



Supporting the Decade of Hydrogen

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Scientific Coordinator of the UPC Hydrogen Lab*

Belfort, March 22 2024



Specific Center for Hydrogen Research

Presentation of the centre



UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Centre Específic de Recerca de l'Hidrogen

CER

H₂

Universitat Politècnica de Catalunya · BarcelonaTech

UPC campuses and broader presence



The UPC has a wide spread presence in Catalonia, with **nine campuses** located in **Barcelona** and nearby towns: **Castelldefels, Manresa, Sant Adrià de Besòs, Sant Cugat del Vallès, Terrassa, and Vilanova i la Geltrú.**

The campuses are accessible, well connected by public transport and equipped with the necessary facilities and services to contribute **to learning, research and university life.**

[Discover the UPC campuses](#) in all their extension, as well as their urban location.

The UPC today

[More figures](#)

30,347
students

3,629
teaching and
research staff

1,989
administrative
and service
staff

67
bachelor's
degrees

91
master's
degrees

45
doctoral
programmes

18
schools

240
lifelong learning
programmes

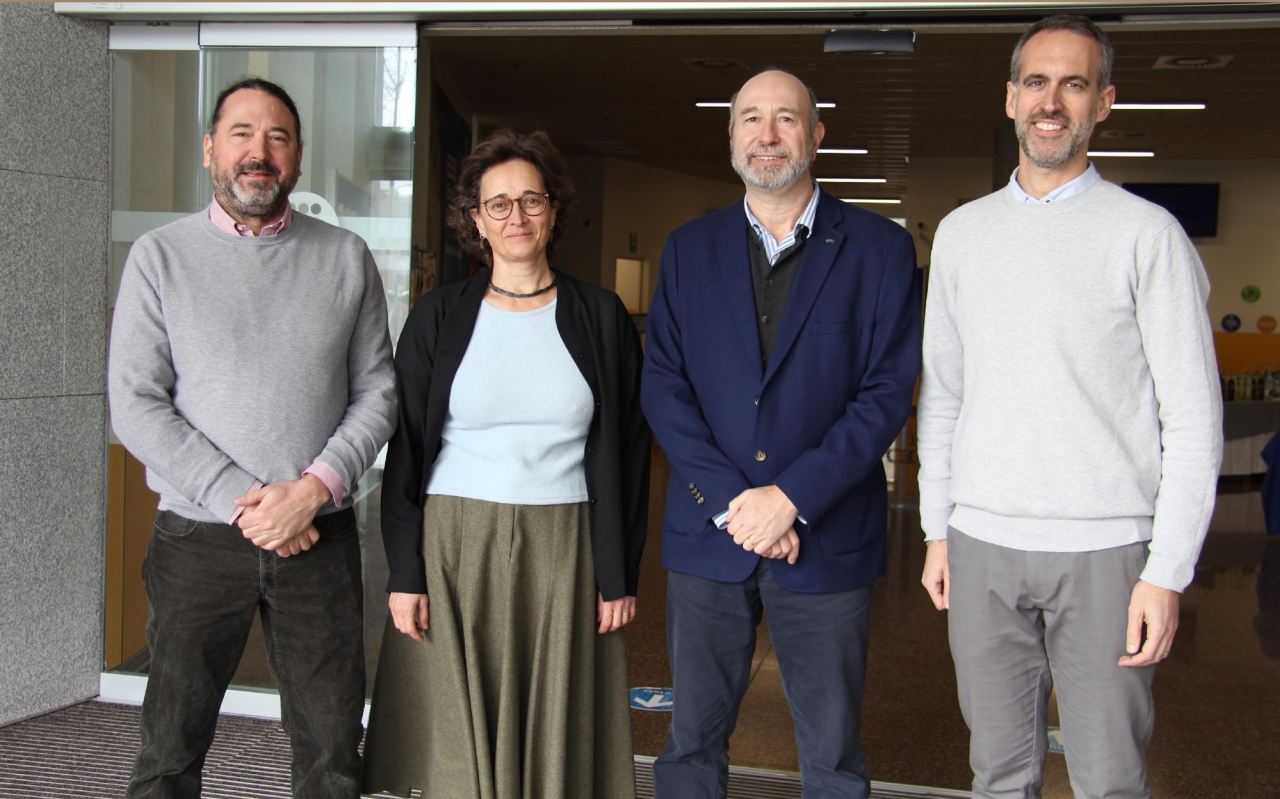
13
patents last
year

371,9
million euros
2024 budget

80,9
million euros
R&D income

87,535
alumni

Members



- Director: [Maria Serra Prat](#)
maria.serra@upc.edu
- Deputy Director: [Attila Peter Husar](#)
- Deputy Director/Secretary: [Lluís Soler Turu](#)

41 members of 10 research groups

CIEFMA

CITCEA

CREMIT

CTTC

GReCEF

NEMEN

R2EM

SAC

CERTEC

ENMA

Mission and Vision

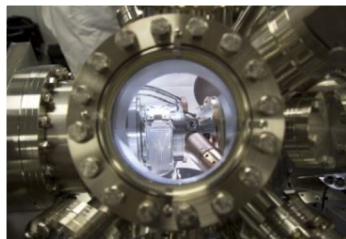
The CER-H2 aims to carry out differentiated and relevant R&D&I projects in the H₂ sector in an environment of creation and innovation of scientific, technological and professional knowledge.

Work on the decarbonization through the H₂ vector

- Research in H₂ processes and systems
- Development of new technologies and solutions for energy systems with H₂
- Technology transfers to society and in particular to the industry
- Raise awareness in society about the energy transition
- Teaching and training for the H₂ sector

Strategy

- Do quality research. We are collaborating with top universities and industrial partners.
- Transfer technology effectively. Projects with companies, experiences and pilot plants
- Do advanced training. Include hydrogen in regulated training (bachelor's and master's degrees), final projects and PhD
- Disseminate and generate opinions in society about energy problems/solutions.



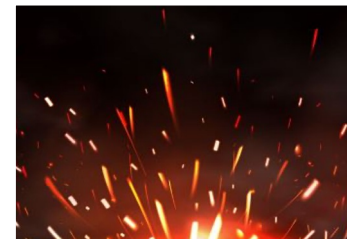
**Hydrogen
production**



**Energy
storage and
distribution**



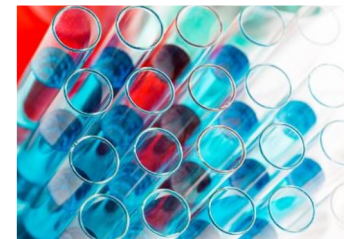
**Heavy
transport,
long-distance
and intensive
transport**



**High
temperature
heat**



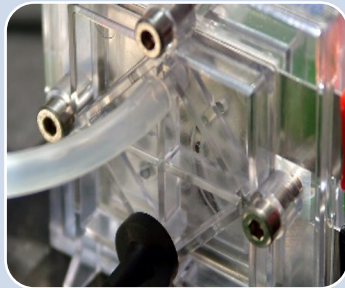
**Electricity
generation**



**Hydrogen as a
raw material**

CER H2 Capabilities

- The CER-H2 aims to cover the complete hydrogen value chain: technologies for the production, storage and use of hydrogen in all its fields of application (energy, industry, transport and housing, among others).



Procurement and production

- Electrolysis and Thermolysis
- Reformation of biogas, agricultural and industrial waste
- Photocatalysis and photoelectrocatalysis
- Ammonia decomposition



Storage and Distribution

- Compressed hydrogen
- Metal hydrides
- Liquefaction at low temperature
- Transport and distribution of H₂
- Infrastructures



Use of hydrogen

- Fuel cells
- Heat Source
- Fuel in combustion engines
- Production of synthetic products and fuels
- Grid injection



Systems Integration

- DC/DC converters and inverters for fuel cell systems and electrolytics
- Energy grids and micro grids with H₂ and generation of renewable electricity
- Fuel cell vehicles
- Integration of H₂ with the water and waste sector
- Economics and sustainability of H₂
- Heat and fuel cell



Monitoring and control

- Dynamic modeling and parameter estimation
- Diagnosis and prognosis
- Control of electrolyzers, reformers and fuel cells
- Energy management
- Real-time monitoring and data logging

Funding received for hydrogen projects (2018-2022)

5.084.606 €

generated through the participation in
21 European, national and local projects
and industrial doctorates.

1.402.980 € in European projects

1.855.128 € in national projects

205.146 € in local projects

76.392 € in industrial doctorates

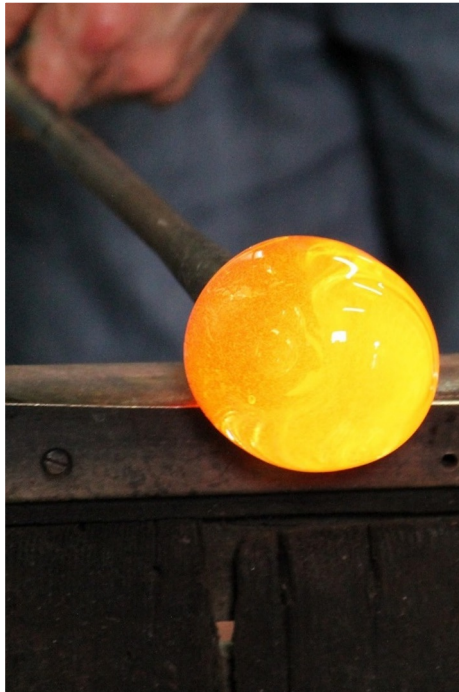
1.544.960 € in infrastructures



European projects (HE)

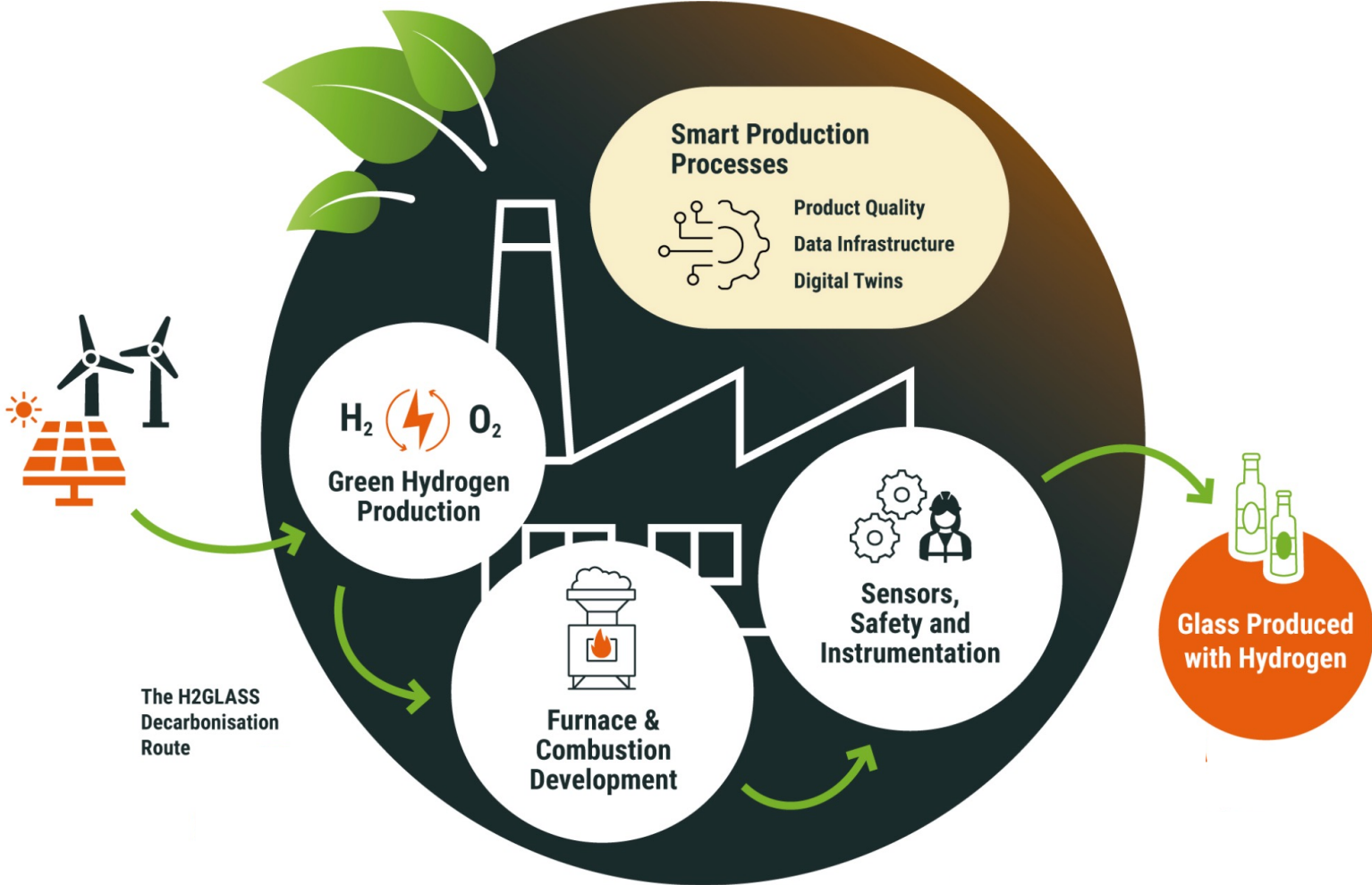
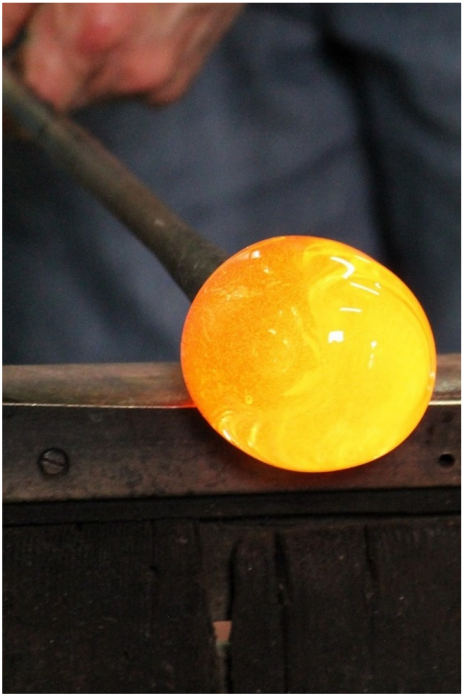


H2GLASS - Advancing hydrogen (H₂) technologies and smart production systems to decarbonize the glass and aluminum sectors



- H2GLASS aims to create the technology stack that glass manufacturers need to accomplish 100% hydrogen combustion in their production facilities, as well as ensure the required product quality and safe handling at industrial sites. This is one of the most important European projects for the study of H₂ combustion in the glass industry, which will collaborate with the manufacturing industry, R&D centers and universities for 4 years, starting in January 2023.
- Partners: 23 entities from 8 different countries.
- Total budget: 33M € (24M € funding).
- UPC budget: 290.625 €
- Period: January 2023 – December 2026

European projects (HE)



H2ELIOS - Hydrogen lightweight & innovative tank for zero-emission aircraft









- H2ELIOS is a project funded by the Clean Aviation JU and supported by the European Union Aviation Safety Agency, in which 14 entities of the sector will work together to enable a technologically and economically feasible H₂-powered aviation.
- The project will develop an innovative and effective lightweight LH₂ storage system for aircraft. The aim is that the concept is ready to be embedded and integrated in a specified aircraft architecture for flight demonstration in later stages. H2ELIOS will provide a feasible and novel low-pressure double-layer composite tank-based system. This concept shall be demonstrated in operational conditions: first on ground up to TRL5 and then in flight by the end of Clean Aviation Phase 2 clearing a TRL6 maturation gate.
- UPC budget: 430.000 €
- Period: January 2023 - December 2025

European projects (HE)



Technologies

					
LH2 storage solution	Virtual models of LH2 Storage	Integration	Sustainability	Testing Methodologies	H2 Management & Safety
Inner tank					Leak detection
External tank	Thermodynamic & hydrodynamic digital twin	Integration at aircraft architecture level	Tank design optimization	Structural and Functional Full Scale Test	Cryogenic valves
Insulation system	LH2 Storage simulation		Sustainability assessment		Shut-off valves
Structural Health Monitoring	Structural Digital Twin	Tank as load bearing structure	Cradle - to - cradle LCA	Damage tolerance	Pressure relief valves
					Internal H2 management system

Public-private partnership projects



GREENKILN - Numerical modelling and experimental validation of H₂ fuel implementation in ceramic sanitary ware manufacturing kilns

- GREENKILN is a public and private collaboration proposal between a company of sanitary ceramic ware manufacture sector and the UPC to evaluate, from a numerical and experimental point of view, the implementation of green hydrogen as fuel in ceramic sanitary kilns which would involve a disruptive milestone and fully aligned with the energy, environmental, economic, and social guidelines required to achieve a sustainability process.
- The European ceramic industry is a key component of Europe's decarbonisation ambition for 2050. All results from this research may be applied for many other firing processes.
- UPC budget: 253.726 €
- Period: September 2022 - August 2025

Training Network

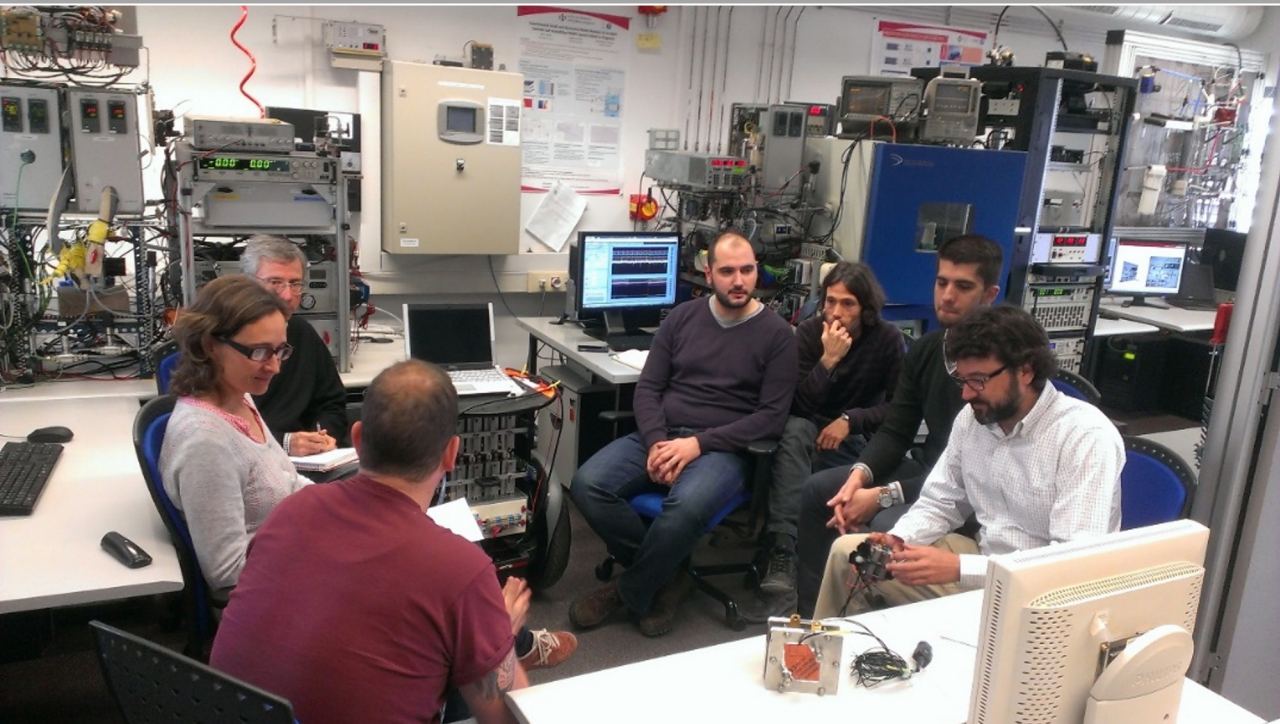
BIKE - Bimetallic catalyst knowledge-based development for energy applications

European training network in advanced catalysts for more efficient hydrogen production



- BIKE is a network for training of young promising scientists who develop and apply, by an innovative “holistic” approach, the next generation of bimetallic catalysts for energy management, in particular for blue and green hydrogen production processes.
- An Innovative Training Network in which 13 European partners and an Australian university participate, funded by Marie Skłodowska-Curie Actions, with a planned duration of 5 years and a total budget for the consortium of 3,7M €.
- UPC budget: 211.373 €
- Period: April 2019 - December 2023

Training



Bachelor's degree in Energy Engineering



Master's degree in Energy Engineering



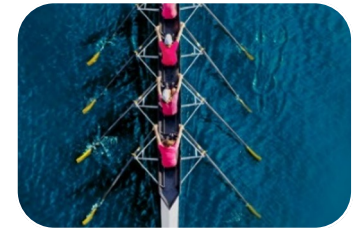
Master's degree in Industrial Engineering



Master's degree in Automotive Engineering



Master's degree in Chemical Engineering



Master's degree in Interdisciplinary & Innovative Engineering



Master in Hydrogen Technologies



Master in Power Electronics



Erasmus Mundus Master in H₂ Technology

UPC Hydrogen Lab

Campus Diagonal-Besòs



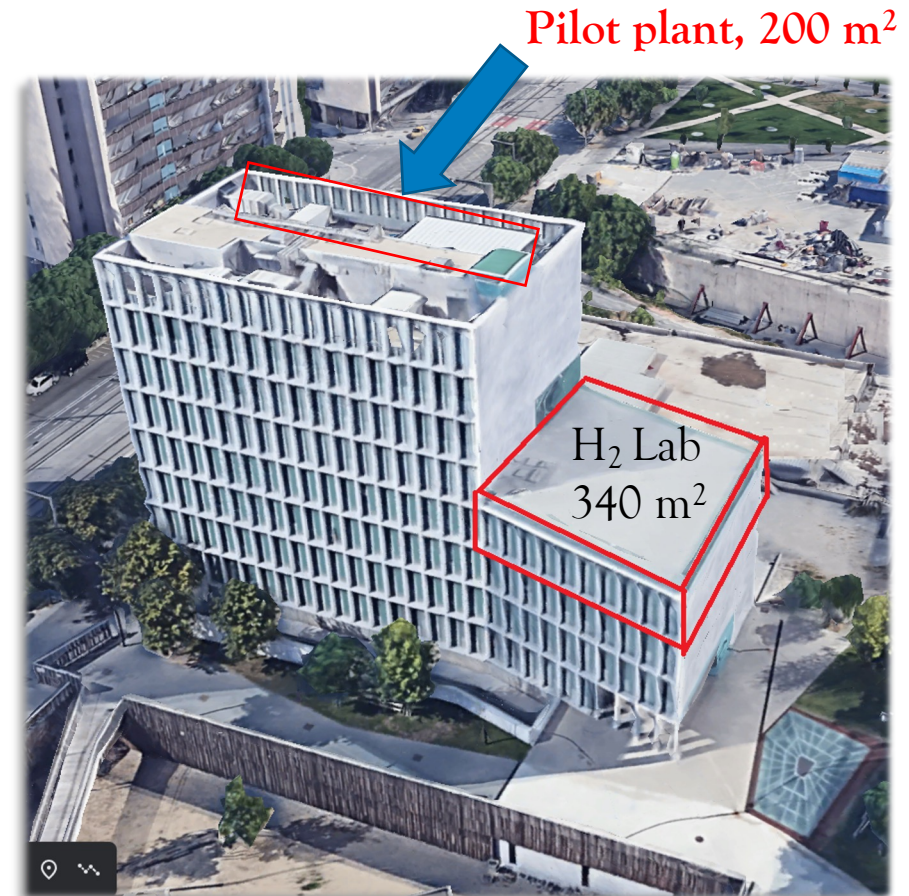
UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

UPC Hydrogen Lab



UPC Hydrogen Lab

Building C of UPC campus
of Diagonal – Besòs EEBE
Barcelona Spain



340 m² Lab and rooftop
H₂ production pilot plant



UPC Hydrogen Laboratory

Mission

Industry Support



- Fundamental testing
- System benchmarking
- Durability testing
- System modeling and validation

Fundamental research



- Supporting UPC research groups
- Supporting Local, National and European research projects
- Testing new materials and designs related to H₂ technologies

Outreach

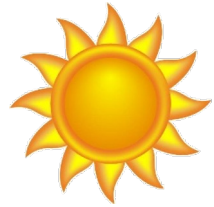


- Academic: Support undergraduate, Master, and Ph.D. projects
- Industry: Show the industry the real-world capabilities of H₂
- General public: Show how H₂ will be produced, stored, and used in the future.

UPC Hydrogen Laboratory

Research lines H₂ Technologies

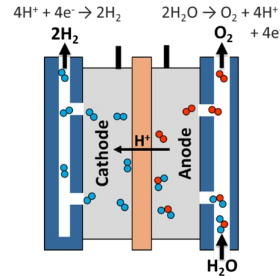
Green H₂ Production



Photocatalysis



Biomass

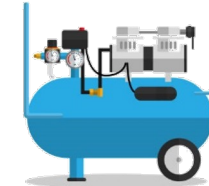


Electrolyzers

Compression and transportation



Transport

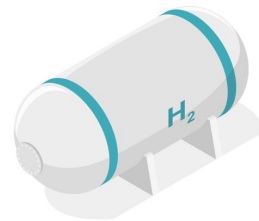


H₂ Compressors

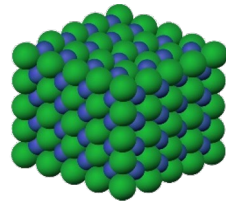


Valving

Storage

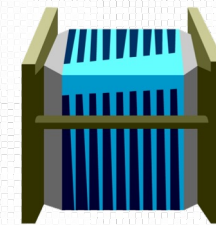


High-pressure tanks



Metal Hydrides

Applications



Fuel cells



Combustion



Synthetic fuels



UPC Hydrogen Laboratory

UPC Multidisciplinary approach

CER **H₂** Centre Específic de Recerca de l'Hidrogen

R2EM Resource Recovery and Environmental Management

CREMIT Engines and Thermal Installations Research Center

GReCEF Fluids Science and Engineering

SAC Advanced Control Systems

H₂ **LAB** **UPC Hydrogen Lab**

Singular Project funded by:
Government of Catalunya and the UPC

CTTC Heat and Mass Transfer Technological Center

CITCEA Research center in Energy, Power Systems, Power Electronics and Electromobility

NEMEN Nanoengineering of materials Applied to Energy

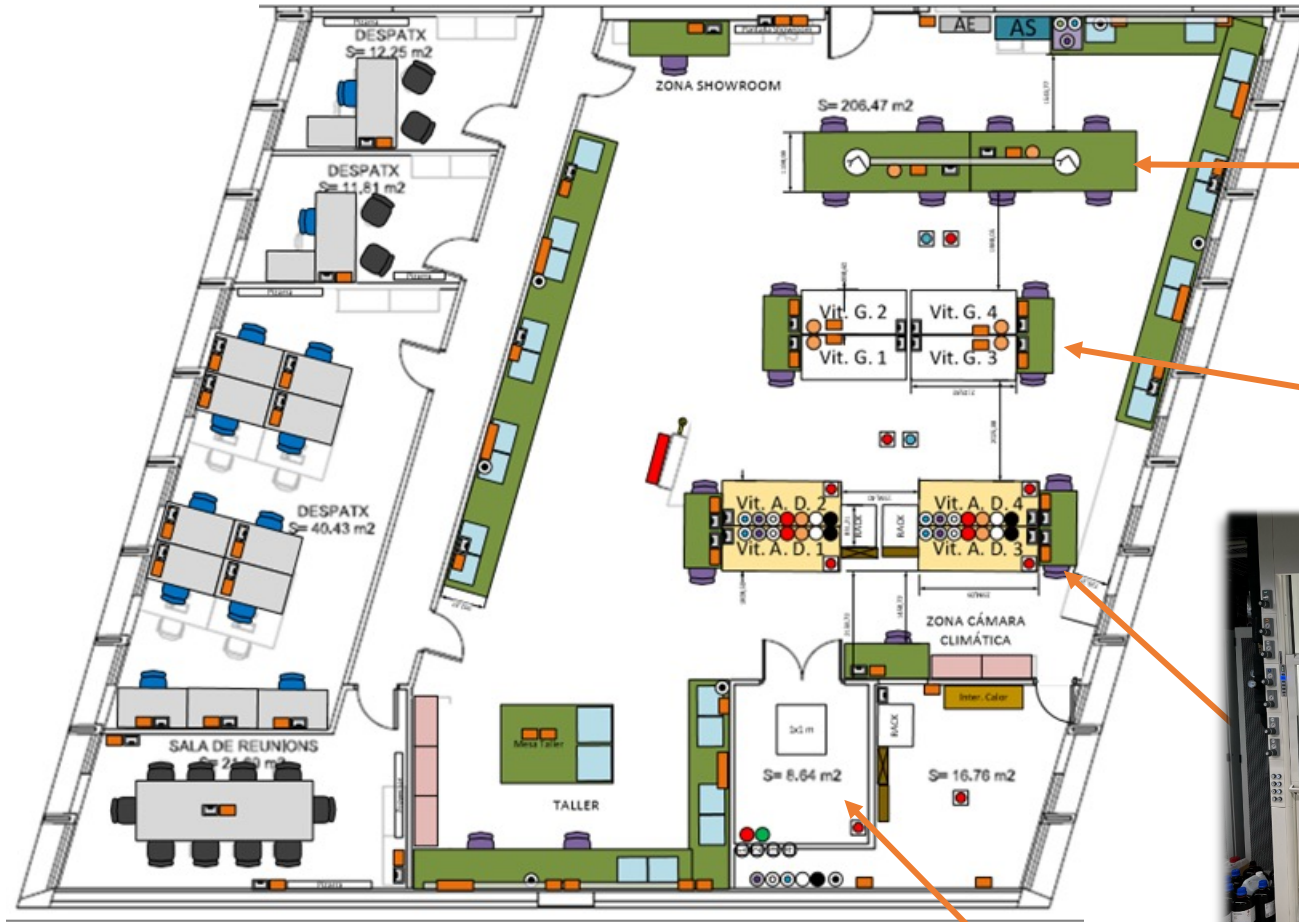
ENMA Environmental Engineering

CERTEC
Center for Technological Risk Studies

CIEFMA – PROCOMAME
Center for Structural Integrity, Reliability and Micromechanics of Materials

UPC Hydrogen Laboratory

UPC Hydrogen Lab Layout



4 x Tabletop: ~100 W



4 x Benchtop hoods: ~1 kW



4 x Walk-in hoods: ~ 10kW



Environmental Chamber up to: ~ 100kW
-20°C to 60°C

UPC Hydrogen Laboratory

UPC Hydrogen Lab Layout



Roof top H₂ production plant



Inside the UPC H₂ Lab



Available gases:
O₂, Synthetic air,
Filtered compressed air,
CO₂, He, Ar, N₂, NH₃, CO,
CH₄, H₂

UPC Hydrogen Laboratory: *Today*

H₂ production plant: rooftop



Photovoltaic:
14 kW

Modular
Compressed
H₂ Storage:
17 kg

Low-pressure tank 35bar

Tanque media presión

DIMENSIONS	
Inner volume	850L
Mass of empty tank	215kg
External dimensions (cm) (without support)	Ø 84 x 187
Orifice diameter	60 mm

High-pressure tank 300bar

Tanque alta presión

TECHNICAL SPECIFICATIONS

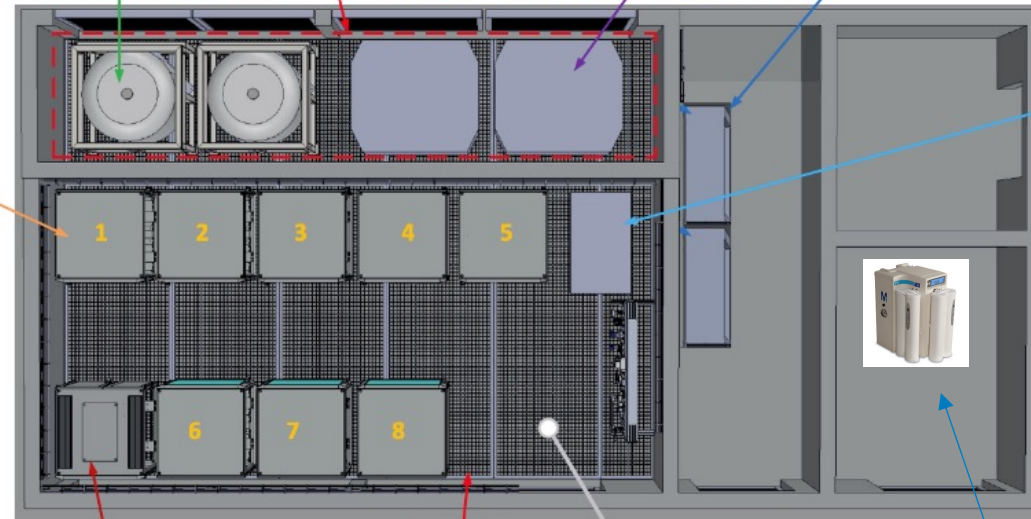
WORKING PRESSURE	300 BAR
HYDRAULIC TEST PRESSURE	450 BAR
MIN. BURST TEST PRESSURE	600 BAR
BLEED CONNECTION	20E 05 1135H1
DESIGN LIFE APPROVAL	25 YEARS

1930, 1848, 1722, 1137, 210, 210, 1000

Phase 1 complete: Nov. 2023

Se instalarán dos armarios:
Uno para suministro y maniobra (Acisa)
Y otros para control, seguridad y visualización de datos (ARPA)

Modular
Electrolyzer
production
6 kg/day



Compresor

Dimension 940 x 292 x 559 mm
Weight 80kg

Se le hará una plataforma de manera que se puedan apilar, si en un futuro se instalan varios en paralelo

H₂ Compressors:
300 bars

H₂ LAB
UPC Hydrogen Lab

RACK FC
Modular Fuel Cell Design:
2 x 2.5 kW systems

Water purification system

UPC Hydrogen Laboratory: *Future*

H₂ production plant *final phase*



**Photovoltaic:
40 kW**

**Modular
Compressed
H₂ Storage:
32 kg**

**Modular
Electrolyzer
Configuration:
40 units with max
production of
40kg of H₂/day**

Low-pressure tank 35bar

Tanque media presión

DIMENSIONES	
Inner volume	850L
Mass of empty tank	215kg
External dimensions (cm) (without support)	Ø 84 x 187
Orifice diameter	60 mm

High-pressure tank 300bar

Tanque alta presión

TECHNICAL SPECIFICATIONS

NET WEIGHT	215 kg
GROSS WEIGHT	280 kg
WORKING PRESSURE	300 BAR
HYDRAULIC TEST PRESSURE	450 BAR
MIN. BURST TEST PRESSURE	300 BAR
SAFETY CONNECTION	DN 80 (1/2")
DESIGN LIFE APPROVAL	20 YEARS

Phase 1: In Nov. 2023 official inauguration
Phase final: In December 2025

Se instalarán dos armarios:
Uno para suministro y maniobra (Acisa)
Y otros para control, seguridad y visualización de datos (ARPA)

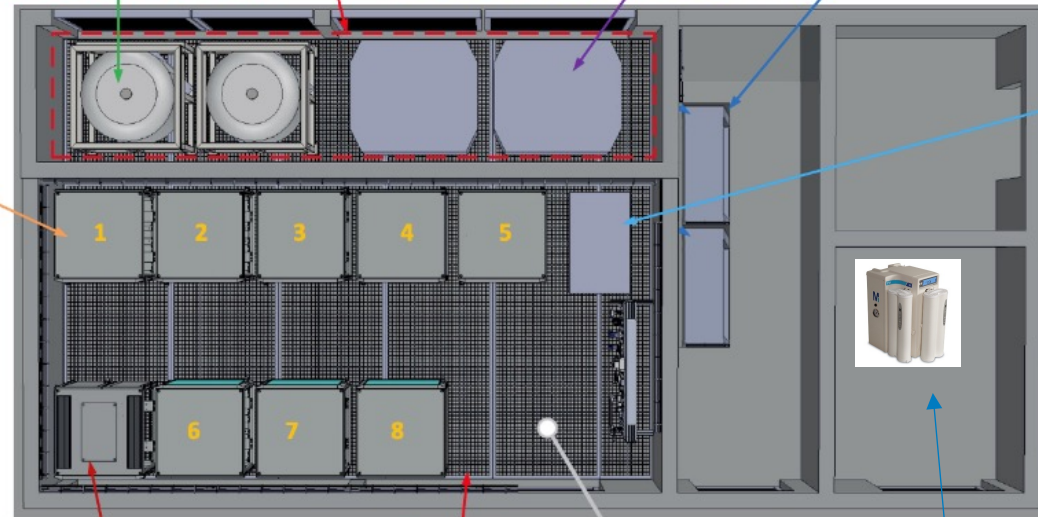
RACKS Electroizador



Dimensiones

Anchura: 800 mm
Altura: 2.000 mm
Profundidad: 800 mm

Peso/UE (Vacío) 120 kg
Lleno entorno a 400 kg



**Modular Fuel Cell Design:
4 x 2.5 kW systems**

**Water purification
system**

Compresor

Dimension 940 x 292 x 559 mm
Weight 80kg

Se le hará una plataforma de manera que se puedan apilar, si en un futuro se instalan varios en paralelo

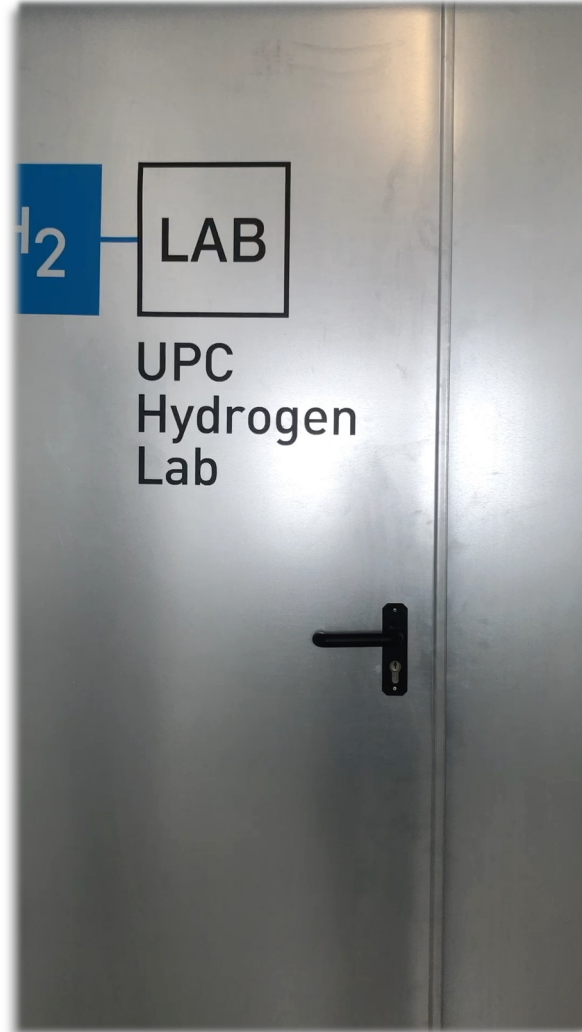
**2 x H₂ Compressors:
300 bars**

UPC Hydrogen Laboratory

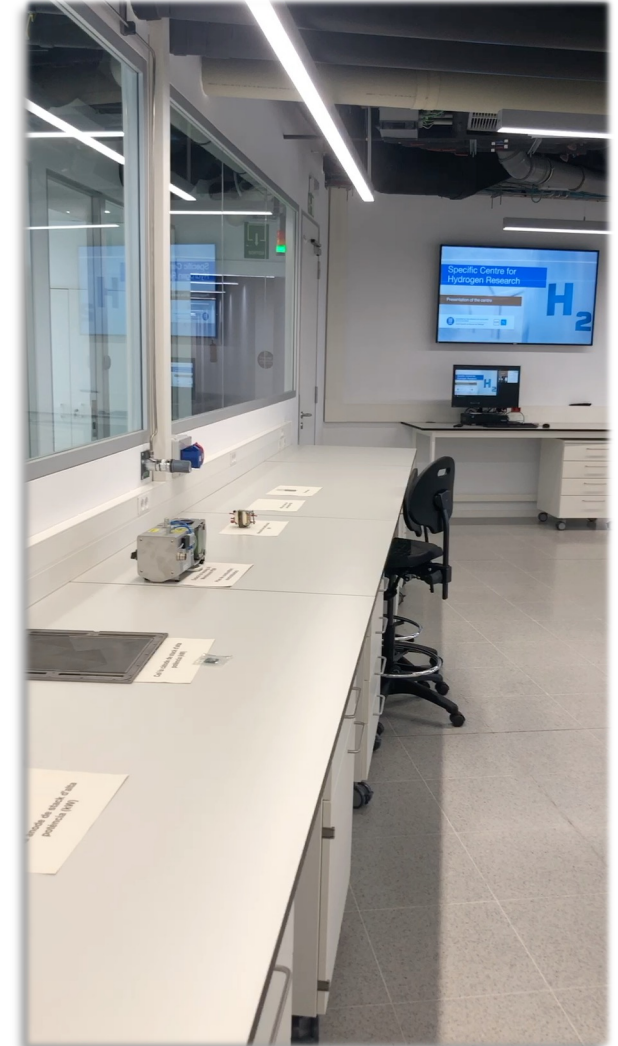
UPC Hydrogen Lab Layout



Solar Photovoltaic Structure



H_2 production plant



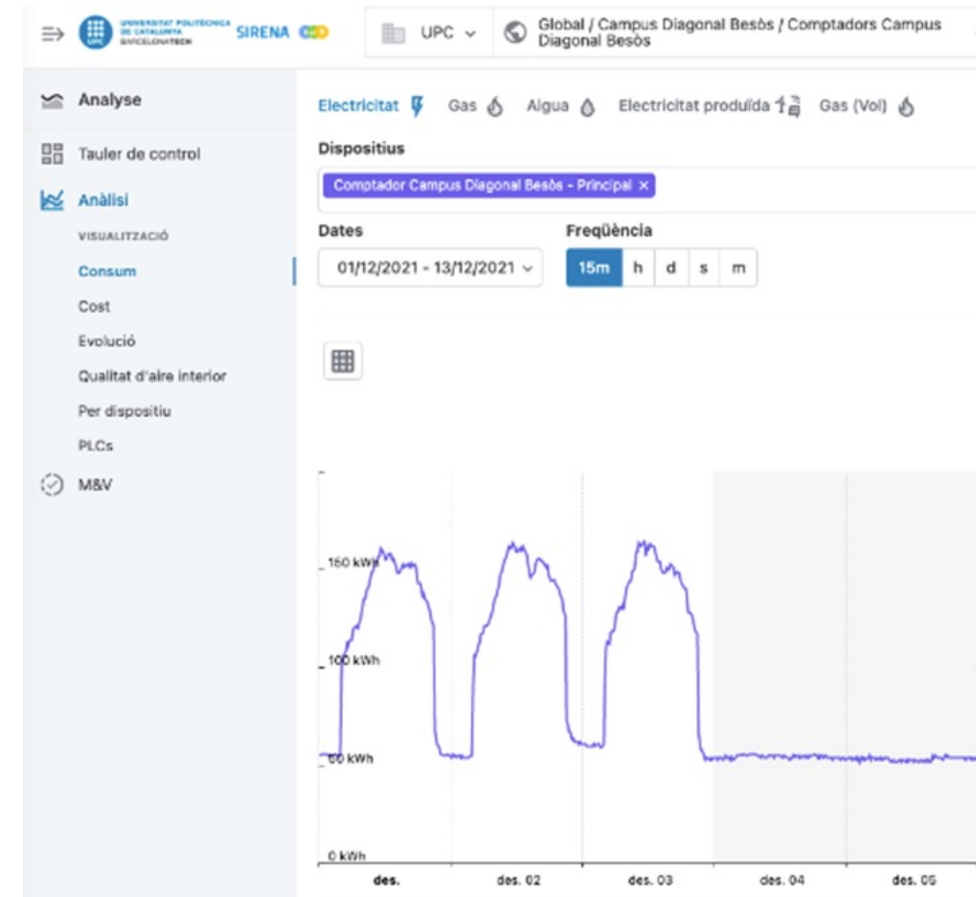
Inside the UPC H_2 Lab

UPC Hydrogen Laboratory

Living Lab

H₂ for the lab is produced by the pilot plant

- ❑ Long-term data will be published on a searchable database for example:
 - Hydrogen production cost
 - Electrolyzer hours of operation, number of cycles
 - Pilot plant efficiency
 - Durability of components
- ❑ Customizable dashboard for control and data monitoring



Similar to the already implemented UPC Sirena web logger:
<https://sirenaupc.app.dexma.com/dashboard/widgets.htm>

UPC Hydrogen Laboratory

Goals of the lab

- **Develop new technologies through novel research in the H₂ space**
- **Provide a showcase for the H₂ technology for industry and academia**
- **Provide technical support, benchmarking, and durability testing to the industry**
- **University courses (Bachelor, Master, Doctorate)**
- **e-Science and e-Education**
- **Public awareness activities**

