



EUROPEAN SUPPLIERS
OF WASTE-TO-ENERGY
TECHNOLOGY

WASTE-TO-HYDROGEN:

A CIRCULAR APPROACH TO
WASTE MANAGEMENT AND
TRANSPORT

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FOREWORD

Over the last few years, hydrogen gained momentum in European policy and is now a key feature of many debates and conferences.

Renewable and low-carbon hydrogen are believed to be a significant part of the solution to achieve carbon neutrality by 2050, especially in energy-intensive industries and transport.

The Waste-to-Energy sector is now developing Waste-to-Hydrogen solutions to contribute to the decarbonisation in Europe.

Indeed, energy produced from Waste-to-Energy plants represents a significant alternative to fossil fuels, as half of it is of biogenic origin and renewable, and can be conveyed to generate low-carbon hydrogen.

Promising pilot demonstrations and projects at various stages of development are now taking off in Europe. Let's have a look at some of them!



1. FROM WASTE-TO-ENERGY TO WASTE-TO-HYDROGEN

Waste-to-Energy plays a key role in the European waste management by treating non-recyclable waste and diverting it from landfills.

Landfills diversion allows to reach many environmental objectives: reducing methane emissions and other long-term pollutants; saving valuable land, and recovering secondary raw materials.

Waste-to-Energy plants generate energy that is used to power and heat households, industrial facilities and buildings.

The recent development of Waste-to-Hydrogen solutions is another way for the sector to support decarbonisation.

Indeed, hydrogen can be produced from the electricity generated by a Waste-to-Energy plant through an electrolyser. Electrolysis is the most common process used for hydrogen production. However, Waste-to-Hydrogen can also be generated from other technologies used in plants, such as gasification.

The low-carbon fuels generated by Waste-to-Hydrogen process can decarbonise heavy transports such as public buses and refuse trucks. Thus, Waste-to-Hydrogen projects are seen with great interest by those involved in projects towards circular waste management and zero-emissions transports.

- **A need for transitional low-carbon hydrogen:**

The deployment of low-carbon and renewable hydrogen has a big role to play in the decarbonisation of energy-intensive sectors.

Low-carbon hydrogen, also called 'blue' hydrogen, is mostly used to describe hydrogen from natural gas for which the carbon emissions are captured and stored. In order to be qualified as 'green', hydrogen has to be completely produced from renewable sources¹.

Renewable hydrogen is recognised as the end-goal, but low-carbon hydrogen have a transitional and complementary role to play in developing the hydrogen value chain in Europe (examples in the Netherlands² or in Italy³).

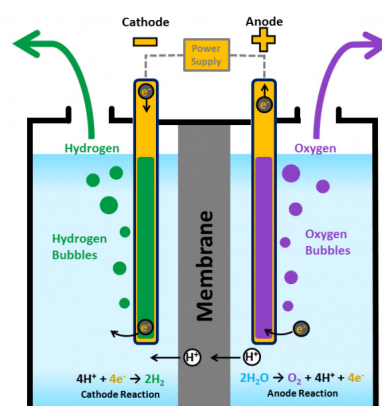


Image by [US Department of Energy](#)

¹ <https://www.iea.org/commentaries/the-clean-hydrogen-future-has-already-begun>

² <https://energypost.eu/the-netherlands-a-blue-hydrogen-economy-now-will-ease-a-transition-to-green/>

³ <https://energypost.eu/case-study-italy-optimising-emissions-cuts-means-well-need-grey-and-blue-hydrogen-too/>

2. CURRENT PROJECTS AND PILOT DEMONSTRATIONS

Hydrogen is expected to have a significant contribution to the decarbonisation of transport. As heavy duty vehicles account for around 25% of European road transport CO₂ emissions⁴, they represent an important mitigation potential.

This is one of the challenges addressed by the ongoing and pilot projects about Waste-to-Hydrogen. In fact, the hydrogen generated by Waste-to-Energy plants can power fuel cell buses for public transport, or refuse trucks collecting municipal waste. Most of those projects receive European funds. Here are some examples:

- **Wuppertal Hydrogen Buses:**

10 buses are using hydrogen generated by the Waste-to-Energy plant in Wuppertal, Germany⁵. A small amount of the energy generated by the plant is used to charge the electrolyser. Each bus is equipped with an 85 kW fuel cell to convert the hydrogen. The process avoids around 700 tonnes per year of CO₂ (as compared to diesel).

Half of the bus fleet of Wuppertal should run on hydrogen by 2025⁶. A first hydrogen-fueled refuse truck was also manufactured in May 2021. The project is likely to be reproduced in other cities, and expand to the local taxi fleet and the Düsseldorf airport's utility vehicles.



Image by [AWG Wuppertal](#)

- **The REVIVE project:**

The REVIVE project aims at building the largest demonstration network of hydrogen fuel cells refuse trucks, with 15 heavy-duty vehicles across 8 sites in Europe⁷.

Part of the project involves trucks powered by Waste-to-Hydrogen: the first one was deployed in 2020 in Breda (the Netherlands), with a second one expected by July 2021⁸.



Image by [REVIVE Project](#)

⁴ https://ec.europa.eu/clima/policies/transport/vehicles_en

⁵ <http://www.awg.wuppertal.de/ueber-uns/aktuelles/artikel/muell-macht-mobil-wsw-busse-fahren-mit-wasserstoff-aus-dem-mhkw.html>

⁶ <http://www.awg.wuppertal.de/ueber-uns/aktuelles/artikel/zum-awg-fuhrpark-gehoert-jetzt-ein-abfallsammelfahrzeug-das-mit-wasserstoff-faehrt.html>

⁷ <https://h2revive.eu>

⁸ <https://www.fch.europa.eu/press-releases/hydrogen-refuse-truck-european-revive-project-starts-operation-breda-using->

The use of Waste-to-Hydrogen trucks is particularly efficient as the refuse trucks operate close by the Waste-to-Energy plant and the hydrogen filling station. To evaluate the potential of this type of operation, the project is also been conducting a study on this business model called “Waste-to-Wheels”.

- **The “Waste-to-Wheels” model:**

The model was first developed by Tractebel (ENGIE) within the REVIVE project⁹. The purpose is to adopt a fully circular approach to waste collection and waste management: hydrogen produced from Waste-to-Energy plants is used as a fuel for refuse trucks and other heavy mobility, which lead to a loop and allows to use renewable and local energy for utility vehicles. The goal is to use part of the energy produced by the plant to generate hydrogen via electrolysis.

Currently, a project under development in Belgium (Bruxelles Energie) is inspired by the Waste-to-Wheels model¹⁰.

The Waste to Wheels model Combination of Valorisations

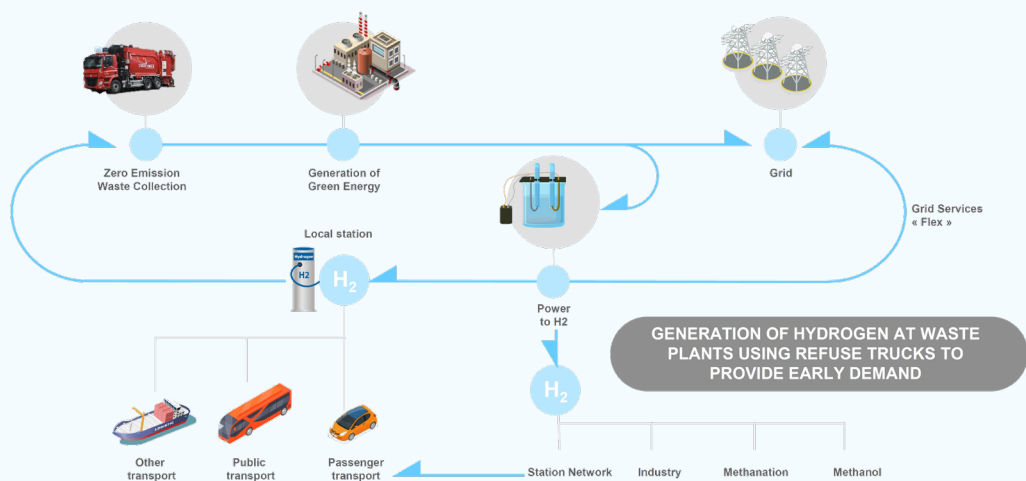


Image by [REVIVE Project](#)

- **Creteil Waste-to-Hydrogen project:**

In France, a Waste-to-Hydrogen plant is under construction in Créteil and should be operational by 2022. The plant is expected to produce 500 kg of hydrogen per day from electrolysis, with a price of 9 to 10 € per kg at the hydrogen fueling station¹¹. This hydrogen will be made available for public buses, utility vehicles and waste collection trucks.

hydrogen

⁹ <https://h2revive.eu/about-revive/>

¹⁰ http://www.europeanenergyforum.eu/sites/default/files/events/doc/2_tractebel_presentation_-_eef_dd_22_october_2019_strasbourg.pdf

¹¹ <https://fuelcellworks.com/news/suez-and-sipperec-join-forces-to-develop-the-1st-green-hydrogen-production-solution-on-energy-from-waste-plant-in-france/>

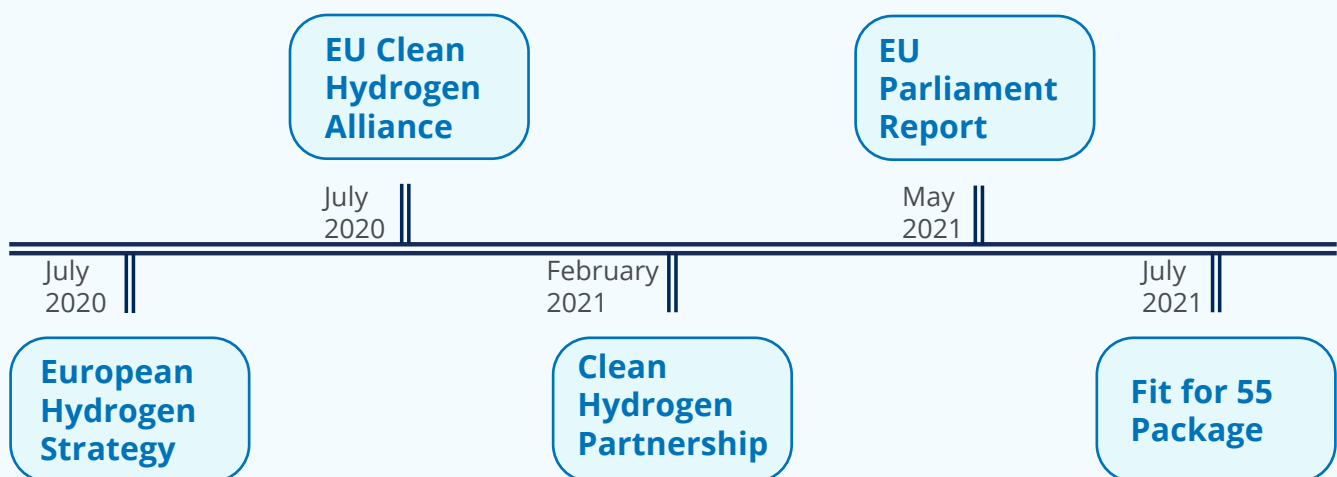
3. OVERVIEW OF HYDROGEN IN EUROPEAN POLICY

The European Union's interest for hydrogen gained momentum in 2020, with several initiatives launched by the institutions and supported by the German then Portuguese presidency of the Council of the EU.

First of all, the European hydrogen strategy was adopted in July 2020. In order to stimulate the development of the hydrogen value chain and to coordinate investments, the creation of an European Clean Hydrogen Alliance was announced the same year¹².

In February 2021, a Clean Hydrogen Partnership was launched. This partnership will build on the work of the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), the current main funding instrument for projects related to hydrogen in Europe.

The FCH JU¹³ involves both the private and the public sector: Hydrogen Europe representing the industry, the European Commission representing the public sector, and the Hydrogen Europe Research representing the research community. Since its creation in 2008, the FCH JU funded and supported 285 projects.



- **European Hydrogen Strategy**

The European hydrogen strategy is a communication document¹⁴ adopted by the European Commission. The strategy states that renewable and low carbon hydrogen should contribute to the 2030 climate target; hydrogen will be necessary to decarbonise energy-intensive sectors; will help to achieve European technological leadership, and will be beneficial for the post-COVID 19 economic recovery.

The roll-out of this strategy is expected in 3 phases:

- **From 2020 to 2024:** decarbonisation of the existing hydrogen production and the installation at least 6 GW of renewable electrolyzers;

¹² https://ec.europa.eu/growth/industry/policy/european-clean-hydrogen-alliance_en

¹³ <https://www.fch.europa.eu/>

¹⁴ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301>

- **From 2024 to 2030:** hydrogen becomes an intrinsic part of an integrated energy system, with at least 40 GW of renewable hydrogen by 2030, and its use is expended to other sectors like trucks and rail;
- **2030 onward:** renewable hydrogen is deployed at a large-scale level.

According to this strategy, the share of hydrogen in the energy mix is expected to be of 14% by 2050. The European Commission also suggests to adopt demand side support policies, such as incentives, with for example a minimum share or quota of renewable hydrogen or derivatives in specific end use sectors.

A large amount of raw materials will be needed. For now, the European strategy is at an early stage, and does not offer an explicit definition of “clean” or “low carbon” hydrogen.

One of the biggest challenge of hydrogen is its transport: if the strategy highlights the potential of using and repurposing existing gas networks, new pipelines will also have to be built to meet the expected level of production and distribution¹⁵.

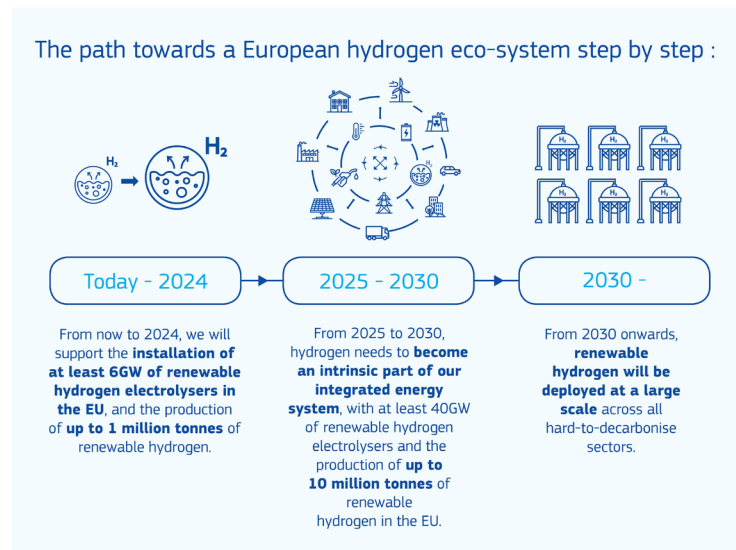


Image by [The European Commission](#)

A regulatory framework for a well-functioning hydrogen market will be needed, in order to bridge the cost gap between conventional solutions and renewable and low carbon hydrogen.

Renewable hydrogen is expected to become cost-competitive by 2030, with a demand gradually including new applications, such as steel making or maritime transport.

• EU Parliament Resolution on the Hydrogen Strategy

On May 2021¹⁶, the European Parliament voted a Resolution on the European strategy for Hydrogen stressing the importance of developing a European hydrogen market in short time. The report backs the use of “low-carbon hydrogen”, which includes green and blue hydrogen.

Even if it is non-binding, the resolution expressed the view of the European Parliament on the topic. It was highly debated, and it was approved by a vast majority¹⁷.

¹⁵ <https://op.europa.eu/en/publication-detail/-/publication/7e4afa7d-d077-11ea-adf7-01aa75ed71a1#document-info>

¹⁶ https://www.europarl.europa.eu/doceo/document/TA-9-2021-0241_EN.pdf

¹⁷ <https://www.euractiv.com/section/energy-environment/news/eu-parliament-backs-low-carbon-hydrogen-despite-green-opposition/>

The resolution highlighted:

- The need for a comprehensive, science-based and uniform EU-wide terminology for the classification of hydrogen;
- The importance of public and stakeholder involvement;
- The role of low-carbon hydrogen as a bridging technology in the short and medium term;
- That hydrogen produced from renewable sources is key to the EU energy transition;
- That a regulatory framework should be proposed by the Commission.



Image by [The European Parliament](#)

4. FUNDING OPPORTUNITIES FOR THE DEVELOPMENT OF WASTE-TO-HYDROGEN PROJECTS

One of the issues with the development of Waste-to-Hydrogen projects, like many hydrogen projects, is the lack of funding, as hydrogen installations and production are now quite expensive.

However, Waste-to-Hydrogen appears to take off in transport, with several European-funded projects focusing on waste collection trucks fueled by hydrogen (as seen above: Wuppertal buses, REVIVE).

Several European programmes are now offering funding for hydrogen projects. The ones relevant to Waste-to-Hydrogen are the following:

- Innovation Fund (launched in 2020)¹⁸:

The goal is to provide funds for projects that are almost ready to be deployed (“sufficiently advanced to reach financial close in four years”). The proposals can be related to decarbonisation, low-carbon technologies in energy-intensive industries, carbon capture and storage, innovative renewable energy and energy storage.

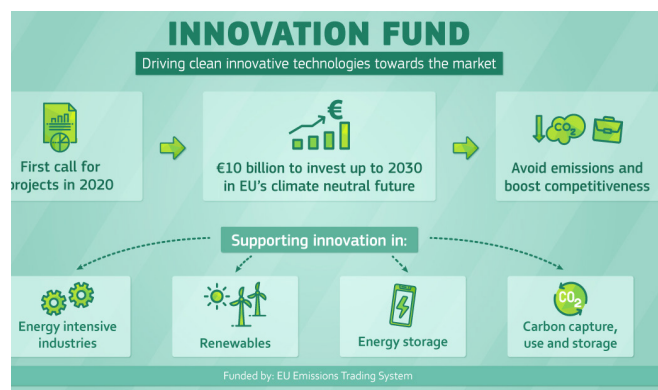


Image by [The European Commission](#)

The development of hydrogen for transport is also included.

The grand amount is only fully paid if the project reaches, over its course, at least 75% of its GHG emissions avoidance target. The recent calls opened were for small-scale (under 7.5 million €) and large-scale projects (above 7.5 million €). The two first calls for projects are now closed, but next ones should open in 2021.

- **Horizon Europe (launched in 2021)**¹⁹:

Horizon Europe is the EU's key funding programme for research and innovation with a budget of €95.5 billion, and includes calls on renewable energy and hydrogen.

The aims to strengthen the impact of research and innovation in supporting EU policies while tackling global challenges.



Image by [The European Commission](#)

CREDITS

Released in July 2021 by ESWET
European Suppliers of Waste-to-Energy Technology
www.eswet.eu

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¹⁹ https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

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