



Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

ENEA initiatives on Hydrogen

Hydrogen: opportunities for Italian companies in Latin America. Focus on Chile

23th September 2024 - Confindustria

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Head of Department of Energy Technologies and Renewable Sources



ENEA: Italian National Agency for New Technologies, Energy and Sustainable Economic Development

- 4 Departments: **Energy Technologies and Renewable Energy Sources**, Energy Efficiency, Environment and Sustainability and Fusion and Nuclear Safety
- 9 Research Centers
- 5 Research Laboratories
- a network of territorial offices providing information and consultancy services
- an ENEA-EU Liaison Office in Brussels
- ENEA headquarter in Rome

The 2° Italian R.O.
around 2700 employees



Our mission

Promote the growth and increase the competitiveness of the business sector, public administration, and society at large through **technology development, the transfer of innovation and advanced services**



Our challenge

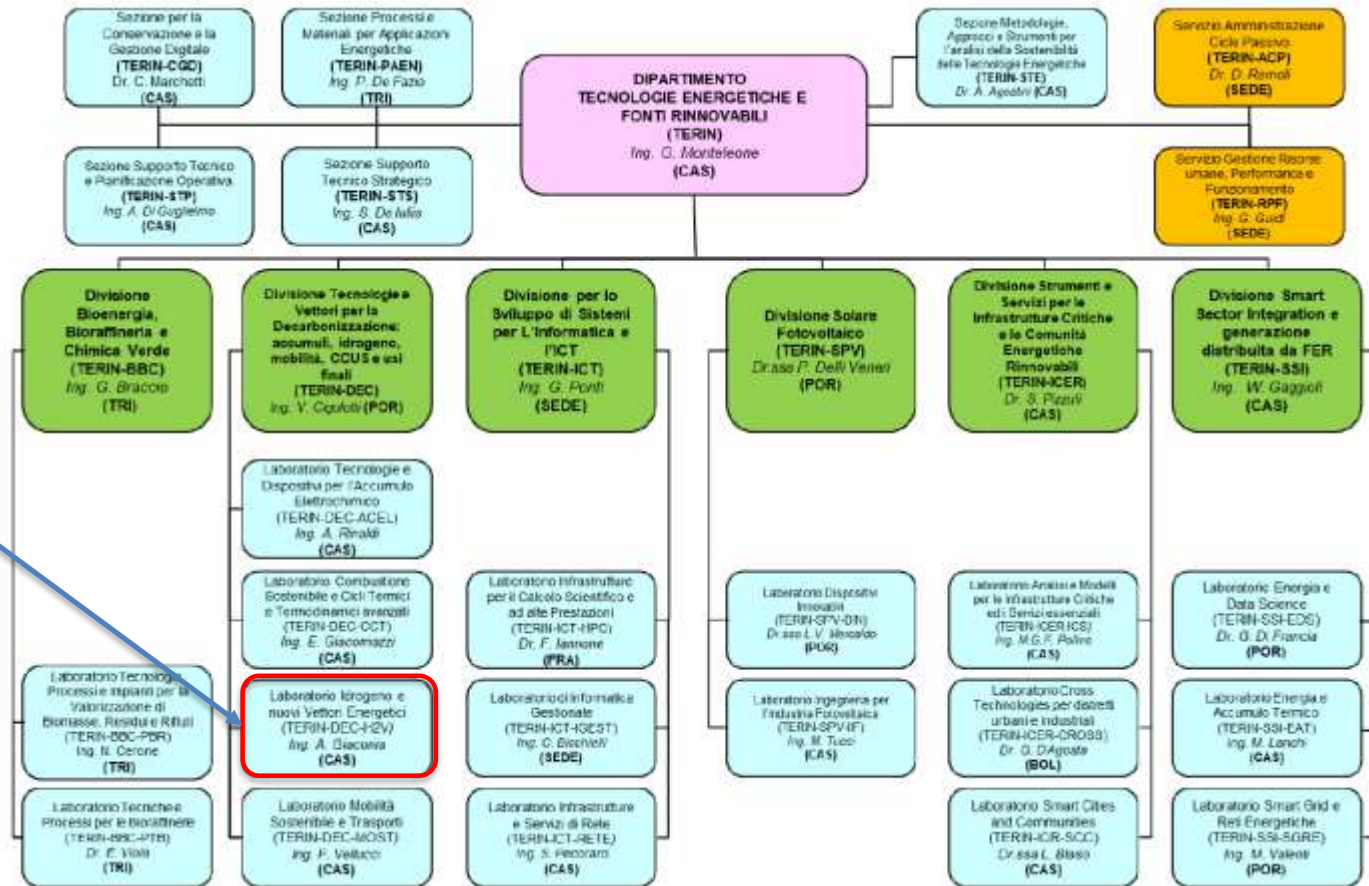
Today ENEA is called to **contribute to the ecological transition**

- Clean Energy, from generation to final use
- Climate change
- Circular economy
- Eco-friendly technologies to protect the environment, health and ensure safety



Department of Energy Technologies and Renewable Sources (TERIN)

Laboratory for Hydrogen and new Energy Vectors (H2V)



CLEAN ENERGY TECHNOLOGY FOR CARBON NEUTRALITY: R&D ACTIVITIES

1	RENEWABLE ENERGY	PHOTOVOLTAIC	SOLAR HEAT - CSP	BIOMASS GASIFICATION
2	ENERGY STORAGE & TRANSPORT	BATTERIES	HYDROGEN PRODUCTION	
3	ENERGY USE & APPLICATION	HYDROGEN USE FUEL CELLS	METHANATION	COMBUSTION
4	CCUS	CARBON CAPTURE AND VALORISATION		
5	ENERGY MANAGEMENT SYSTEM	GRID INTEGRATION WITH RES	SMART NETWORKS	SUSTAINABLE MOBILITY
6	LIFE CYCLE ASSESSMENT			
7	SOCIAL ACCEPTABILITY			

R&D&I topics - [Department of Energy Technologies and Renewable Sources of ENEA](#) (Italian National Agency for New Technologies, Energy and Sustainable Economic Development), Italy.

Key messages from Italy

Italy adopted in 2016 the EU Directive for the creation of infrastructures for alternative fuels, including hydrogen (DAFI).

National Integrated Energy and Climate Plan submitted to the European Commission in December 2018

By 31 December 2025, an adequate number of publicly accessible hydrogen refuelling points must be in place



- **allowing** the delivery of hydrogen at a pressure of **700 bar**
- allowing the use of the engineering approach for the assessment of the installations on a case by case basis, guaranteeing the safety of the work and of the refuelling activity of the station;
- allowing the application of internationally recognized technical standards

Hydrogen has been explicitly included in the proposal, where it is expected to contribute around 1% of the 2030 RES-Transport target.



In October 2019 the speech of the Italian Prime Minister at "*The Hydrogen Challenge*"

Conference confirmed the endorsement of the Italian Government for hydrogen

From 2020 to 2023

Financed a total of 54 Hydrogen Valleys with overall hydrogen production of 7 kton/year.

First three IPCEI waves dedicated to hydrogen launched and a third in preparation.

Italian Hydrogen Strategy on going

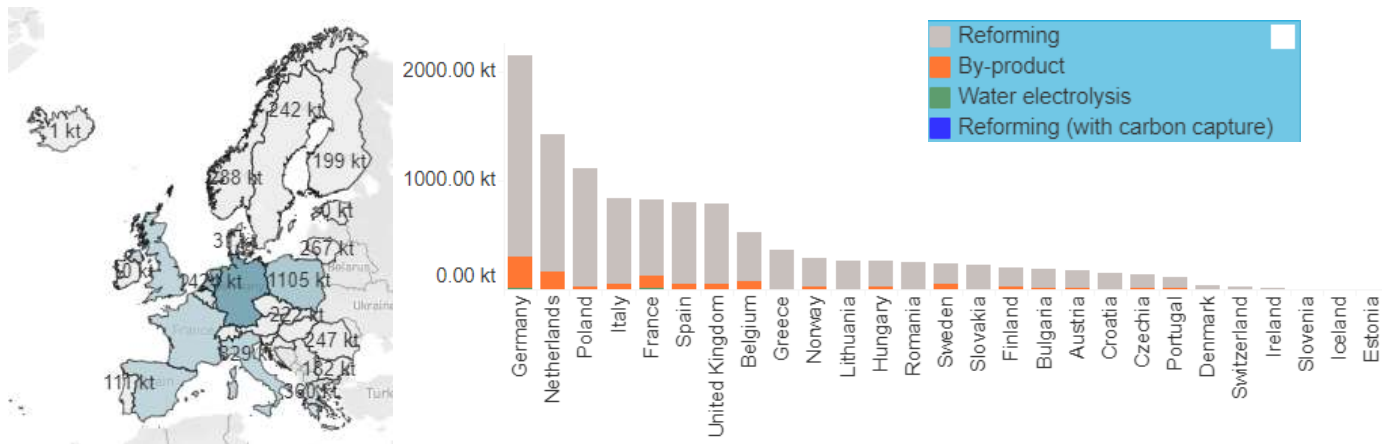
2023 UPDATE:

251 kton/year H2 by 2030 of which 80% domestically produced; **3 GW of electrolysers** to be installed by 2030



Key messages from Italy

About 829.000 ton of Hydrogen (29.930 GWh) was produced in Italy in 2023 (519.000 ton in 2022). However, today almost 95% comes from steam reforming.



National Programmes and Policy



More than 3 bn € will be explicitly dedicated to build a national hydrogen economy in line with the EU hydrogen strategy



Italy participates in IPCEI (important Project of Common European Interest): 20 projects involve Italy in the first three waves, to develop production of sustainable hydrogen, mobility applications, solutions for the storage, transmission and distribution; infrastructures for hydrogen production and distribution

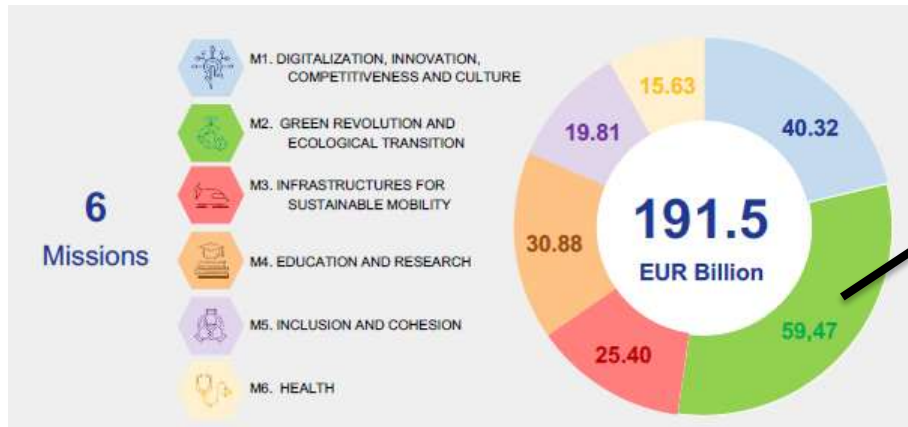


Italy participates in MISSION INNOVATION: IC8 - Renewable and Clean Hydrogen Innovation Challenge and on MI 2.0 Clean Hydrogen Mission



Italian Recovery and Resilience Plan: Hydrogen investments

Recovery and Resilience Plan (RRP): **what**



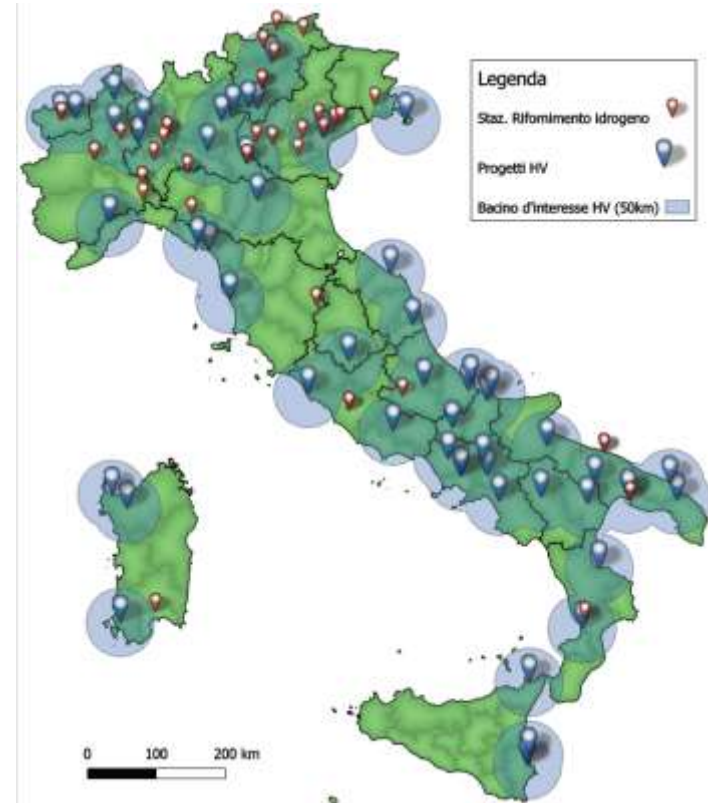
More than 3 bn € will be explicitly dedicated to build a national hydrogen economy in line with the EU hydrogen strategy

- Hydrogen production on decommissioned industrial sites
- Using hydrogen in hard-to-abate sectors
- Hydrogen in road transport
- Hydrogen in rail transport
- R&D

Hydrogen Valleys in Italy

Recovery and Resilience Plan (RRP, Mission 2, Component 2, Investment 3.1)

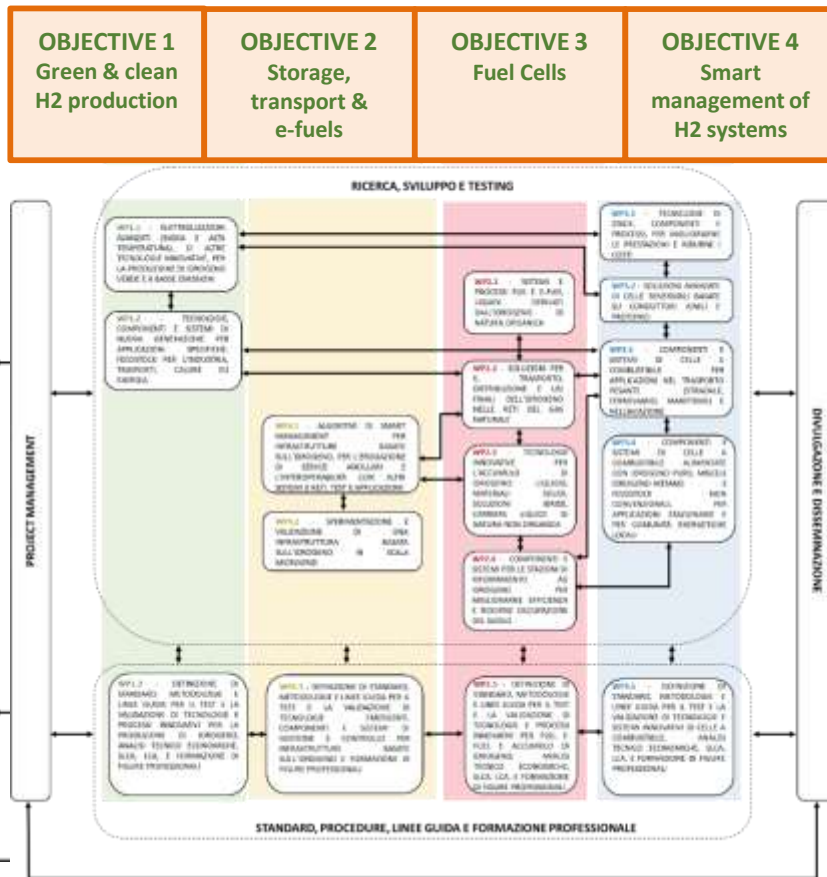
- to support the establishment of dedicated infrastructures, named **Hydrogen Valleys**, for the production of green hydrogen in brownfield areas and its local use
- 54 projects funded for tot. 433 M€ financial support
- tot green H₂ production capacity: 7000 ton/year



National research programme on Hydrogen



Finanziato dall'Unione europea
NextGenerationEU



160 M€ for R&D activity in 4 years

2022-2026

Partner involved

ENEA (coordinator)

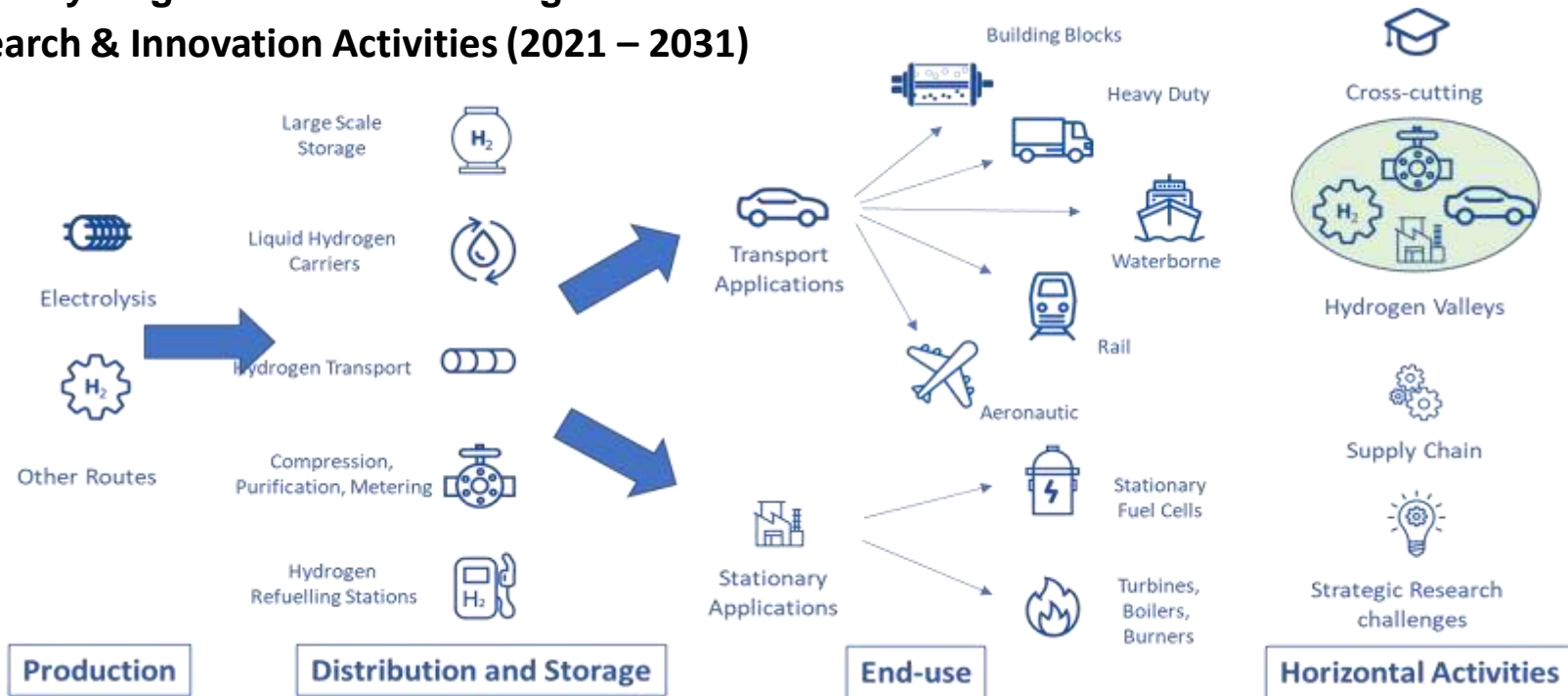
CNR, RSE

Main activity on:

- Hydrogen production
- Hydrogen storage
- FC
- Integration in the grid

Status on European R&D&D Programs

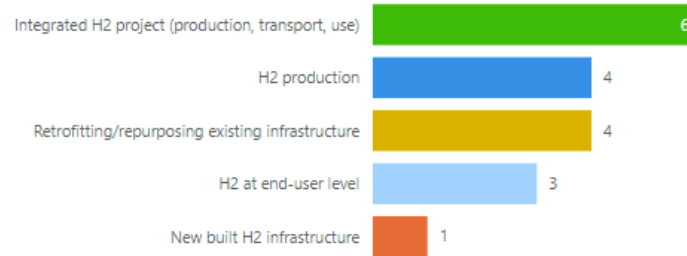
Clean Hydrogen Joint Undertaking Research & Innovation Activities (2021 – 2031)



Status on European R&D Programs



Active projects with Italian coordination



ENEA - Current activities and expertise

- Green hydrogen production

- Electrochemical (water-splitting):

- Materials for polymer electrolyte (PEM & AEM) electrolysis
 - Testing and characterization of PEM & AEM cells and short stacks
 - High-T and high-p polymer electrolyte (PEM & AEM) electrolysis
 - Testing and characterization of Molten Carbonate electrolysis (MCEC)
 - Testing and characterization of Solid Oxide Electrolysis (SOEC)
 - Integration of electrolyzers with renewable heat & power sources

- Photo-Electrochemical (water-splitting):

- Preliminary investigations on the use of active perovskite materials in progress

- Biotechnologies:

- Microbic electrolysis
 - Fermentation of biowastes and CO₂

- Thermochemical Water-Splitting Cycles (TWSC):

- A new TWSC based on a modification of the well-known Sulfur-Iodine cycle patented
 - Capability to study two-steps complex metal oxide TWSCs up to 1500° C

- Thermochemical conversion of (bio)wastes:

- Innovative reforming of (bio)methane in electrified reactors
 - Cracking of (bio)methane (planned)
 - Pyrolysis of solid (bio)wastes with valorization of the solid by-product (biochar)
 - Plasma pyrolysis of bio(methane) or CO₂



ENEA - Current activities and expertise

- Hydrogen conversion to synthetic fuels
 - Methanation
 - Synthetic thermo-catalytic methane production (MENHIR pilot plant developed)
 - Bio-methanation (in-situ, ex-situ)
 - Liquid Organic Hydrogen Carriers
 - Green methanol and DME production (laboratory demonstrator)
 - Formic acid (planned)
 - Hydrogasification
 - Hydrogenation and reduction of solid carbon-rich wastes for clean fuels production
 - Green ammonia production & cracking
 - New solutions for the integration with renewable heat & power sources
 - Development of an ammonia cracking reactor (preliminary design in progress)
- Hydrogen storage
 - Metal hydrides
 - Laboratory validation tests
 - High-p hydrogen gas storage
 - New materials for compressed hydrogen gas storage (planned, IPCEI Hy2Tech project)



ENEA - Current activities and expertise

- Fuel Cells and end-use applications
 - Fuel Cells (FC)
 - Testing and characterization of PEM FC
 - Testing and characterization of Molten Carbonate electrolysis (MCEC) also in reversible MCEC/MCFC mode
 - Testing and characterization of Solid Oxide electrolysis (SOEC) also in reversible SOEC/SOC mode
 - Design and validation of demonstrators (PECFC with Balance of Plant) for small boat applications
- Other cross-cutting topics
 - Hydrogen distribution
 - Blending with methane (from 5% up to 100%)
 - Pre-normative studies
 - Safety
 - Hydrogen Refueling Stations (HRS)
 - Modelling & analysis
 - Hydrogen systems demo & analysis
 - Hydrogen Demo Valley



Mission Innovation IC8 – ENEA H2 demo Valley

Hydrogen Valleys

Hydrogen demo Valley @ Casaccia aims to replicate a fully integrated hydrogen valley combining renewable production, storage, blending, distribution, heat, power and mobility in a fully monitored environment and at relevant scale. For testing, demonstration of industrial solutions and services to ENEA staff

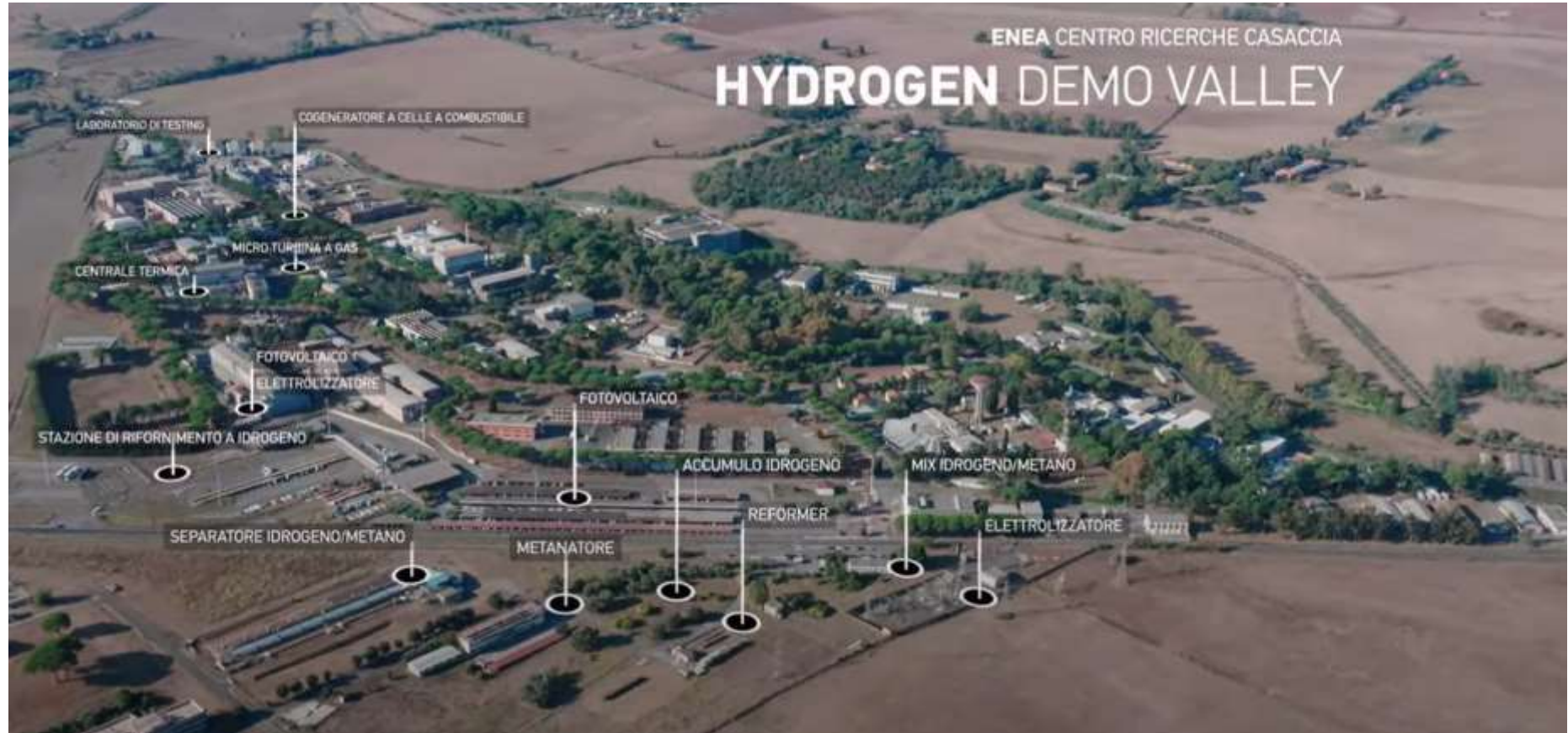


- 36M
- 14 M€
- High TRL
- Technological incubator

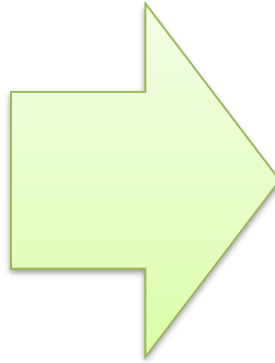


1. At Research Center Casaccia ENEA, Rome
2. At CNR Capo d'Orlando (Messina, Sicily)

Projects & collaborations



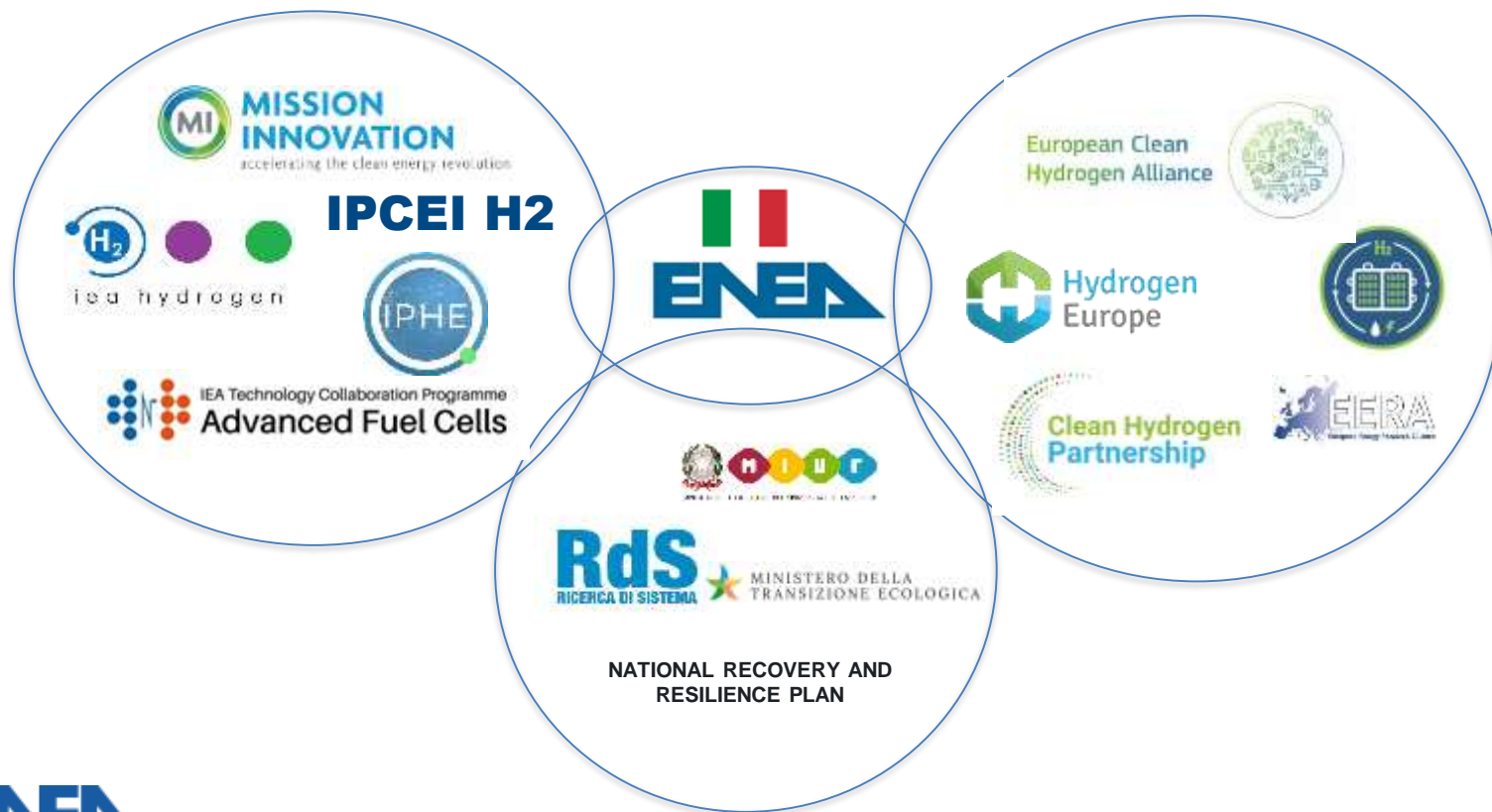
Mission Innovation IC8 – ENEA H2 demo Valley



ENEA Institutional Commitments on Hydrogen

- **ENEA** is the main beneficiary in **Recovery and Resilience Plan**, coordinating R&D project on H2 Value chain with 110 M€
- **ENEA** is the main beneficiary in **MISSION INNOVATION IC8: Renewable and Clean Hydrogen** with the ENEA Casaccia Hydrogen Demo Valley
- **ENEA** supports the **Min. Economic Development** in preparing the Italian project portfolio for the first **IPCEI(s) - Important Project of Common European Interest on H2**
- **ENEA** is Member of **Hydrogen Europe Research** within Clean Hydrogen Partnership
- **ENEA** participates to the European Energy Research Alliance (**EERA**) **Joint Programme on Fuel Cells and Hydrogen** (www.eera-fch.eu)
- **ENEA** is national delegate for the **IEA Technology Collaboration Programme on H2 and FC**

International, European and National hydrogen initiatives



*Thanks for your
kind attention*

*Giulia Monteleone
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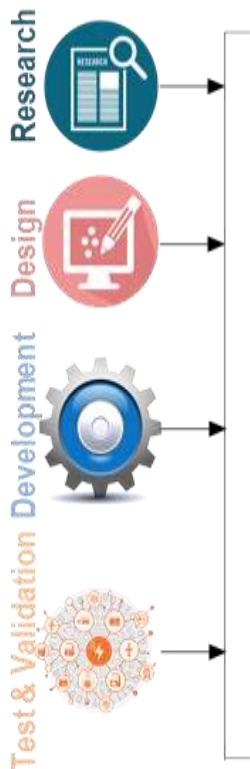


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Back-up slides

HYDROGEN PRODUCTION

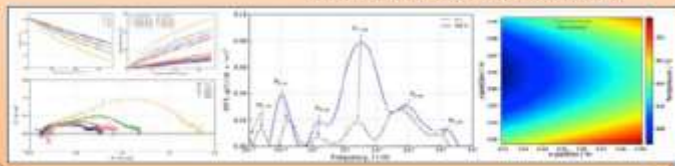
TOPICS



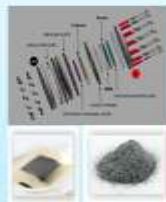
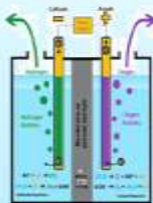
High temperature electrolysis via solid oxide cells



- evaluation and quantification of the electrochemical performance
- study of the material degradation phenomena.
- definition of experimental procedures for the qualification of commercial cells and modules.



Low temperature electrolysis via AEM and PEM electrolyzers



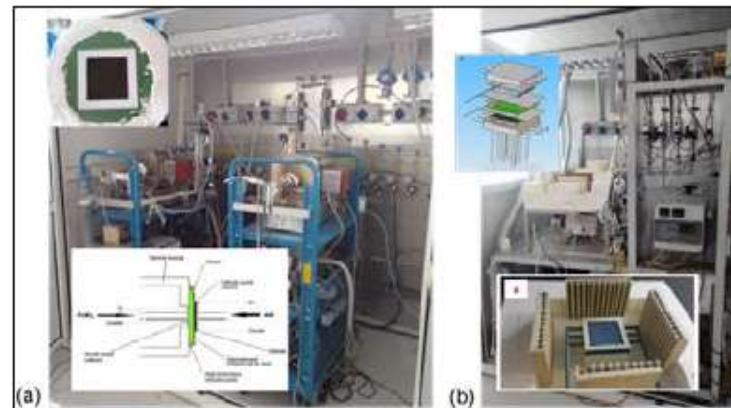
- Reduction of the load of noble metals.
- Development of efficient membranes and alternatives to commercial ones but with reduced costs
- Development of a cell and system engineering to guarantee high pressures without degradation of the system.

INFRASTRUCTURES

Button Cells Test Stations



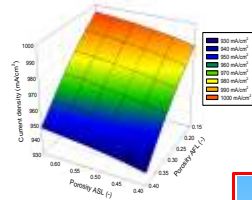
Experimental facilities able to explore all the electrolysis technology spectrum from **TRL 2** with dedicated test bench for button cell testing up to **TRL 9** with the first **Italian Hydrogen Valley** able to produce more than 21 ton/year of green



HYDROGEN FINAL USE - FUEL CELLS

TOPICS

- Advanced analyses of **SOC performances** in relevant environment at different operating conditions (hydrogen, syngas, biogas, reversible operation).
- Material & components characterization.**
- Computational modelling** at different levels (electrodes, cells, modules).
- Development of **testing protocols**, definition of operative **standards**, **LCA**, policy support.



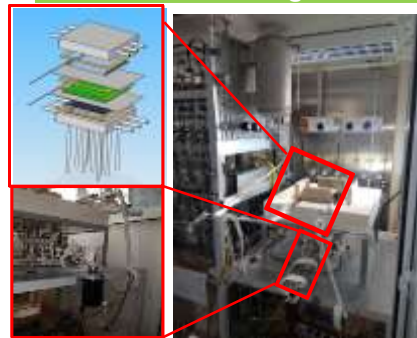
INFRASTRUCTURES

Button Cells Test Stations



Test stations for electrochemical analyses of small Solid Oxide Fuel Cells samples (active area 2 cm²). Applied for in-depth electrochemical characterizations by means of Impedance Spectroscopy (EIS) coupled with the Distribution of Relaxation Times (DRT) technique to investigate on: physicochemical phenomena, estimation of physical quantities of modelling purposes, characterization of novel electrodes / electrolyte materials, impact of contaminants on electrodes, degradation phenomena.

Single Cells / Short Stacks Test Stations



Test stations for performance and durability analyses of single cells (active area up to 100 cm²) and short stack modules (up to 10 cells in series). Investigation on the impact of different operating conditions with respect to specific applications for heat and power generation from hydrogen, hydrocarbons, syngas and biogas. Development of testing protocols and validation of prototypes and commercial products.

Research

Design

Development

Test & Validation

HYDROGEN PRODUCTION & USE

MAIN FUNDED PROJECTS



Development of **reversible high temperature electrolyzers** to support the integration of wind and solar energy with the electricity grid

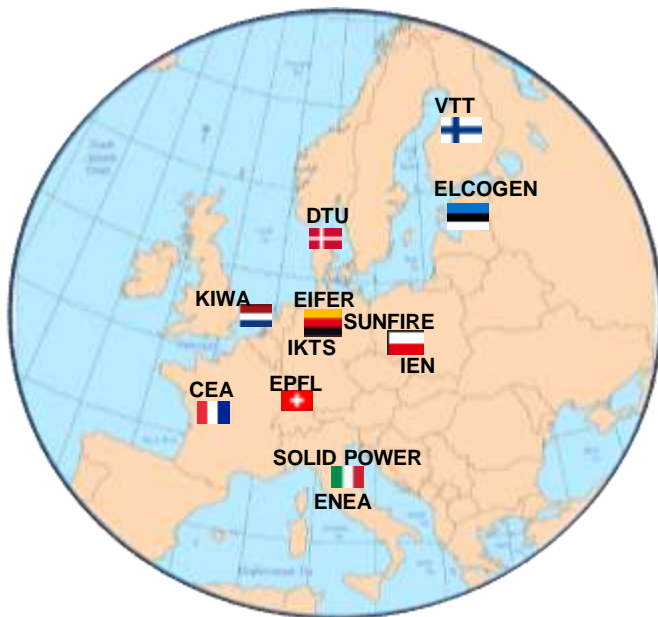


Solid oxide fuel cell combined heat and power's Future-ready Energy

Development of a fully future-ready solid oxide fuel cell (SOFC)-based system for combined heat and power (CHP) generation for efficient, near-zero-emission, **fuel-flexible** and truly modular power and heat supply.



Use of **biogas and syngas (from biomass)** for **small SOFC** CHP integrated modules (5-50 kW)



Definition and development of Accelerated Stress Testing (AST) protocols for **Solid Oxide Cells (SOC)** for **Power to X (P2X)** and **Combined Heat and Power (CHP)** applications



Coupling BFB **gasifier with SOFC** modules for CHP applications



Optimise the coupling of solid oxide electrolysis (the hydrogen generator) with intermittent renewable heat and power from solar energy

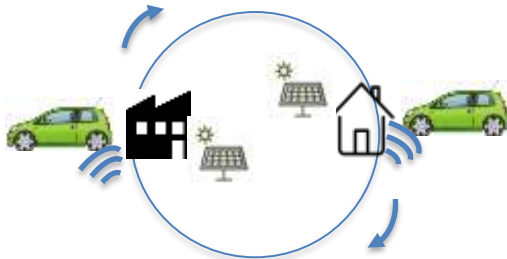


Developing a monitoring, diagnostic, prognostic and control tool for SOEC systems.

APPLICATION: SUSTAINABLE MOBILITY

TOPICS

- Theoretical & Experimental activities on new technologies for Sustainable Mobility, low environmental impact vehicles and storage systems for automotive and stationary applications
- Development and testing on zero emission technologies for transportation including:
 - Innovative fuel mixtures (Hydrogen/methane, biodiesel,...)
 - Hydrogen vehicles (FC and ICE)
 - Propulsion systems for industrial and off-road applications (overhead cranes, cableways, ...)
 - Charging systems for EVs
 - Batteries (e.g., lifespan and 2nd life; safety, etc.)



INFRASTRUCTURES

Sustainable Mobility Research Infrastructure



Design, testing and demonstration of new technologies for Sustainable Mobility and storage systems for automotive and stationary applications: (i) EVs and stationary storage ; (ii) Hydrogen vehicles; (iii) Battery lifespan and 2nd life; (iv) Charging system for EVs; (v) Batteries Safety



- Battery cyclers of different sizes (from cell to pack level)
- Climate chambers
- Rolling test bench
- Propulsion system test facility

Funded Projects



Design and development of a V2H application based on wireless technology aimed to support home consumption, promoting the use of renewable energy in the context wide energy community (home & work)



Research on Ports and Maritime applications with H2

e-SHyIPS - Ecosystem Knowledge in standards for hydrogen implementation on passenger ship

e-SHyIPS project will integrate theoretical pre-normative research activities on standards with simulation and laboratory experiments, in order to provide the needed knowledge to design an appropriate certification process and spot future standardization activities to enhance the EU normative and regulatory landscape.



www.e-shyips.com



H2Ports - First application of hydrogen technologies in port handling equipment in Europe

H2Ports aims to boost the transition of the European port industry towards an effective low-carbon / zero – emission and safe operative model by piloting and demonstrating new Fuel Cell Technology



www.h2ports.eu

