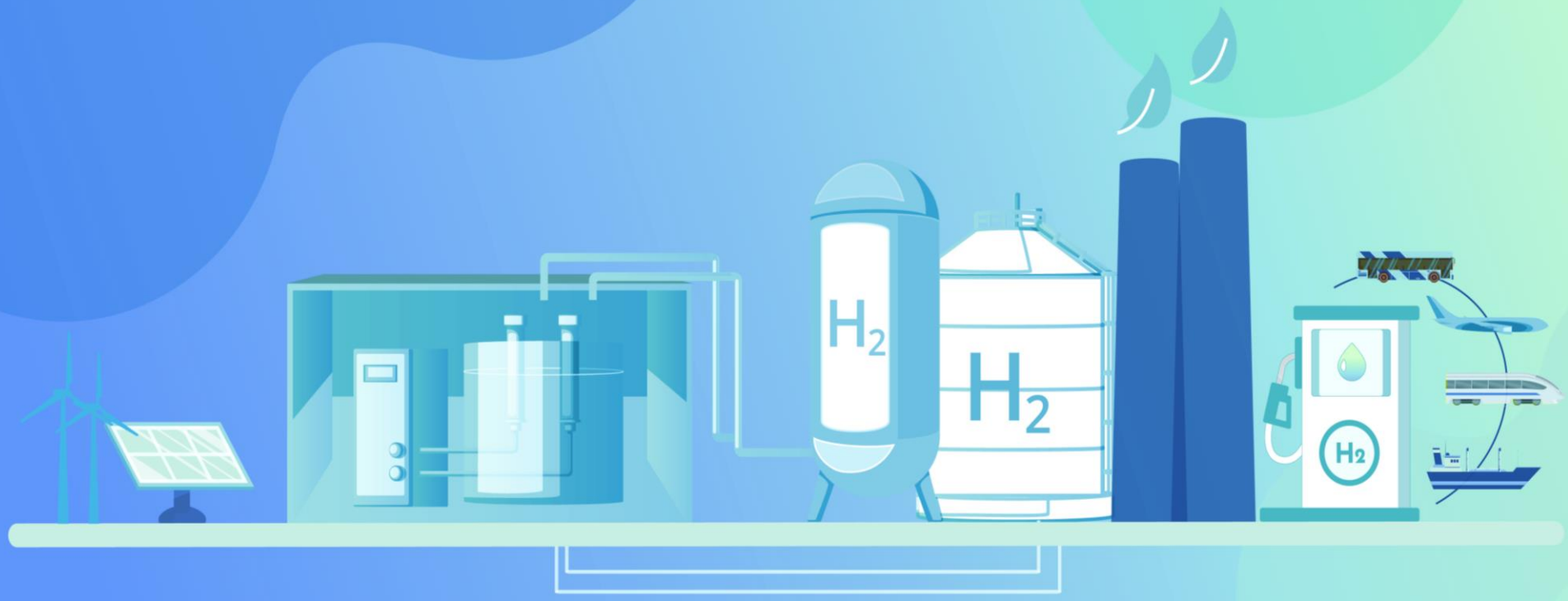
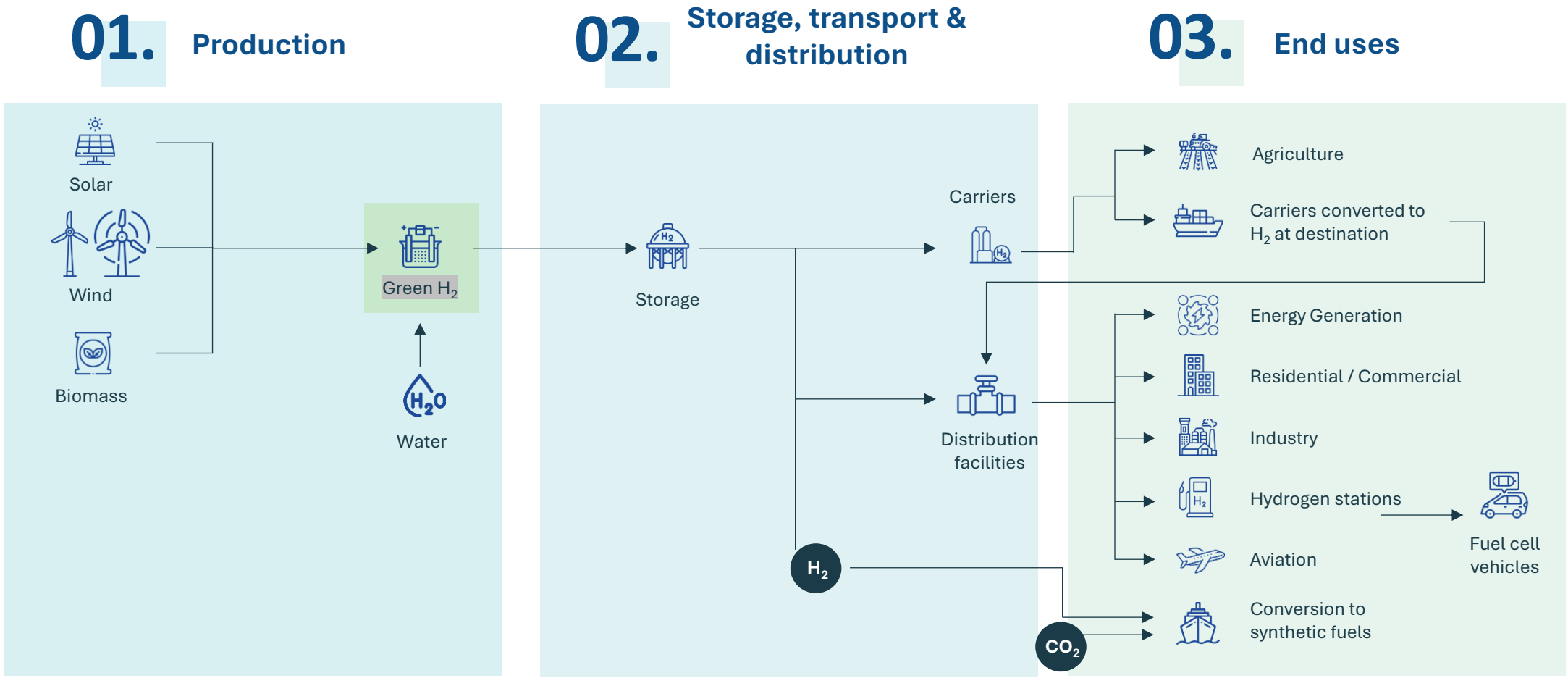
Basque Hydrogen Industry



BASQUENERGY CLUSTER

Green hydrogen is a key factor in the energy transition, as it provides a versatile, clean and flexible option for the decarbonization of certain sectors

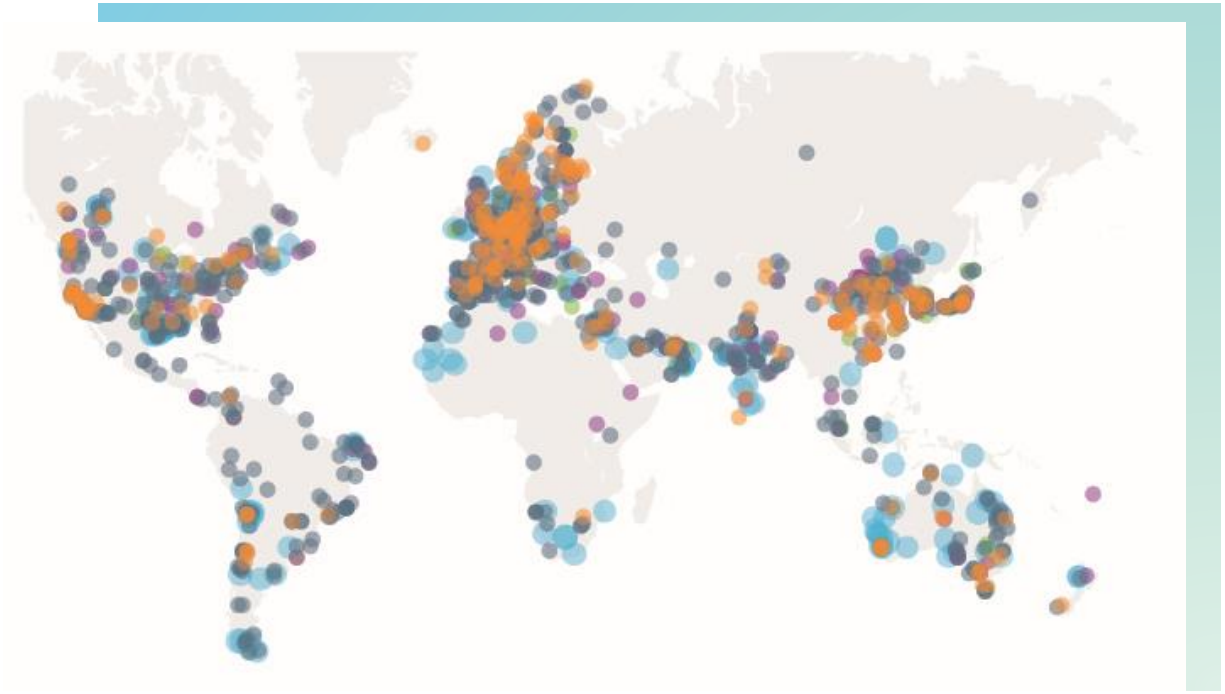
The hydrogen value chain is structured into three main areas:



Hydrogen momentum is strong: more than 1,500 projects and € 620 billion of investments and 48 million tons per year of renewable hydrogen supply announced globally until 2030

Europe continues to have the largest number of projects (617), followed by North America (280). Europe also has the highest total investments announced (€ 179 billion). The global hydrogen project pipeline has grown 7-fold since 2020.

1,572 projects



186
Giga-scale production

783
Large-scale industrial use

268
Mobility

190
Integrated H2 Economy

138
Infraestructure projects

Considering projects with a COD through 2030:

353
Projects announced

208
Projects in feasibility studies

130
Projects in FEED studies

434
Projects commited
(FID taken, under construction or operational)

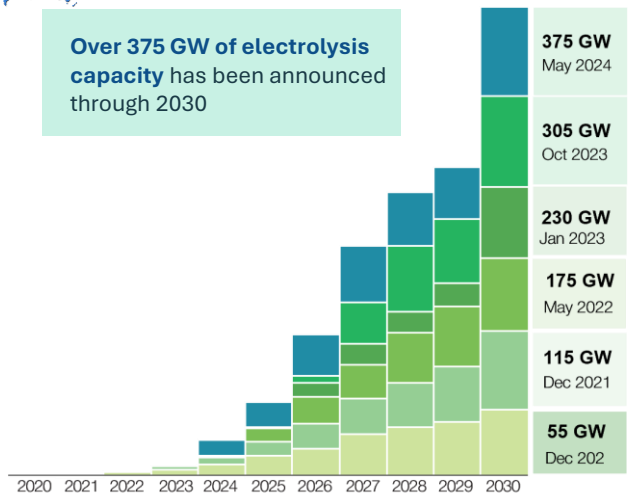
› *Source: Hydrogen Insights September 2024*

3

Global rollout of clean hydrogen continues in Europe despite macroeconomic headwinds

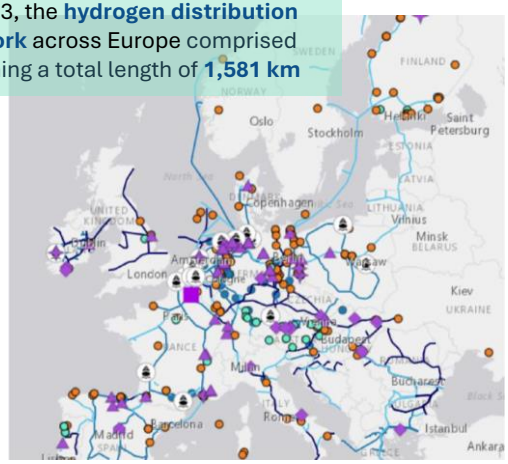
Deployment continues, with more than 1.75 GW electrolysis capacity deployed globally and a total of 26 GW having passed FID. However, continued efforts are needed to foster the faster maturing of projects from announcement to deployment.

Over 375 GW of electrolysis capacity has been announced through 2030

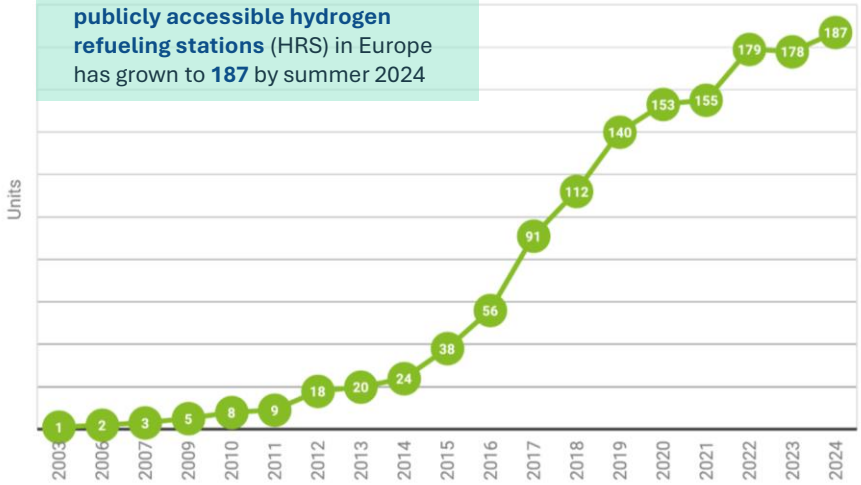


The industrial sector is projected to maintain the highest hydrogen demand, followed by the transport sector

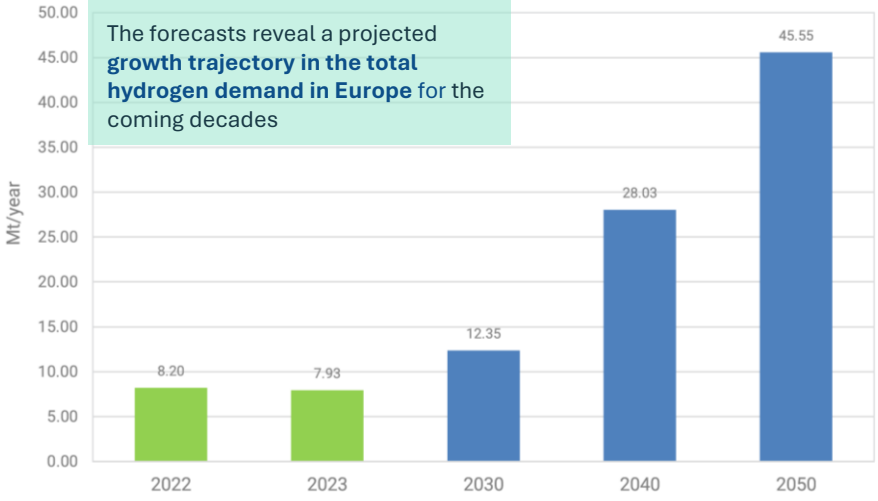
In 2023, the **hydrogen distribution network** across Europe comprised spanning a total length of **1,581 km**



The total number of **operational and publicly accessible hydrogen refueling stations** (HRS) in Europe has grown to **187** by summer 2024



The forecasts reveal a projected **growth trajectory in the total hydrogen demand in Europe** for the coming decades



Source: The European hydrogen market landscape November 2023

The deployment of hydrogen technologies has the clear and unequivocal support of various government administrative bodies

HYDROGEN STRATEGY FOR A CLIMATE-NEUTRAL EUROPE

August 2020

EUROPEAN COMMISSION

40 GW of renewable hydrogen electrolysers for 2030

HYDROGEN ROADMAP: A COMMITMENT TO RENEWABLE HYDROGEN

October 2020

11 GW of installed capacity of electrolysers for 2030
update of NECP 2023-2030

BASQUE HYDROGEN STRATEGY

April 2021

EUSKO JAURLARITZA
GOBIERNO VASCO

300 MW of installed electrolysis capacity for 2030

5

The Basque Hydrogen Strategy drives the creation of a hydrogen production, distribution and consumption ecosystem in the Basque Country, based on the region's industrial, logistical and technological capabilities

Targets for 2030

PRODUCTION

- Installed electrolysis capacity **of 300 MW**
- 100% of all hydrogen produced of renewable or low-carbon origin
- Annual production of **2,000 t/year of synfuels**

END USES
Industry

- 90% of hydrogen consumed in industry as feedstock to be of renewable or low-carbon origin
- Hydrogen accounting for 5% of total energy consumption in the industrial sector

END USES
Transport and Mobility

- Fleet of **20 hydrogen buses** in the Basque Country
- Fleet of **450 goods transport vehicles** of varying sizes
- Network of **10 public access hydrogen filling stations**, covering all three provinces

› *Source: The Basque Hydrogen Strategy April 2021*

Training, R&D and industrial development will position the country as a technology exporter

ENERGIAREN EUSKAL ERAKUNDEA
ENTE VASCO DE LA ENERGÍA

EUSKO JAURLARITZA
GOBIERNO VASCO

energiBasque

The RIS3 Energy Steering Group agreed to include the field of hydrogen as a new area of the Energibasque strategy for technological and industrial development in 2021.

The Basque Country has all the elements to become a benchmark region for a hydrogen ecosystem

VALUE CHAIN

Industrial hub with **capabilities in the engineering and manufacturing of equipment at all levels of the value chain**

- Strong capital goods industry
- Science and Technology R&D Entities
- Competitive SMEs network

STRATEGIC LOCATION

On an **international transport hub**

- **TEN-T** (on the Atlantic Energy and Transport routes)
- **TEN-E** (strategic electricity and gas infrastructure)

INDUSTRIAL PORT AND REFINERY

Industrial port **with LNG (regasification) expertise** and connected to an extensive pipeline network.

Petronor refinery:
a producer and consumer of hydrogen.

INDUSTRIAL FABRIC TO BE DECARBONISED

- Refining
- Cement
- Steel
- Foundry
- Pulp and paper
- Glass

7

The Basque Country is home to a technological and industrial network with capabilities and expertise in all segments of the hydrogen value chain

Large concentration of potential **industrial users**

Strong capabilities in **engineering and manufacturing** of H2 components and systems

R&D organisations

Universidad del País Vasco Euskal Herriko Unibertsitatea
Mondragon Unibertsitatea Faculty of Engineering
CIC energiGUNE
ceit
cidetec
ikerlan
tecnalia
CTA
Tekniker
Tknika
Gaiker
AZTERLAN

Support network

Cluster Energía Basque Energy Cluster
Grupo spri Taldea
Energiaren Euskal Erakundea Ente Vasco de la Energía

The hydrogen sector forum of the Basque Energy Cluster is the meeting point for companies and stakeholders willing to share their knowledge and proposals

An initiative designed to energise the sector, facilitating the exchange of information and knowledge between members and other organisations active in the hydrogen economy in the Basque Country, and identifying opportunities for collaboration.

The Hydrogen Sector Forum is coordinated by PETRONOR.

Petronor

Cluster Energía
BASQUE ENERGY CLUSTER

+150 associated companies and entities participate in it.

The Forum was set up in collaboration with eight other cluster associations (ACICAE, ACLIMA, FLUIDEX, FMV, MAFEX, MLC ITS, HEGAN and SIDEREX), to provide access for their member companies to information and to participate in forthcoming events.

ACICAE Basque Country Automotive Cluster · aclima Basque Environment Cluster · Foro Marítimo Vasco

hegan basque aerospace cluster · MAFEX · mlc-its euskadi mobility and logistics cluster · SIDEREX

9

Rollout of clean hydrogen is also relevant in the Basque Country,

01. PRODUCTION: GREEN H2

Petronor

Comissioning of a 2,5MW electrolyser.

Ingeteam

Manufacturing of a new rectifier solution for powering electrolysers based on IGBT technology.

H2SITE

World’s first palladium alloy membrane manufacturing plant to obtain hydrogen from ammonia or methanol.

02. TRANSPORT & DISTRIBUTION

nortegas

H2SAREA, the first Spanish demonstration project to verify the optimal behaviour of current gas networks for use with 20% hydrogen.

nortegas

100% hydrogen distribution network.

CALVERA Hydrogen

The world's largest tube trailer in terms of pressure (517 bar) and capacity (1.3 ton) for hydrogen transport.

10

with milestones achieved in the complete value chain

03. END USES: MOBILITY

Irizar i6S: Efficient Hydrogen long-distance bus prototype.

HYMPULSO: Comprehensive project in rail mobility through hydrogen.

Urbino 18 hydrogen and Urbino 12 hydrogen commercial busses.

FCH2RAIL: First hydrogen train to perform tests on the Spanish railway network.

04. END USES: STEEL INDUSTRY

Reheating furnace prototype for the evaluation of hydrogen combustion technologies.

First spoon heater capable of running entirely on green H2.

Oxyfuel prototype to evaluate the use of H2 in metallurgical cutting.

11

Collaboration on key R&D initiatives is essential to overcome

HYNNOVA was created to provide a solution to the technological **limitations existing in large hydrogen production plants**, seeking to carry out the necessary research to create new advanced technological solutions for the modular design and **efficient and safe management of high-capacity renewable** hydrogen production plants.

www.hynnovaproject.com

Basque HAZITEK programme

Coordinator: BOSLAN

HIMUGI focuses on the **conceptualization of safe and sustainable H2 systems based on three lines of research**: sustainability in advanced manufacturing processes for Type IV (tubular) tanks, the study of critical metallic components, and the comprehensive safety of the system.

www.himugiproject.com

Basque HAZITEK programme

Coordinator: Argolabe Ingeniería

H2MAT+ focuses on **developing knowledge, capabilities and robust methodologies to design, produce and evaluate metallic materials** and structures from the point of view of their behaviour in the presence of hydrogen.

www.h2matproject.com

Basque ELKARTEK programme

Coordinator: Mondragon Unibertsitatea Goi Eskola Politeknikoa

HIDRURA will develop **key components for three innovative technologies for green hydrogen generation.** Each of these technologies presents both advantages and technical challenges to consider.

www.hidruraproject.com

Basque ELKARTEK programme

Coordinator: tecnalia

12

the main technological challenges of hydrogen development

ONTZHI
Tecnologías Clave para Almacenamiento y Transporte de Hidrógeno

ONTZHI researches more secure, compact, cost-effective, and sustainable **H2 storage and transport technologies and solutions**. It has 4 workstreams: metal tanks and components, tanks for light vehicles, distribution pipelines, and characterization and modelling.

www.ontzhiproject.com

Basque ELKARTEK programme

EUSKO JAURLARITZA GOBIERNO VASCO

Coordinator: tecnalia MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

H2salt

H2SALT seeks to develop a system for the comprehensive management of **hydrogen storage in salt caverns** and validate its technical-economic viability, with the development of H2 injection and extraction systems and auxiliary elements.

www.h2saltproject.com

PERTE incentive programme

Financiado por la Unión Europea NextGenerationEU · IDAE · Plan de Recuperación, Transformación y Resiliencia

Coordinator: team engineering consulting group

AVOGADRO

AVOGADRO researches into innovative technological solutions for new generations **of H2 refueling stations for heavy goods vehicles and trains,** with fiber optic systems for detecting leaks and BoP, to help the Basque Country gain international recognition as a technological benchmark for the HRS of the future.

www.avogradoproject.com

Basque HAZITEK programme

EUSKO JAURLARITZA GOBIERNO VASCO

Coordinator: Iberdrola

H2 INTEGRA

H2INTEGRA researches into **physical and digital solutions** for the creation of a H2 ecosystem that optimally connects and manages the end uses of H2 with the production and distribution infrastructures. The project **integrates different industrial companies** with recognized positions in the Basque industry.

www.h2integraproject.com

Basque HAZITEK programme

EUSKO JAURLARITZA GOBIERNO VASCO

Coordinator: Petronor

13

The Basque Hydrogen Corridor (BH2C), spearheaded by Petronor-Repsol, is the hydrogen valley of the Basque Country, gathering 55 projects all along the value chain

BH2C has been selected by the Mission Innovation – Clean Hydrogen Mission (CHM) as one of the eight leading examples of 'Hydrogen Valleys' globally, which places it among the world's elite of projects driving the energy transition to green hydrogen.

73 organisations **55 projects**

BH2C GLOBAL INDICATORS

Investment of **€1.1 billion** over the period 2021-2030

~132.5 MW of electrolysis

Production of **~21,000 tons** per year of H_2

Production of **~8,000 liters** of synfuels per day

Reduction of **~230,000 tons** per year of CO_2 emissions by H_2

The Energy Intelligence Center (EIC), founded in 2023, is a key infrastructure that hosts some of the Basques companies leading the clean energy transition

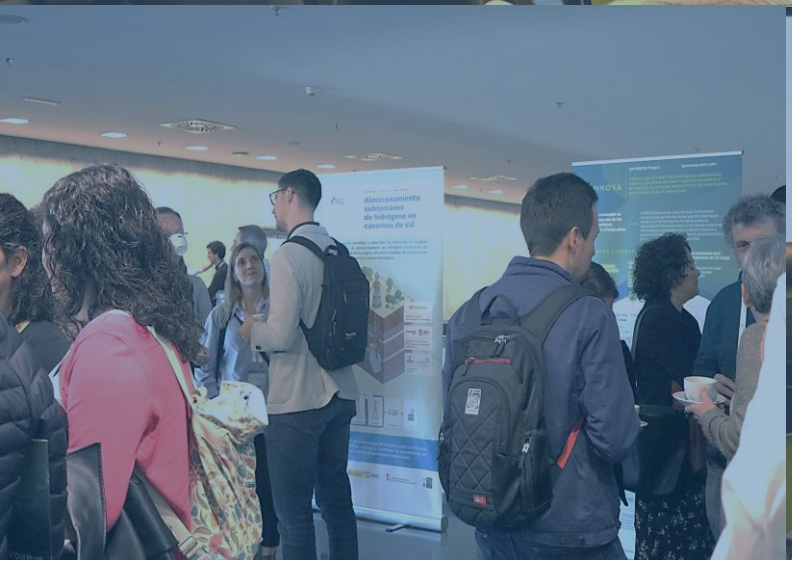
EIC – Energy Intelligence Center aims to build on the opportunities of the energy transition and contribute to the development of the necessary industrial and technological capabilities of the Basque energy sector.

It is a strategic commitment for the future of both the Regional Government of Bizkaia and the Basque Government to contribute to consolidating the competitiveness of the sector.

With a total surface of 19,000 sqm, the center boasts a direct supply of green hydrogen from a 2.5 MW electrolyser located at the Petronor refinery, that feeds 24/7 both its testing facilities and a fuel cell that backs-ups the electrical system.

Foundation board

15



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www.basquenergycluster.com