



CARMA-H2

Waste reimaged. Energy reborn.



Co-funded by
the European Union



Clean Hydrogen
Partnership

01.

Project overview

Key figures & consortium

Project name: Carbon-negative pressurised hydrogen production from waste using an energy-efficient protonic membrane reformer (CARMA-H2)

Project coordinator: AIN: Asociación de la Industria Navarra

Number of partners: 12 partners, from 5 European countries

Total EU budget: €9,954,419

Duration: 48 months. From 01/10/24 to 30/09/28

The logo for AIN (Asociación de la Industria Navarra) consists of the lowercase letters 'ain' in a bold, red, sans-serif font.The logo for COORSTEK features the word 'COORSTEK' in white, uppercase letters on a red rectangular background. Below it, the words 'MEMBRANE SCIENCES' are written in smaller, black, uppercase letters on a white background.The logo for HERA consists of the word 'HERA' in a bold, black, sans-serif font.The logo for PENTAIR HAFMANS features a blue square icon with a white geometric pattern to the left of the words 'PENTAIR' and 'HAFMANS' in blue, uppercase letters.The logo for Mancomunidad Comarca de Pamplona features a green and yellow stylized graphic of a building and waves to the left of the text 'Mancomunidad Comarca de Pamplona' and 'Iruñerriko Mankomunitatea' in green.The logo for ICONS consists of the word 'ICONS' in a blue, sans-serif font, with the letter 'O' replaced by a solid blue circle.The logo for CSIC (Consejo Superior de Investigaciones Científicas) features a small crest to the left of the word 'CSIC' in a red, serif font. Below it, the full name 'CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS' is written in small, black, uppercase letters.The logo for SINTEF features a blue circular icon with a white geometric pattern to the left of the word 'SINTEF' in a bold, blue, sans-serif font.The logo for NILSA features a blue stylized graphic of a building or structure to the left of the word 'NILSA' in a blue, sans-serif font.The logo for PENTAIR UNION ENGINEERING features a blue square icon with a white geometric pattern to the left of the words 'PENTAIR' and 'UNION ENGINEERING' in blue, uppercase letters.

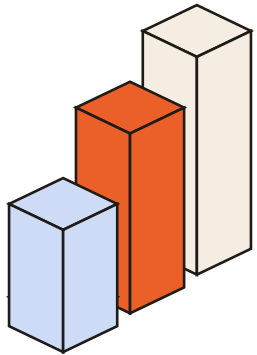
Clean hydrogen from local waste

CARMA-H2 is a four-year EU-funded project demonstrating a circular, decentralised route to hydrogen production. At its core lies the bioPMR (Protonic Membrane Reformer), which will convert biogas from organic waste into pressurised hydrogen while producing a food-grade CO₂ stream.

The technology will be validated at a wastewater treatment plant in Navarra, Spain, supporting local energy systems and advancing Europe's green transition.

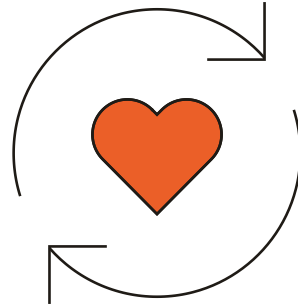


Putting communities first



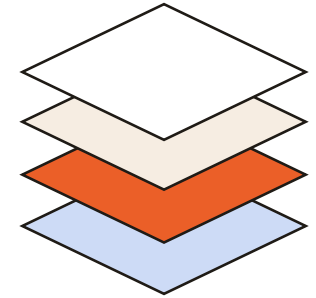
Efficient and adaptable

CARMA-H2 optimises hydrogen production for local biogas plants, cutting energy use and resource needs.



Circular economy in action

Hydrogen and CO₂ production from waste supports local industries and green mobility.



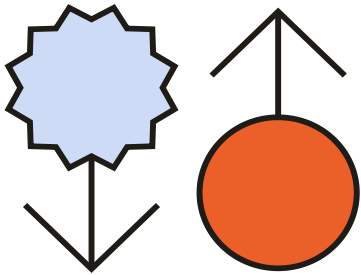
Maximising local resources

CARMA-H2 taps into underused biogas to create new environmental and economic value for regions and communities.

02.

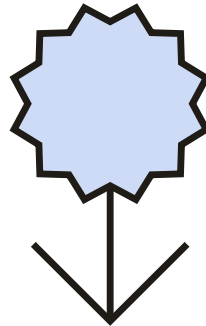
CARMA-H2 innovations

Rethinking hydrogen production



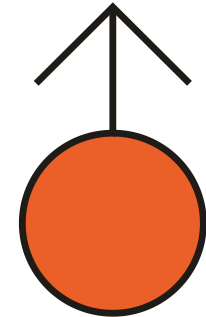
The problem

Hydrogen must be extracted from other compounds – most commonly methane from biogas – through complex and energy-intensive processes.



The traditional solution

Steam methane reforming (SMR) is usually used to produce hydrogen through a multi-step, high-temperature process that generates significant CO₂, requiring careful management.



The new project solution

CARMA-H2 offers an innovative approach: adopting a novel reactor design – the bioPMR – to make hydrogen production from biogas more efficient, integrated, and sustainable.

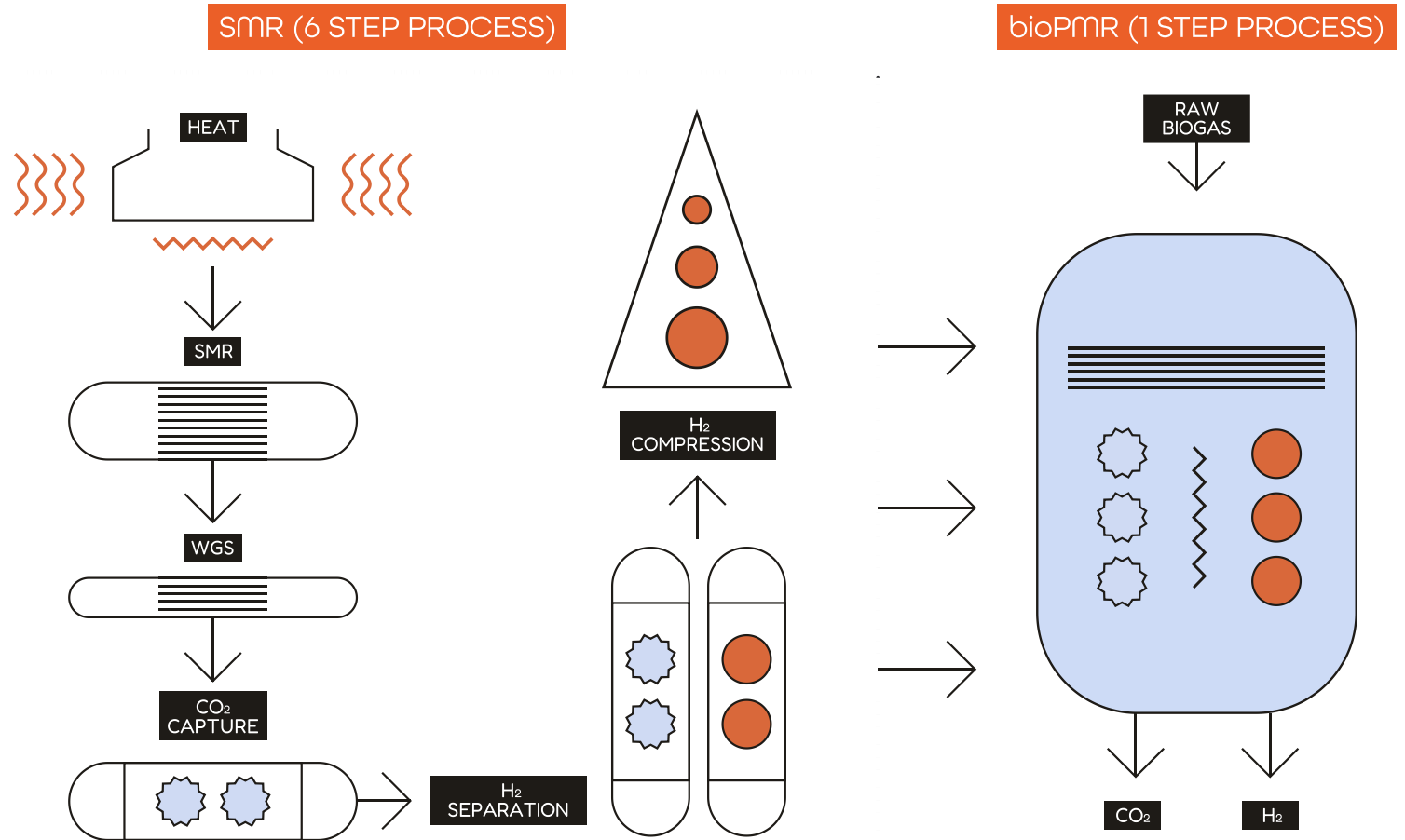
From SMR to bioPMR

Traditional **SMR** uses multiple sequential units:

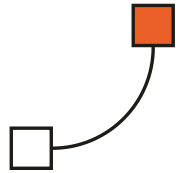
- heat management, methane reforming, water-gas shift, CO₂ capture, hydrogen separation, and compression.
- This leads to high thermal losses and system complexity.

Instead, **bioPMR** combines all steps into one membrane reactor:

- Reforming and shift reactions occur in a single chamber.
- H₂ is electrochemically extracted through a protonic membrane.
- CO₂ is retained as a pressurised, food-grade stream.

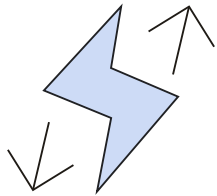


Advantages of bioPMR



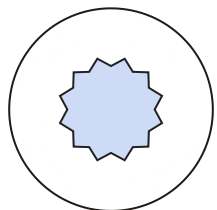
Compact and scalable

It unifies multiple process steps into a single, modular system, reducing complexity and enabling decentralised hydrogen production.



Reduced energy demand

Operates at lower temperatures and recycles internal heat, improving efficiency through integrated thermal management and electrochemical separation.



Integrated CO₂ capture

Delivers pure hydrogen and captures CO₂ as a pressurised, food-grade stream, eliminating the need for additional capture systems.

03.

Arazuri plant

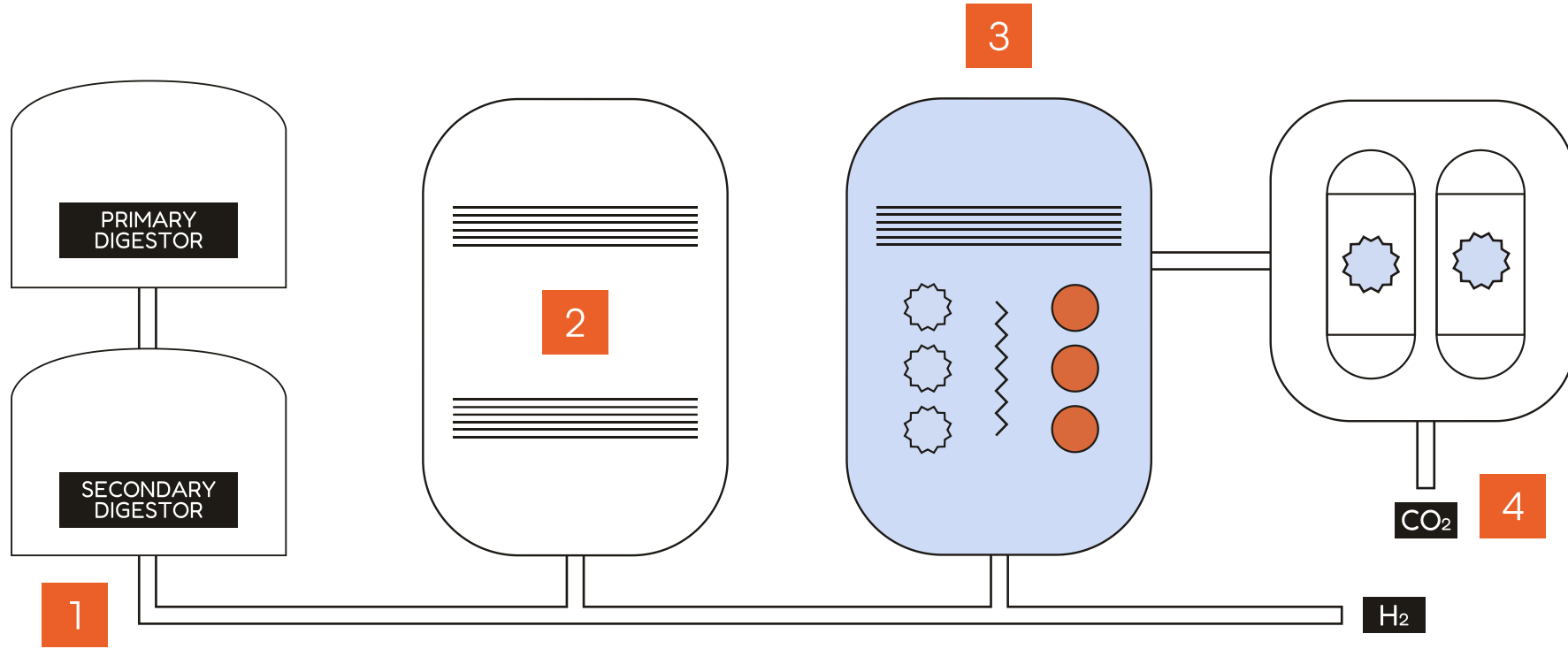
Testing site

CARMA-H2 demonstrates bioPMR technology at the **Arazuri wastewater treatment plant** in Navarra, Spain, through a full-scale pilot that includes:

- Operation of two bioPMR units for at least **4,000 hours**.
- Production of **500 kg of hydrogen per day**, for energy and mobility applications.
- Generation of **4,000 kg of food-grade CO₂ daily**, ready for use.



Pilot structure



1. Biogas production

Organic waste from wastewater is transformed into biogas through anaerobic digestion.

2. Biogas pre-treatment

The raw biogas is compressed and cleaned of unwanted impurities.

3. bioPMR modules

The purified biogas is transformed into hydrogen and food-grade quality CO₂.

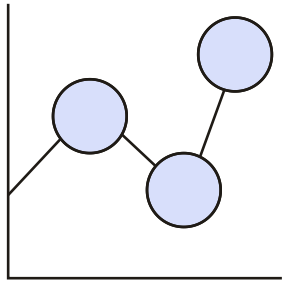
4. CO₂ liquefaction

CO₂ is liquefied for storage or reuse, completing the net-zero cycle.

04.

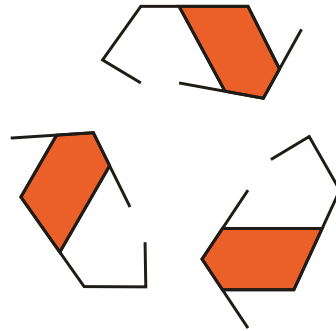
A wider scope

Local roots, EU reach...



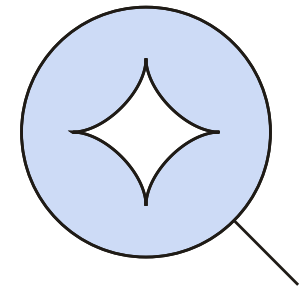
Economic growth

CARMA-H2 supports EU climate and energy goals by scaling up clean hydrogen technologies, reinforcing industrial capacity, and strengthening Europe's position in the sector.



Environmental impact

By optimising biogas utilisation, CARMA-H2 significantly cuts greenhouse gas emissions and enhances waste valorisation, supporting the European circular economy.



Scientific innovation

CARMA-H2 advances electrochemical reforming for hydrogen from raw biogas, supporting European research excellence and knowledge sharing.

A shared vision

- CARMA-H2 contributes to shared EU ambitions by bridging local deployment and European-scale innovation through real-world demonstration and collaboration.
- Yet CARMA-H2 does not act alone – it collaborates with other EU initiatives to share knowledge and extend its impact, such as:
 - HERMES
 - HYIELD



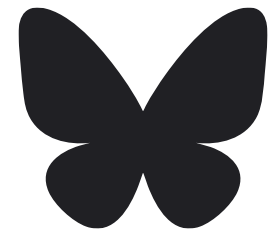
Stay in the loop!



[carma-h2](#)



[carma-h2.eu](#)



[@carma-h2.bsky.social](#)



Thank you!



Co-funded by
the European Union



Clean Hydrogen
Partnership

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Clean Hydrogen Joint Undertaking. Neither the European Union nor the granting authority can be held responsible for them.