UNLOHCKED

UNLOCKING THE POTENTIAL OF LOHCS THROUGH THE DEVELOPMENT OF KEY SUSTAINABLE AND EFFICIENT SYSTEMS FOR DEHYDROGENATION

Project ID	101111964
PRR 2025	Pillar 2 – H_2 storage and distribution
Call topic	HORIZON-JTI-CLEANH$_2$-2022-02-05
Project total cost	EUR 2 941 312.75
Clean H_2 JU max. contribution	EUR 2 941 312.75
Project period	01-06-2023 - 31-05-2026, ES
Coordinator Beneficiary	UNIVERSIDAD DEL PAIS VASCO/ EUSKAL HERRIKO UNIBERTSITATEA,
Beneficiaries	HyGear Fuel Cell Systems B.V., HYGEAR OPERATIONS BV, HYGEAR HYDROGEN PLANT BV, FRAMATOME GMBH, HYGEAR TECHNOLOGY AND SERVICES BV, HERAEUS DEUTSCHLAND GMBH and CO KG, HYGEAR FUEL CELL SYSTEMS BV, HYGEAR BV, NOORDWES-UNIVERSITEIT, COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS

https://unlohcked.cnrs.fr/

PROJECT AND GENERAL OBJECTIVES

By advancing breakthrough research on liquid organic hydrogen carrier (LOHC) technologies, UnLOHCked aims to develop a radically disruptive, versatile and scalable LOHC-dehydrogenation plant. Firstly, highly active and stable catalysts without critical raw materials will be developed to reduce LOHC dehydrogenation at moderate temperatures. Secondly, a solid oxide fuel cell system will be developed to be thermally integrated in the dehydrogenation process. The heat demand of the dehydrogenation unit will be fully covered by the fuel cell, while generating electric power. The surplus of hydrogen will be exported. These innovative systems, when fully integrated, will allow significant increase of overall efficiency (>50%) of hydrogen and electric power production from LOHC.

The main objectives of this project are:

- To develop a critical raw material (CRM) free or low CRM-catalyst with high conversion rate, selectivity and productivity for dehydrogenation.
- To scale-up of one of the developed catalysts from a gram at laboratory scale to multiple kilograms for the demonstration plant.
- To develop a breakthrough integrated system in which the reactor is thermally coupled to an SOFC simplifying the dehydrogenation plant and improving the thermal efficiency.
- To demonstrate the feasibility of producing hydrogen and generating renewable electricity from LOHC-stored hydrogen by heat integration between endothermic hydrogen release and exothermic fuel cell operation.

NON-QUANTITATIVE OBJECTIVES

- To reduce capital expenditure (i.e. owing to the use of less expensive materials, no chemical reagents, no cleaning cycles and extended materials lifetime) and operational expenditure (i.e. owing to continuous mode of operation and optimised process controls).
- To decrease the cost of hydrogen transport and to demonstrate the feasibility and cost-effectiveness of LOHC technologies, from on-shore tank to on-shore tank, all inclusive.
- To develop a scale-up plan, through a techno-economic analysis, in order to improve techno-economic viability and to include comparisons with alternative hydrogen technologies for long distance transport.
- To develop a dissemination, exploitation and communication plan targeting key stakeholders and end-users at EU and international level to maximise the impact of UnLOHCked results.
- To put the EU at the forefront of hydrogen technologies ensuring a competitive and commercial advantage in Europe in order to incentivise future investments.
- To reduce the environmental impact of hydrogen technologies by reducing the use and release of toxic substances and CRMs with a huge environmental impact.
- To contribute to the European Green Deal Goals through a fully CO_2-free dehydrogenation system.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

After the first year and a half UnLOHCked is in the middle of the scale-up of a low CRM catalyst. So far UnLOHCked has achieved catalysts with conversions, selectivities and productivities higher than the state-of-the-art and is reaching the project's key performance indicators.

FUTURE STEPS AND PLANS

- Continue scaling up a catalyst from lab scale to industrial scale that reach the project targets.
- Continue the reactor design for the dehydrogenation unit integrated with a solid state fuel cell unit.

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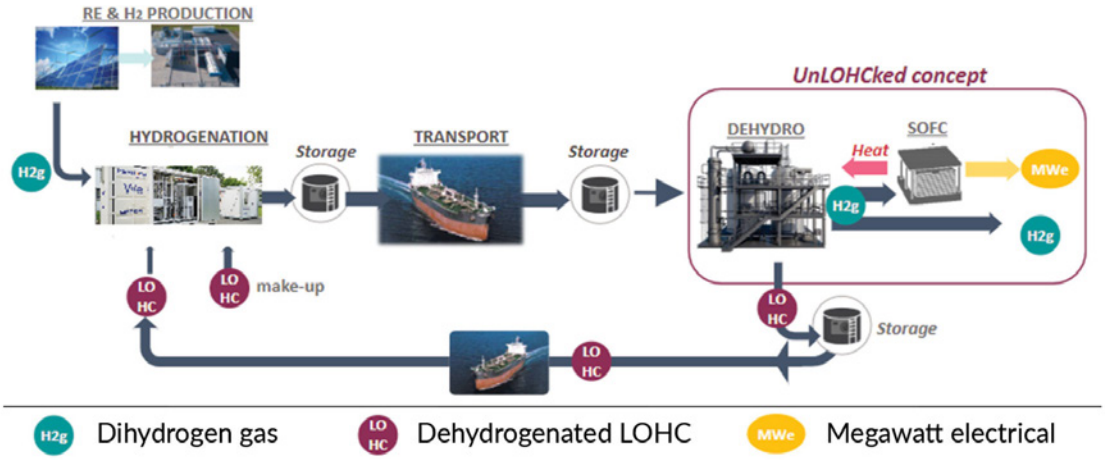

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Grade of conversion	%	>95	96.6	✓
	Catalyst selectivity	%	>99.8	99.8	
	Catalyst productivity in dehydrogenation	g H_2/g catalyst/min	>0.02	0.031	
	No dissemination materials	Number	>8 (website, social media, videos etc.)	6	
	No peer-reviewed scientific publications and patents	Number	>10 publications and ≥1 patents	2 publications	
	Catalyst productivity in dehydrogenation	kg H_2/day	10	-	
	Catalytic stability	%	Leaching of active material <0.1%/cycle Loss of performance < 0.1%/cycle: Grade of conversion >95%	-	
	Catalyst selectivity	%	>99	-	
	Hydrogen carrier specific energy consumption	kWh input/kg H_2 recovered	>17	-	
	Operating hours	hours	>500	-	
	Overall efficiency	%	>50	-	
	H_2 production	kg/day	10	-	
	Overall efficiency (electrical)	%	>50	-	
	Reduction in CAPEX and OPEX	%	CAPEX: 65 OPEX: 80	-	
	Hydrogen carrier delivery cost	€/kg	<2.5	-	
	H_2 Production (TEA)	kg H_2/day	100-1 000	-	
	Reduction in the footprint	%	75	-	
	Reduction in CO_2 emissions	% in the end-to-end UnLOHCked process	>90	-	

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