

Hydrogen Research & Innovation Days

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SINGLE

Electrified Single Stage Ammonia Cracking to Compressed Hydrogen

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SINGLE - 101112144

- Partners: CTMS, CSIC (ITQ), GECRIO, UL, SINTEF, ICONS, UPC
- Project start date: May 2023
- Duration: 3 years

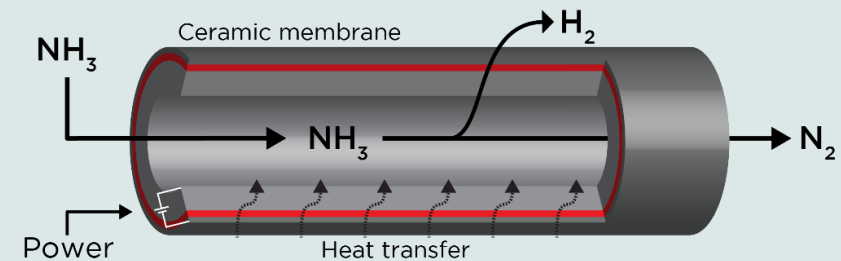




Ammonia as Hydrogen carrier

- Carbon-free liquid: high energy and hydrogen density
- Well-established infrastructure:
 - Ammonia has been produced industrially for over 75 years, with large existing infrastructure and offtake, despite its toxicity and HSE concerns
- Favorable storage and transport properties:
 - At atmospheric pressure, hydrogen exists as a liquid at -253 °C, which makes it very challenging to transport as liquid
 - Ammonia exists at -33 °C: ability to be liquefied and maintained in liquid form for extended periods at ambient pressure
- Ammonia fuel bunkering network being developed (example Green platform project Norway)

Proton Ceramic Electrochemical Reactor (PCER)



PCER for ammonia dehydrogenation : 1-step process to pressurized H₂ with superior energy efficiency

- Ammonia dehydrogenation (ADH) reaction
- Hydrogen separation
- Heat management
- Compression



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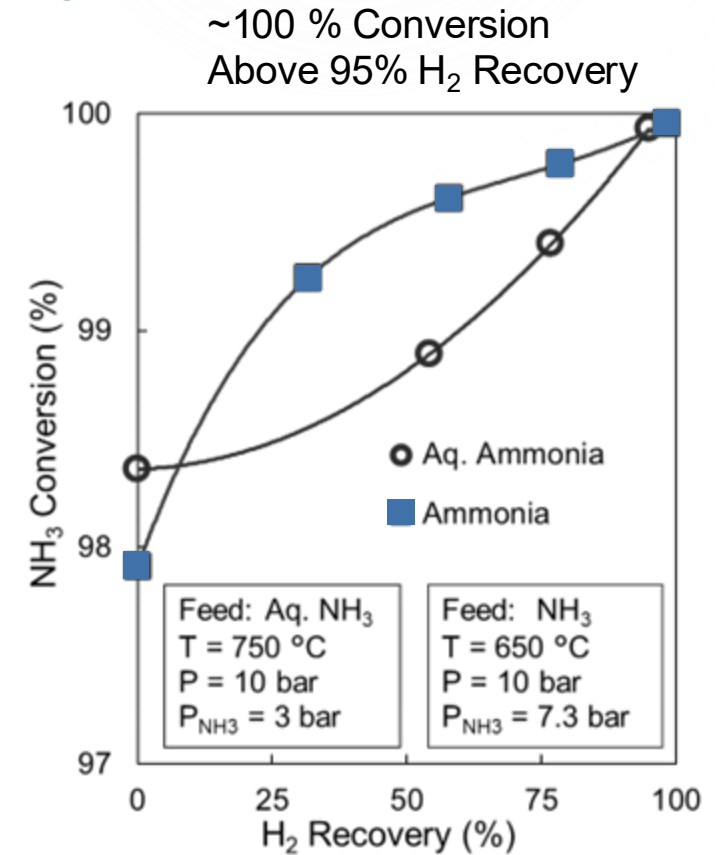
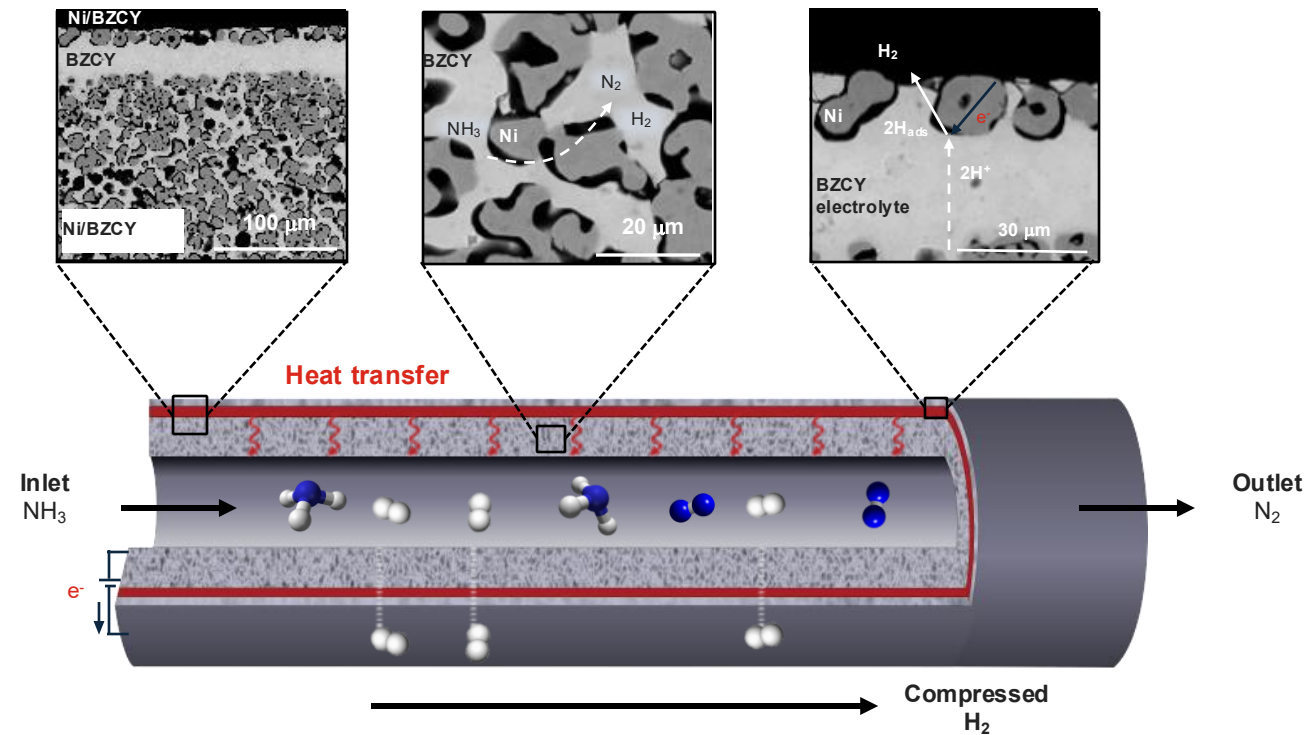
Main objectives

- Proton Ceramic Electrochemical Reactors (PCERs) for Ammonia Dehydrogenation (ADH)
- High purity pressurized hydrogen
- Demonstration module of 10 kg H₂/day
- Evaluation the value stream for scale up economics for future large-scale deployment





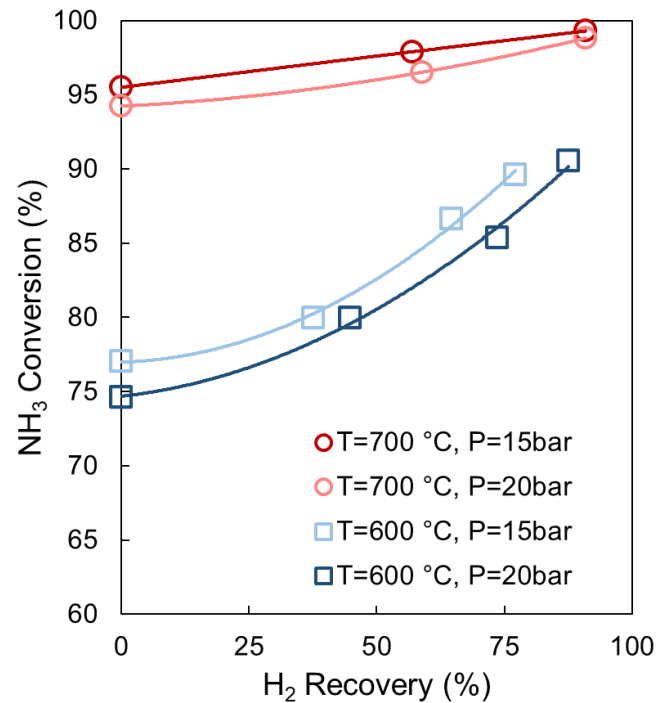
PCER for H₂ production from Ammonia



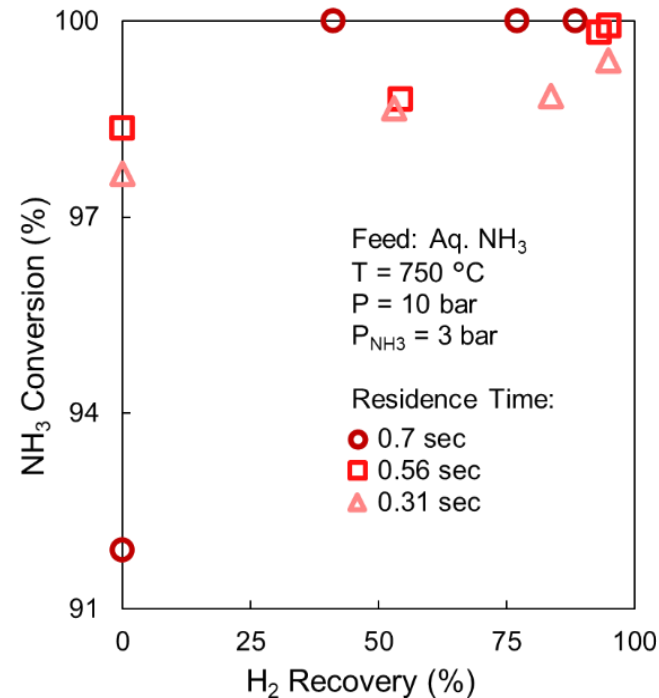


PCER performance and efficiency

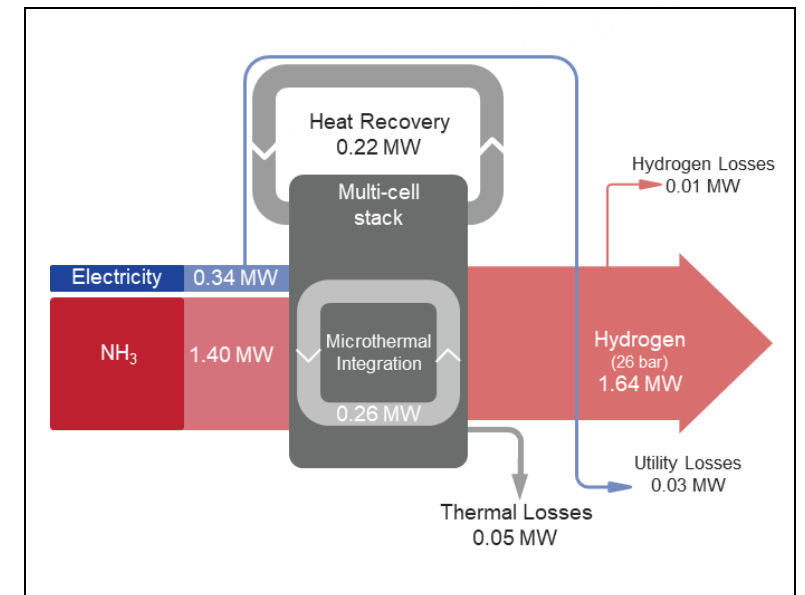
Wide operation window



Flow & fuel flexibility



High efficiency

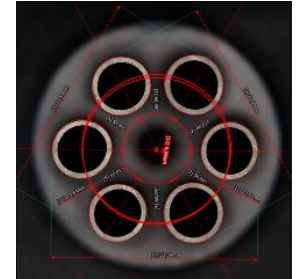
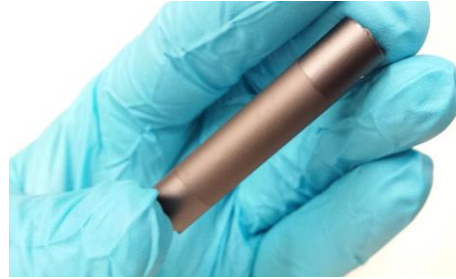
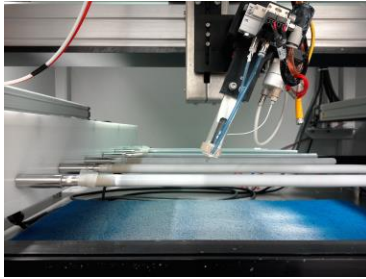
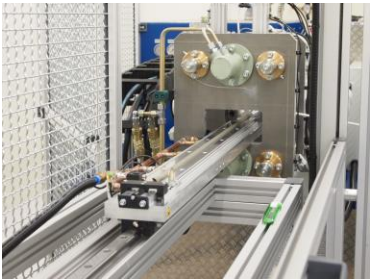
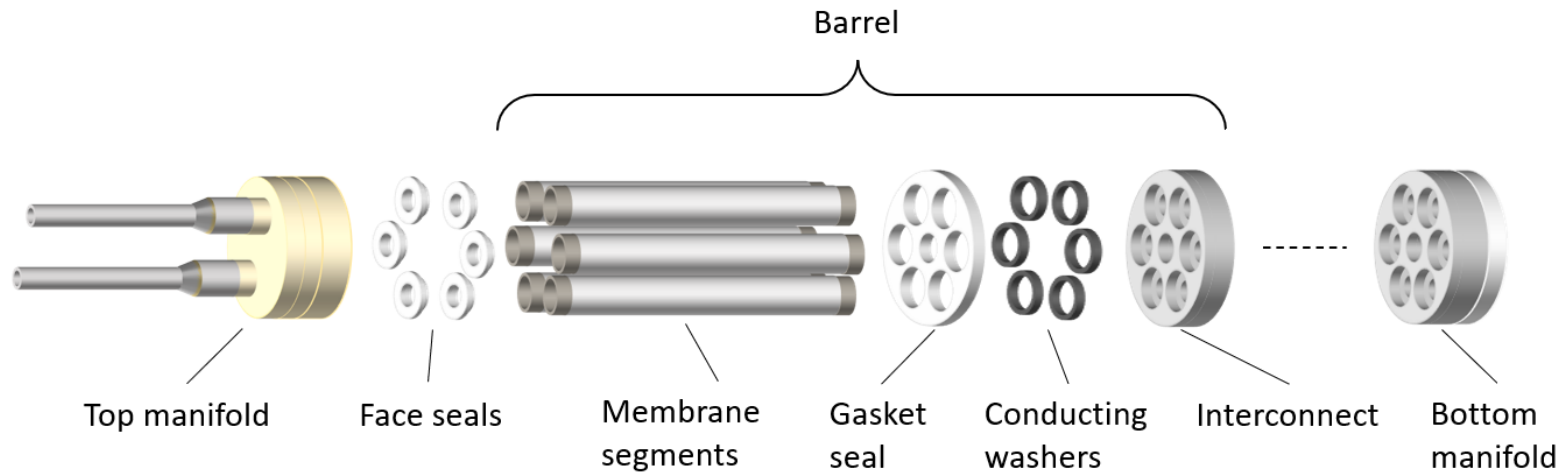


NH₃-PCER 1tn/day plant
94.5 % efficiency



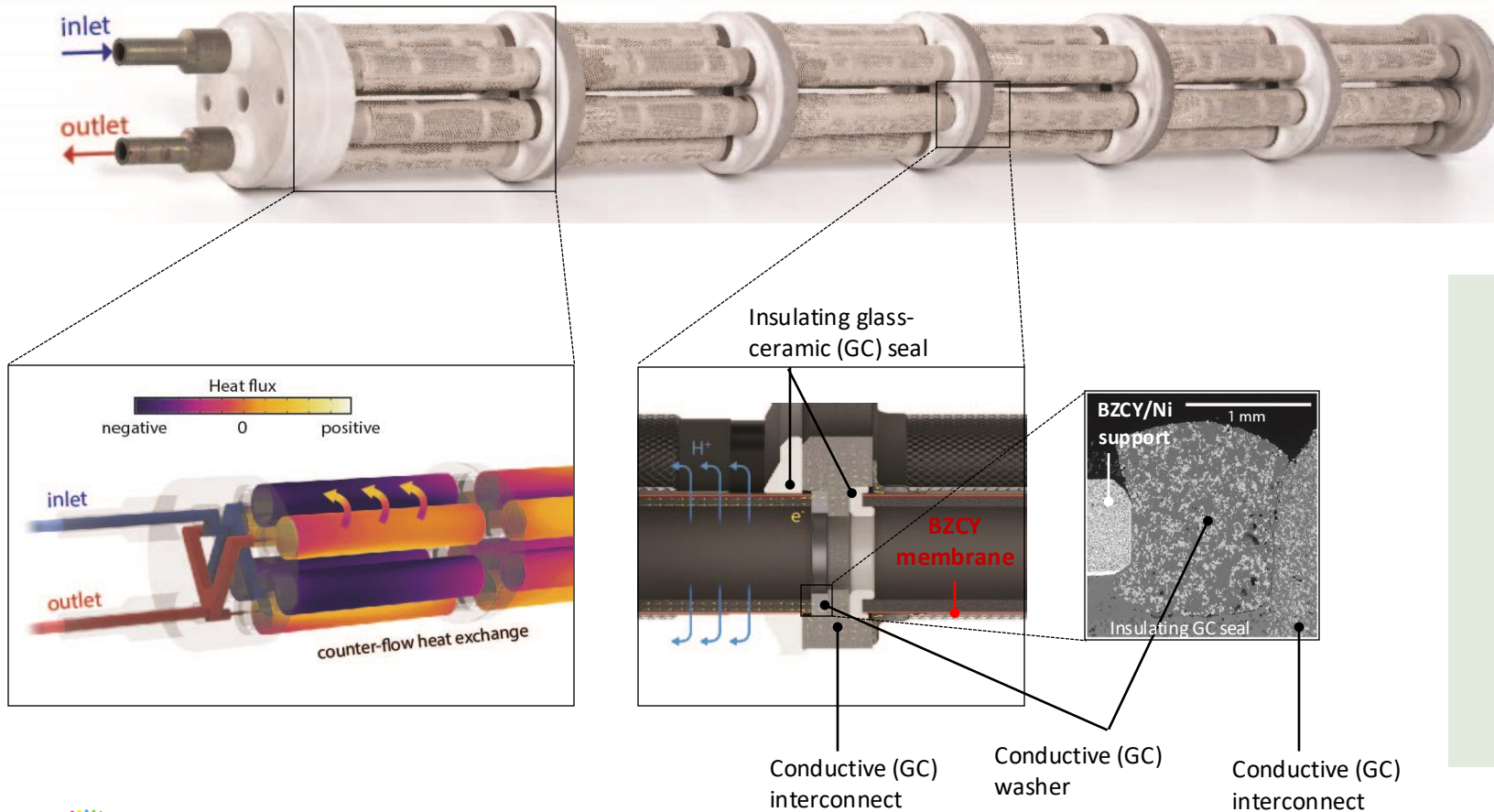
From cell to stacks

Series of six barrels (six single cells per barrel)





PCER stack



- Cells (six) within a barrel electrically in parallel
- 6 barrels electrically in series
- Highly conductive Ni-based IC:
 - Efficient current distribution
 - Mechanical robustness
- Designed for high pressurize operation.
- U-bend type gas flow covering 12 cells
- Microthermal heat integration

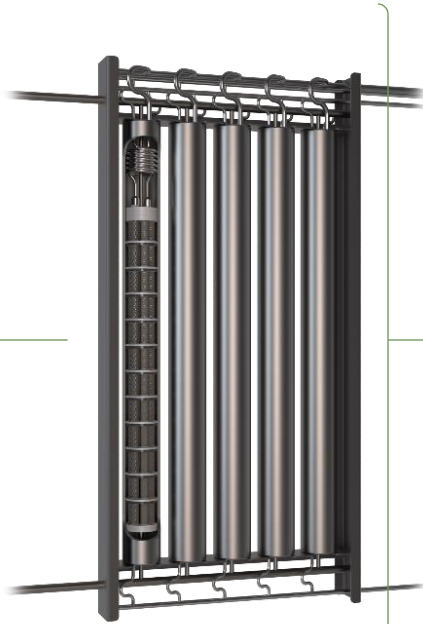


From stacks to module

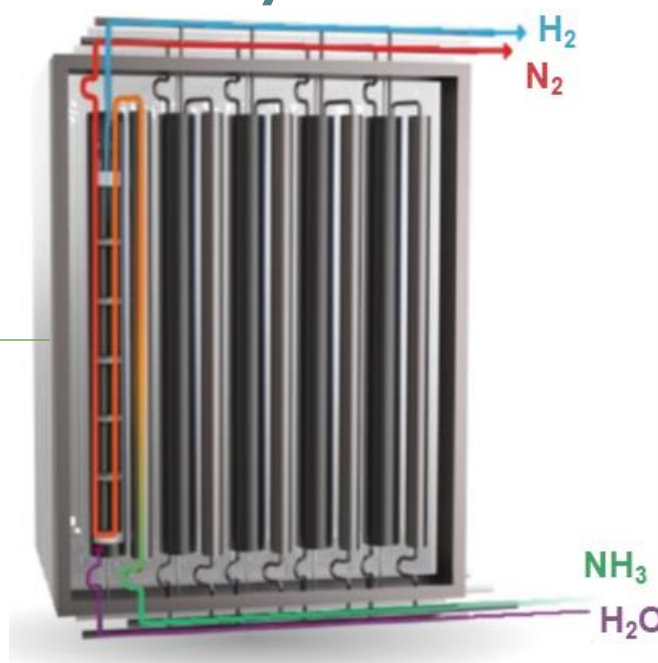
Delivery Q1 2026



Stack
0.5 kg H₂/day



Panel
2.5 kg H₂/day



Module
10 kg H₂/day

BoP arrived Valencia (Spain)



Targets 10 kg of H₂ per day module:

- Efficiency > 90 % HHV
- NH₃ conversion > 99.5 %
- Hydrogen recovery > 95 %
- > 500 h continuous operation
- Hydrogen purity according to ISO 14687:2019*



Project outcomes

- **From single cell to stack**

First PCER stack proven, achieving NH_3 conversion 99 % and H_2 recovery > 98 % at 750 °C and 10 bar, and 100 hours of stable continuous operation

- **Pilot-scale manufacturing**

PCER stacks are being produced advancing toward TRL 5 and industrial integration.

- **Catalyst optimization**

Ni-BZCY electrodes were enhanced by metal infiltration, for low-temperature activity (< 600 °C) and durability

- **Alloy nitridation resistance**

Ni-based Alloy 625 identified as the most corrosion-resistant material, validated under 750 °C, 20 bar wet NH_3 conditions

- **Advanced modelling and control**

CFD and real-time control algorithms developed to enable maximum hydrogen output even with fluctuating renewable power inputs.

- **Sustainability validation**

LCA and RED III methodologies confirmed that PCER-based meets the RED III threshold for renewable hydrogen (Spain, 70 % PV electricity, only 14 % of the RED III carbon footprint limit is emitted in the cracking process)

- **Grid-compatible flexibility**

The modular PCER architecture supports distributed hydrogen generation close to demand centers



To explore the project's key insights in more depth, **a set of infopacks is available on SINGLE Zenodo community.**

Scan here to access all the infopacks available:



Coming soon

100 kg H₂/day demo unit

New project from TRL 5 to TRL 7
8m€ - 2026 to 2029



Thank you

Selene Hernández Morejudo, Research manager CoorsTek Membrane Sciences

Follow the project : <https://singleh2.eu>
Contact smorejudo@coorstek.com

SINGLE – Partners

1. **COORSTEK MEMBRANE SCIENCES AS** (CTMS) (Norway)
2. **CSIC** (Spain) Instituto de Tecnología Química
3. **GEA ENERGIA CRIO S.L.** (GECRIO) (Spain) is a company specialized in cryogenic installations and LNG and CNG supply stations for vehicles
4. **UNIVERISTY OF LUBLIJANA** (UL) (Slovenia) leading team in Slovenia for life cycle assessment methodology, hydrogen economy, hydrogen experimental research, and theoretical and applied thermodynamic analyses of energy conversion systems.
5. **SINTEF** (Norway) Sustainable Energy Technology, with the subgroup Thin Film and Membranes Technologies.
6. **ICONS** (Italy) science communication, social and business innovation.
7. **UPC** (Spain) Automatic Control research line in the Institut de Robòtica Informàtica Industrial (UPC/CSIC).

