HERAQCLES

NEW MANUFACTURING APPROACHES FOR HYDROGEN ELECTROLYSERS TO PROVIDE RELIABLE AEM TECHNOLOGY BASED SOLUTIONS WHILE ACHIEVING QUALITY, CIRCULARITY, LOW LCOH, HIGH EFFICIENCY AND SCALABILITY

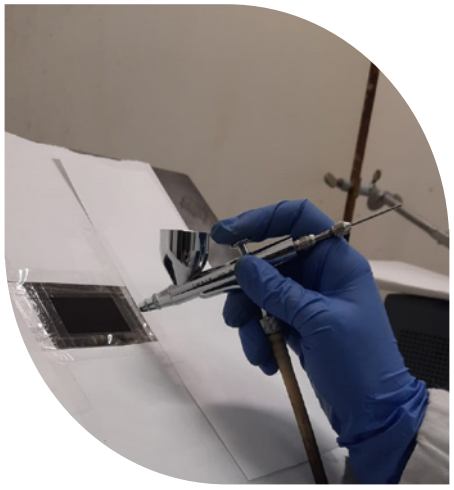
Project ID	101111784
PRR 2025	Pillar 1 - H_2 Production
Call Topic	HORIZON-JTI-CLEANH$_2$-2022-01-04
Project Total Costs	2 342 385.00
Clean H_2 JU Max. Contribution	1 999 622.50
Project Period	01-06-2023 - 31-05-2027
Coordinator Beneficiary	SCHAEFFLER TECHNOLOGIES AG and CO. KG, DE
Beneficiaries	HyGear Fuel Cell Systems B.V., JOHN COCKERILL HYDROGEN BELGIUM, EXENTIS TECHNOLOGY GMBH, HYGEAR OPERATIONS BV, HYGEAR HYDROGEN PLANT BV, HYGEAR TECHNOLOGY AND SERVICES BV, MONOLITHOS KATALITES KE ANAKIKLOSI ETAIREIA PERIORISMENIS EVTHINIS, MANUFACTURE FRANCAISE DES PNEUMATIQUES MICHELIN, HYGEAR FUEL CELL SYSTEMS BV, HYGEAR BV, VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V., CONSIGLIO NAZIONALE DELLE RICERCHE

https://www.schaeffler.com/en/technology-innovation/culture-of-innovation/funded-projects/

PROJECT AND GENERAL OBJECTIVES

HERAQCLES has the following project aims:

- Development of automated manufacturing processes for anion-exchange membrane (AEM) water electrolysers and validate a proof-of-concept 25 kW system operating at 30-50 bar with a hydrogen production rate of about 12.5 kg H_2/d (manufacturing readiness level 5) with detailed design and cost calculation for a 100 MW electrolysis plant.
- Marked increase in operating current density (1A/cm^2 nominal at 1.8 V/cell and 2 A/cm^2 at 2.2 V) while keeping energy consumption < 48 kWh/kg at 1 A/cm^2 with a stack efficiency of 80% in respect of higher heating value (~70% in respect to lower heating value). This will bring an efficiency improvement of at least 2-4 % in respect of the lower heating value compared with the present state-of-the-art in the field of liquid alkaline electrolysers while enabling operation at much higher current density.
- Reduction in capital cost in large scale production (100 MW production volume) to less than 0.6 € million/(tonnes/day H_2). This corresponds to 300 €/kW for a production volume of 100 MW. The development of an automated manufacturing process for a novel stack architecture, the use of non-critical raw materials (cheap Ni-based electrocatalysts, hydrocarbon membranes, and cost-effective Ni-coated stainless-steel bipolar plates), the minimisation of materials use, a simplified balance of plant for differential pressure operation, and the increased current density (according to the Faradays law) will bring a perspective.
- Validation of the durability under steady and intermittent duty cycles conditions in time studies of at least 2 000 hours cumulative (1 000 hours of steady-state and 1 000 hours of cycled operation) with targeted degradation rate lower than 5-7 mV/h at a fixed current density of 1 A/cm^2 corresponding to about 0.2-0.4 %/1 000 h.



- System lifetime of 10 years operation without stack replacement and of 20 years with a single stack replacement (cut-off voltage: 2.4 V).
- Significant reduction in the levelised cost of hydrogen to less than 2-3/kg H_2 with 0.6 € million/(tonnes/day H_2) in capital expenditure and operation and maintenance costs of less than € 20/(kg/day)/year assuming a € 40 /MWh renewable electricity cost and 4 000 h/year of uptime.
- Market competitiveness for green hydrogen targeting a cost of 2-3 €/kg H_2 (theoretically corresponding to about 50-75 €/MWh).

NON-QUANTITATIVE OBJECTIVES

HERAQCLES aims to address new manufacturing approaches for AEM electrolysers to provide reliable AEM technology-based solutions, directly fulfilling targets for the large-scale deployment of cheap green hydrogen. Thus, the project will contribute to the EU policy in terms of limiting the environmental impact of current hydrogen technology applications, minimising materials usage, avoiding critical raw materials, improving the cost-effectiveness of clean hydrogen solutions and reinforcing the EU's scientific and industrial ecosystem.

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FUTURE STEPS AND PLANS

- Testing of Loop 1.
- Stack defining parameters for loop 2 stack.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Voltage	V	1.8V/cell @ 1A/cm^2 current density	1.8V/cell at 1A/cm^2 achieved at single cell level by partner CNR-ITAE.	
	Hydrogen costs	€/kg	2-3		
	Electricity consumption @ nominal capacity	kWh/kg	48 kWh/kg@1A/cm^2	48 kWh/kg@1A/cm^2 achieved for the first period at single cell level by partner CNR-ITAE.	
	CAPEX	€/(kg/d)	600	N/A	
	CAPEX	€/kW	300		
	O&M cost	€/(kg/d)/y	20		
	Degradation	%/1 000h	0.4	Prototype tested for at least 2 000 hours cumulative (steady state/dynamic) with targeted degradation rate at 5-7 µV/h at a current density of 1 A/cm^2 (0.2 to 0.4 %/ 1 000 h).	
	Current density	A/cm^2	1	MEA performance of 1.82 V/cell at 1 A cm-2 and 50°C and 2.2 V at 3.6 A cm-2 was achieved at CNR-ITAE in the presence of a noble metal loading of 0 mg cm-2.	
	Use of critical raw materials as catalyst	mg/W		achieved for the first period at single cell level at partner CNR-ITAE.	

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