Solid oxide electrolysis development through the Open Innovation Test Bed H2SHIFT project

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SERVICE FOR HYDROGEN INNOVATION FACILITATION AND TESTING

H2shift

H₂ PRODUCTION TECHNOLOGY
SINGLE ENTRY POINT

2024-2028
48 Months
***Coord:* SNAM**

TESTING SERVICES

- **Advanced Electrolysis** — Hi-TEL / AEMEL
- **Biohydrogen production** — BIOGAS / BIOMETHANE / BIOETHANOL
- **Direct-solar H₂ production** — THERMO / PHOTO
- **Offshore H₂ production**

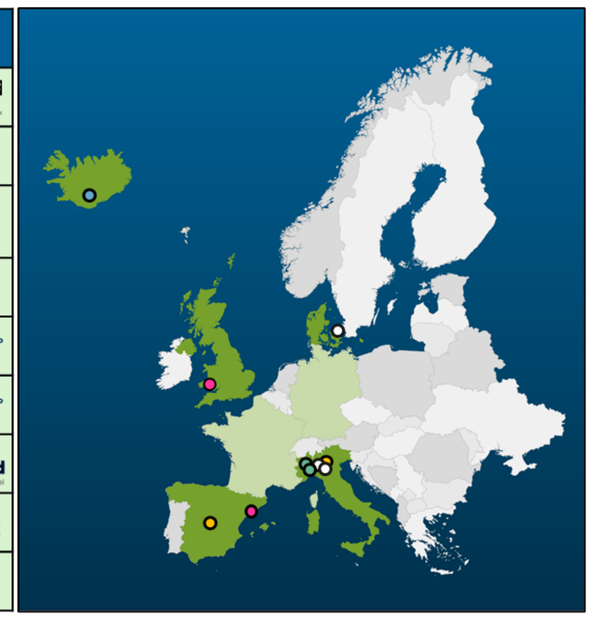
TECHNOLOGY UPSCALING SERVICES

NON-TECHNICAL SERVICES

INNOVATIVE SOLUTIONS

Service offers through showcases and 2 waves of Open Calls

#	Testlines	Leader
TL1	*High-temperature electrolysis*	IREC
TL2	*Anion Exchange Membrane electrolysis*	University of South Wales
TL3	*Biogas Reforming and Biomethane Pyrolysis and Plasmalysis*	snam
TL4	*Bioethanol Reforming*	Tecnicas Reunidas
TL5	*Thermochemical water splitting*	Politecnico di Torino
TL6	*Photo(electro)catalytic H_2 production*	Politecnico di Torino
TL7	*Production of H_2 in off-shore environment*	Youwind
TL8	*Technology upscaling services*	resolvent
TL9	*Non-technical Services*	



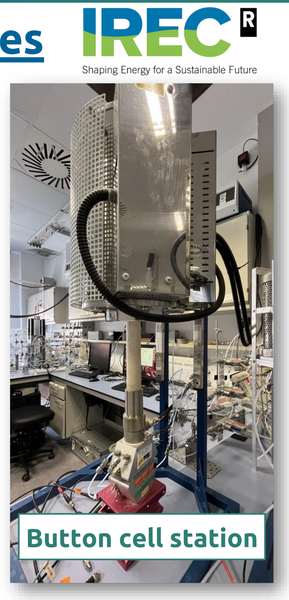
Advanced Water Electrolysis · Bio-Hydrogen · Direct Solar to H_2 · Offshore · Non H_2 production testing services

Partners: snam · College des Ingénieurs · IREC Shaping Energy for a Sustainable Future · Politecnico di Torino · Tecnicas Reunidas · Environment Park Parco Scientifico Tecnologico per l'Ambiente · Fondazione Politecnico di Milano · University of South Wales Prifysgol De Cymru · Youwind · resolvent Modelling Solutions · Viver Cleantech · Politecnico Milano 1863 · H2B2 Electrolysis Technologies

TL#1: HT electrolysis

IREC testing facilities



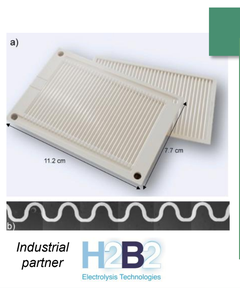


- Characterisation of materials, cells and stacks
- 3 button cell stations, 4 stack stations
- Multiple gas atmosphere and precise steam flow
- IV, EIS at cell, multi-cell and stack level
- Durability, RES profiles and thermal cycling
- Post-mortem analysis by XRD, SEM-EDX, Raman, and GDOES.





SHOWCASE: Ultra-compact 3D printed SOEC stack



Test Line #1	Test Line #8	Test Line #9	Test Line #9	Test Line #9
HT electrolysis technical study — IREC	**Multiphysics simulations** — resolvent	**Technology benchmark** — IREC	**Life cycle analysis** — Politecnico Milano 1863	**Techno-economic assessment** — snam, IREC



Experimental study of the 3D printed based stack (TL#1)

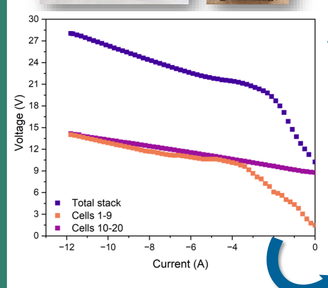
Expected outcomes from TL#1:

- Electrochemical characterisation of a 20-cell stack made with 3D printed electrolytes of 3YSZ
- Electrochemical characterisation of a short stack made with 3D printed electrolytes of 8YSZ
- Characterisation of an optimised cell or stack based on TL#8 recommendations

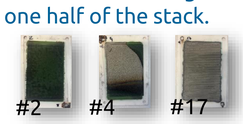
20-cell stack with 3D printed 3YSZ electrolytes

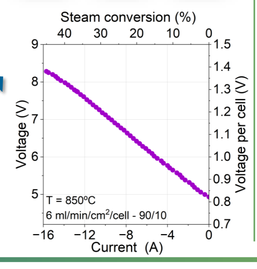


Stack assembled with 200 µm-thick interconnects, metallic meshes and compressive sealants



Anormal iV behaviour related to leakages in one half of the stack.

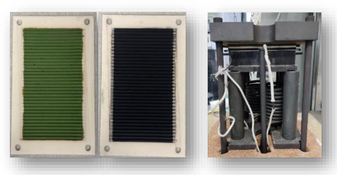


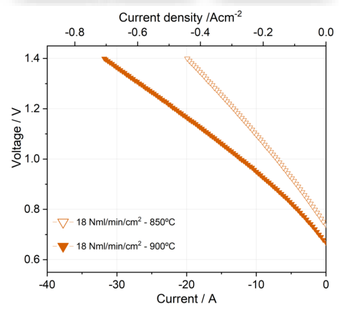


Re-measurement of 6 cells in a short stack:

- no leakages
- higher performance than in the first test.

SRU with 3D printed 8YSZ electrolyte





Current density strongly increased in comparison with 3YSZ electrolyte

Simulation of the 3D printed based stack (TL#8)

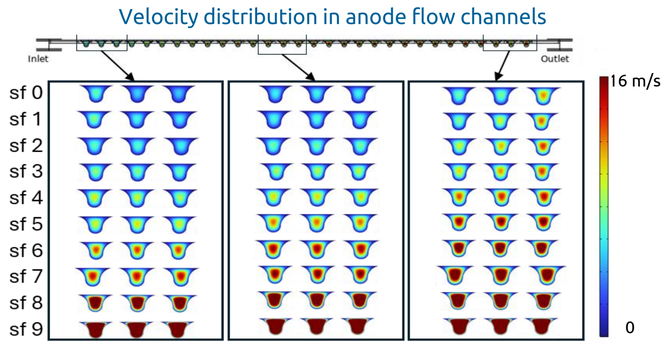
Expected outcomes from TL#8:

- Validation of the actual cell and stack design
- Suggestion of design improvements
- Focus on the fluid dynamics and thermomechanical behaviour under operation

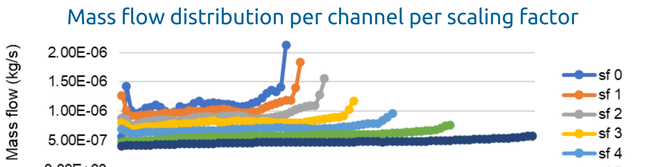
Effect of the number of channels



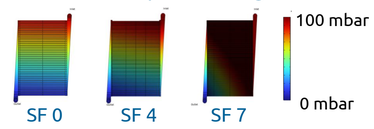
Velocity distribution in anode flow channels



Mass flow distribution per channel per scaling factor



Pressure drop in the single cell



Other studied parameters: manifold shape, manifold distance and channel inlet shape

Benchmark

Performance and durability compared with main HT players

LCA (TL#9)

- Comparison with SoA ESC and ASC-cell based stacks
- Focus on the 3D printing technology

TEA (TL#9)

Scenarios for MW-scale plant

- Electricity withdrawal from the grid
- Electricity and heat supply from nuclear
- Dedicated PV and electricity withdrawal from the grid

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