogen production. The production cost of clean hydrogen ranges from \$2.3 to \$5.2 per kilogram while that of grey hydrogen ranges from \$2 to \$2.2 per kilogram, in the EU.<sup>10</sup>

## HYDROGEN STRATEGY BY COUNTRY



Source: BloombergNEF

<sup>5</sup>Inflation Reduction Act of 2022 – Policies – International Energy Agency. <sup>6</sup>Inflation Reduction Act of 2022 – Policies - IEA. <sup>7</sup>Financial Incentives for Hydrogen and Fuel Cell Projects \_ Department of Energy. <sup>8</sup>BloombergNEF Hydrogen Levelized Cost Update. <sup>9</sup>BloombergNEF 2H 2023 hydrogen Market Outlook, October 2023. <sup>10</sup>BloombergNEF Hydrogen Levelized Cost Update

**EU Innovation Fund:** The EU Innovation Fund is one of the world’s largest funding programmes for the deployment of net-zero carbon and other innovative technologies. The Innovation Fund aims to bring solutions to the market to decarbonise European industry and support its transition to climate neutrality, while fostering its competitiveness.

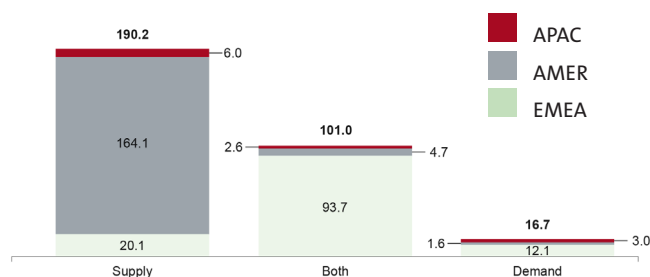
The EU Emissions Trading System (EU ETS) – the world’s largest carbon pricing system – provides the revenues for the Innovation Fund from the monetisation of 530 million ETS allowances. The unspent funds from the NER300 programme, the Innovation Fund’s predecessor, were also transferred to the Innovation Fund.

**EU Emissions Trading System (EU ETS):** The EU ETS is the world’s first and largest carbon market, and the EU’s primary strategy to efficiently reduce greenhouse gas emissions. Operating on the “polluter pays principle”, companies are obliged to purchase emissions allowances (EUAs) for each tonne of CO<sub>2</sub>e they emit into the atmosphere. The money raised via the EU ETS is reinvested in the EU Innovation Fund.



## HYDROGEN FUNDING BY SEGMENT ALONG THE VALUE CHAIN

\$ billion (2022 real)



Source: BloombergNEF

## DECARBONISATION INCENTIVES FOR HYDROGEN DEMAND

Clean hydrogen production incentives are far outpacing incentives for its use – subsidies aimed at boosting demand represent only 5.5% of the total available government funding.<sup>13</sup>

But Europe is taking the lead in developing demand-side incentives, primarily through the EU Innovation Fund, which has the potential to reach a budget of over €74 billion by 2030 (based on carbon price forecasts for the EU ETS, from which the funds are derived).<sup>14</sup> The fund aims to support all types of clean hydrogen production projects and the end-use of clean hydrogen or clean hydrogen-based products, like e-fuels or steel produced with hydrogen.

Additionally, state-aid subsidies provided by EU member states, the EU quotas for hydrogen use in transport and industry, and rising carbon prices under the EU ETS are set to boost hydrogen demand.

## EU QUOTAS FOR HYDROGEN

The EU quotas stand out as the most robust demand-side incentive for clean hydrogen worldwide. In 2023, the EU implemented quotas for Renewable Fuels of Non-Biological Origin (RFNBOs) and renewable hydrogen-based fuels, targeting industrial users of hydrogen such as oil refineries, steel producers and new companies in the transportation sector like the maritime and aviation sectors.

<sup>13</sup>Ashurst Investing in hydrogen- A global Guide. <sup>14</sup>Ashurst Investing in hydrogen- A global Guide. <sup>15</sup>BloombergNEF 2H 2023 hydrogen Market Outlook, October 2023. <sup>16</sup>BloombergNEF 2H 2023 hydrogen Market Outlook, October 2023.

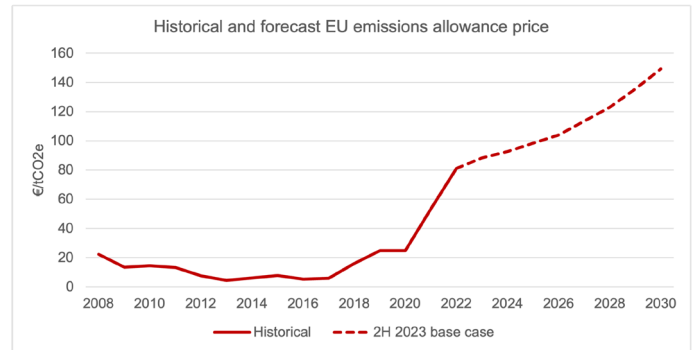
The EU quotas (see graph below) are projected to generate a green hydrogen demand of 2.1–4.2 Mt by 2030, and 5 Mt by 2035.<sup>15</sup> The quotas are part of the revised Renewable Energy Directive II (RED II), which was adopted by EU member states in 10/ 2023.

## RENEWABLE ENERGY DIRECTIVE II (RED II)

The Renewable Energy Directive, established in 2018, serves as the legal foundation for advancing clean energy throughout all sectors of the EU economy, fostering collaboration among EU nations to achieve this objective. The directive was revised in 2023 to include more stringent targets and increase the use of renewables – including green hydrogen – across the economy.

**EU Allowance (EUA) prices:** An EUA allows a firm to emit 1 metric tonne of CO<sub>2</sub>e within a given year. These allowances are traded as part of the EU ETS, with the price being set by the market through supply and demand.

## HISTORICAL AND FORECAST EU EMISSIONS ALLOWANCE PRICE

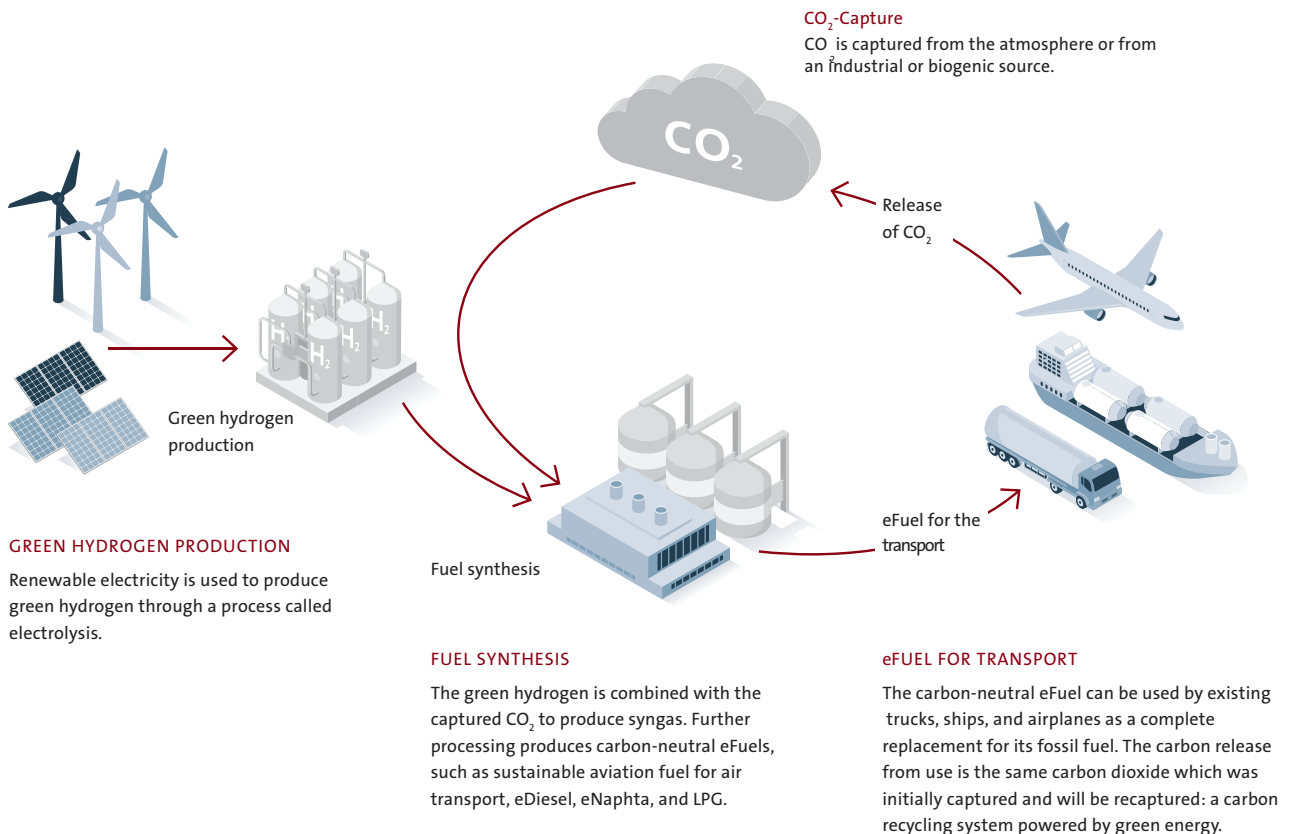


Source: BNEF

Putting a price on carbon emissions makes green hydrogen projects more financially feasible. In the EU, emission allowance prices are projected to increase by 69% between 2023 and 2030. This is expected to jumpstart a significant rise in hydrogen uptake.

## CASE STUDY VORDINGBORG: CARBON NEUTRAL EFUEL BENEFITTING FROM EU QUOTAS

KGAL has a stake in the Vordingborg hydrogen-based e-kerosene project in Denmark, which is being developed by Arcadia. The plant is expected to produce 68,000 tonnes of e-kerosene per year, starting 2026. The project benefits very much from the EU’s mandatory quotas for sustainable aviation fuels (SAFs) in the EU. As early as 2025, at least 2 percent of SAFs will have to be in the tank on all EU-departing flights, rising to 6 percent in 2030 and 70 percent in 2050.



<sup>15</sup>BloombergNEF 2H 2023 hydrogen Market Outlook, October 2023.



## MOST IMPORTANT HYDROGEN CATEGORIES

### US

- **Clean hydrogen** is defined as hydrogen produced with emissions of less than 4 kilograms (kg) of carbon dioxide equivalent (CO<sub>2</sub>e) per kilogram of hydrogen produced, measured on a life-cycle basis. This excludes hydrogen produced through electrolysis powered by nuclear energy.
- **Green hydrogen** is hydrogen produced through electrolysis powered by renewable energy. It is a subcategory of clean hydrogen.
- **Blue hydrogen** is produced from natural gas with carbon emissions captured and stored. It is also categorised under clean hydrogen if emissions are less than 4 kilograms (kg) of carbon dioxide equivalent (CO<sub>2</sub>e) per kilogram of hydrogen produced.
- **Grey hydrogen**, the most common form of hydrogen production in the US, is produced with natural gas but without carbon capture. Emissions range from around 10 to 12 kg of CO<sub>2</sub>e per kilogram of hydrogen produced.

### EU

- **Green/clean hydrogen:** Also called renewable hydrogen, refers to hydrogen produced through electrolysis powered by renewable electricity.
- **Blue hydrogen:** Also called low-carbon hydrogen, is produced from natural gas with carbon emissions captured and stored.
- **Grey hydrogen:** Also called fossil-based hydrogen, grey hydrogen is produced with natural gas but without carbon capture.

## CONCLUSION

Green hydrogen is key to decarbonisation, but the challenge is to establish a new market that balances demand as well as supply, and where green hydrogen can be profitable without government incentives. While the US government targets the production of hydrogen through tax incentives, the EU goes one step further in also incentivising the demand side through quotas and other supporting policies. The European approach offers greater market predictability for new businesses entering the hydrogen market.

At KGAL, we observe a promising outlook for business cases in green hydrogen production in Europe. The combination of policy support, growing demand, technological advancements in renewable energy technologies and international cooperation instils confidence among investors.

## YOUR CONTACT

**Britta Roden**

Head of Research at KGAL

E-Mail: [britta.rodén@kgal.de](mailto:britta.rodén@kgal.de)

Phone: +49 89 64143 083

This presentation/report is aimed exclusively at professional investors. The present document is for general information purposes only. The document does not constitute an offer or investment advice and should not be used as the basis for an investment decision. No investment can be made on the basis of this document. Any investment should only be made by any potential investor based on prior Due Diligence by the investor and upon extensive prior advice by third party professional consultants for particularly legal and tax matters and only based on the specific investment fund or investment vehicle legal and other documentation. This document may not be published or used in any way without the prior written consent by KGAL GmbH & Co KG. Imprint: KGAL GmbH & Co. KG · Tölzer Straße 15 · 82031 Grünwald; T + 49 89 64143 – 0; [kgal@kgal.de](mailto:kgal@kgal.de); [www.kgal.de](http://www.kgal.de)