ECOHYDRO

ECONOMIC MANUFACTURING PROCESS OF RECYCLABLE COMPOSITE MATERIALS FOR DURABLE HYDROGEN STORAGE

Project ID	101138008
PRR 2025	Pillar 8 - Strategic Research Challenge
Call Topic	HORIZON-JTI-CLEANH$_2$-2023-07-01
Project Total Costs	9 617 290.00
Clean H$_2$ JU Max. Contribution	9 617 290.00
Project Period	01-01-2024 - 31-12-2027
Coordinator Beneficiary	INSTITUT MINES-TELECOM, FR
Beneficiaries	HAESAERTS FOR HYDROGEN, ELECTRA COMMERCIAL VEHICLES LIMITED, BASALTEX NV, FEV TR OTOMOTIV VE ENERJI ARASTIRMAVE MUHENDISLIK LIMITED SIRKETI, LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY, MAHYTEC SARL, PROMAT RESEARCH AND TECHNOLOGY CENTRE, TEMSA SKODA SABANCI ULASIM ARACLARI ANONIM SIRKETI, M.D.P. MATERIALS DESIGN AND PROCESSING SRL, CENTRE TECHNOLOGIQUE NOUVELLE-AQUITAINE COMPOSITES and MATERIAUX AVANCES, ARKEMA FRANCE SA, POLITECHNIKA WROCLAWSKA, AIRBUS, KATHOLIEKE UNIVERSITEIT LEUVEN

https://ecohydro-project.eu/

PROJECT AND GENERAL OBJECTIVES

ECOHYDRO's global objective is to ensure an economic process for manufacturing recyclable composite materials for durable hydrogen tanks through the usage of high-strength carbon fibre, low-viscosity thermoplastic liquid resin and instant in-situ photopolymerisation for composite pressure vessels.

ECOHYDRO has six ambitious general objectives:

- Identify and develop multi-functional sustainable materials enabling a circular design and reducing the whole life cost of hydrogen storage solutions.
- Develop standardised inspection and repair methods that improve safety aspects of hydrogen storage and increase the lifetime of hydrogen storage solutions.
- Develop smart solutions that allow for cross-application uses of hydrogen storage to reduce the total number of storage tanks produced.
- Demonstrate increased storage size and reduced capital cost for aboveground storage of hydrogen.
- Demonstrate increased tube trailer payload, reduced capital cost and increased operating pressure for road transport of hydrogen.
- Demonstrate increased gravimetric capacity, conformability, reduced capital costs and increased tank gravimetric efficiency for onboard storage of hydrogen in heavy-duty truck and aviation applications.

NON-QUANTITATIVE OBJECTIVES

- Increase of public acceptance of hydrogen technologies by improving the safety aspects of hydrogen storage in tanks.
- Improvement of public perception of composite material solutions by developing new recycling technologies.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

Testing of various initiators for polymerising acrylic resin through photopolymerisation, thermal polymerisation, and dual polymerisation.

- Modification of acrylic resin with phosphorus comonomers for fire resistance.
- addition of special fillers to enhance thermal insulation while optimising the balance with resin viscosity.
- Creation of self-healing acrylic resin to repair cracks at the fiber/matrix interface.
- Impregnation of different fiber rovings with acrylic resin.
- Optimisation of winding parameters.
- Analysis of microstructures and mechanical properties of the composites, revealing good properties for carbon fiber composites but lower for basalt fiber due to defects.
- Numerical modelling for the filament winding process as well as simulations for resin flow and fiber deformation.
- Finalisation of preliminary designs for four hydrogen storage demonstrators, focusing on various storage types.
- Start with thermal and mechanical modelling for the aviation demonstrator, along with multi-scale damage modelling and the development of a digital twin for monitoring hydrogen tank lifecycle.
- Initial work on hybrid and physico-chemical recycling and development of a life cycle analysis model.

FUTURE STEPS AND PLANS

- Mechanical and thermal characterisation (including cryogenic tests, hydrogen permeation, etc.) of newly developed functional materials.
- Optimisation of manufacturing process in terms of process defects and energy consumption.

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- Modelling of manufacturing process and damage analysis.
- Process monitoring and structural health monitoring by sensor integration and data analysis by an artificial intelligence algorithm.
- Optimisation of recycling process and life cycle analysis of the new materials and manufacturing process.
- Improvement of the preliminary design of demonstrators.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?	SoA result achieved to date (by others)	Year for reported SoA result
Project's own objectives	Storage size (Above ground storage)	tonnes	20	5		1.1	2020
	Cost reduced (Above ground storage)	€/kg	600	700		750	2020
	Trailer payload (Road transport of hydrogen (Gaseous H_2))	kg	1 500	700		850	2020
	Trailer capital cost (Road transport of hydrogen (Gaseous H_2))	€/kg	350	450		650	2020
	Operating pressure (Road transport of hydrogen (Gaseous H_2))	bar	700	500		300	2020
	Storage tank capital cost (Onboard storage of hydrogen in heavy duty truck applications (Gaseous H_2))	€/kg H_2	300	500		600	2020
	Increase in gravimetric capacity (Onboard storage of hydrogen in heavy duty truck applications (Gaseous H_2))	%	7	6.5		6	2020
	Tank gravimetric efficiency (Onboard storage of hydrogen for aviation applications (LH_2))	% weight	35	15		12	2020
	Increase of the number of safe cycles before replacement (Safety and lifetime of hydrogen storage)	Number of cycles	7 500	5 000		5 000	2020
	Life cost reduction (Life cost of hydrogen storage solutions)	%	50	50		N/A	2020

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ELECTROLIFE

ENHANCE KNOWLEDGE ON COMPREHENSIVE ELECTROLYSERS TECHNOLOGIES DEGRADATION THROUGH MODELING, TESTING AND LIFETIME PREVISION, TOWARD INDUSTRIAL IMPLEMENTATION

Project ID	101137802
PRR 2025	Pillar 8 - Strategic Research Challenge
Call Topic	HORIZON-JTI-CLEANH$_2$-2023-07-02
Project Total Costs	9 995 705.00
Clean H$_2$ JU Max. Contribution	9 995 705.00
Project Period	01-01-2024 - 31-12-2028
Coordinator Beneficiary	POLITECNICO DI TORINO, IT
Beneficiaries	STARGATE HYDROGEN SOLUTIONS OU, VOLYTICA DIAGNOSTICS GMBH, 1S1 ENERGY PORTUGAL UNIPESSOAL LDA, OU STARGATE HYDROGEN SOLUTIONS, UNIVERSITE DE LILLE, KERIONICS S.L., HYTER SRL, PIETRO FIORENTINI SPA, SOLYDERA SPA, ENEL GREEN POWER SPA, AEA s.r.l., UNIRESEARCH BV, AALBORG UNIVERSITET, TECHNISCHE UNIVERSITAET GRAZ, CONSIGLIO NAZIONALE DELLE RICERCHE, FORSCHUNGSZENTRUM JULICH GMBH, FRIEDRICH-ALEXANDER-UNIVERSITAET ERLANGEN-NUERNBERG

https://electrolife-project.eu/

PROJECT AND GENERAL OBJECTIVES

ELECTROLIFE aims to comprehend the fundamental mechanisms and causal relationships underlying aging processes of electrolysers to mitigate the limited understanding of degradation phenomena. This understanding will enable the development of models and daily operational strategies to prolong the lifespan of electrolysers. Therefore, ELECTROLIFE integrates advanced modeling techniques, diagnostic tools, next-generation stacks, standardised test benches, testing protocols, and post-mortem analysis.

ELECTROLIFE addresses the scalability challenges of electrolyser technologies by extending their lifespan, enabling operation at higher current densities with reduced overpotentials, and incorporating innovative materials to minimise the reliance on critical raw materials and precious group metals. Thus, ELECTROLIFE contributes to the sustainable development and scaling-up of electrolysis technologies.

NON-QUANTITATIVE OBJECTIVES

- Advancement of electrolyser degradation modelling through the implementation of standardised testing methods.
- Development of dedicated diagnostic tools for precise state of health assessment.
- Development of tailored testing and diagnostic instruments to suit ELECTROLIFE requirements.
- Refinement of operational strategies to enhance efficiency and effectiveness.
- Establishment of guidelines for next-generation robust stacks, diagnostic tools, and optimised operational strategies to extend the lifetime of electrolysers.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

Discussions on the preliminary design of testing instruments and protocols for all electrolyser technologies.

- Establishment of benchmarks for ongoing development by sharing existing models.
- Preliminary single-cell testing of electrolysis components has been initiated to assess beginning-of-life performance.
- Conduction of accelerated stress tests.
- Analysis of the current state-of-the-art knowledge on degradation mechanisms for electrolysers, including the influence of renewable energy sources.

FUTURE STEPS AND PLANS

ELECTROLIFE will:

Undertake testing on individual cells and short stacks.

- Develop and validate models integrating degradation mechanisms.
- Validate use of functional materials at the stack level through dedicated testing, diagnostic instruments, and online data analysis.

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PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Data collection from previous or ongoing projects and/or data available at electrolysis manufacturers.	% Data Completeness Index = (Total amount of data collected / Total amount of data expected*) x 100. *(at least 1 set of data for each electrolysis technology, 100% EU funded projects analysed; >100 publications analysed)	> 90	100	✓
	Identification of degradation mechanisms and effects of their superposition by modelling and simulation activities validated by relevant experimental methods.	% Number of models Index = (Total amount of models developed / Total amount of data expected*) x 100. *(#5 models)	100	20	
	Evaluate the impact of RES electrical profile on electrolysers durability in terms of the dynamic operating conditions.	% Number of RES profiles Index = (Total amount of RES profiles made available / Total amount of RES profiles expected*) x 100. *(#4 RES profiles)	100	10	
	Modelling of degradation resulting from different degradation phenomena and operating conditions, including RES operation models, should be validated by experimental data.	% Degradation Modelling Accuracy Index = (1 - |Predicted degradation - Actual degradation| / Actual degradation) x 100.	> 90	10	
	With the support of dynamic modelling, simulation of the transient electrical and thermal behaviour in view of the impacts on degradation effects.	% Degradation Modelling Accuracy Index = (1 - |Predicted degradation - Actual degradation| / Actual degradation) x 100	DMAI > 80	-	
	Development of lifetime prediction models based on the degradation modelling proposals may include verification testing for such models for selected technologies defining predictive modelling of state-of-health / state-of-life for given operation.	% Lifetime Prediction Tool Accuracy Index = (1 - |Predicted lifetime - Actual lifetime| / Actual lifetime) x 100	> 90	-	
	Development of operation solutions diminishing the degradation in stationary or transient operations (e.g. novel operating and control strategies, diagnostics etc.)	% Operating strategies Index = (Total amount of deliverables on operating strategies made available / Total amount of operating strategies expected) x 100	100	-	
	Adaptation or improvement of advanced characterisation methods for deeper understanding by in situ, ex-situ or in-operando analyses.	% Testing procedures Index = (Total amount of deliverables on testing procedures made available / Total amount of testing procedures expected) x 100	100	25	
	Validation of novel solutions in short stack level (minimum 5 repeating units) for at least 10 000 hours by meeting degradation rate while keeping similar level of performance (current density, hydrogen production rate) or in accelerated stress tests.	% SRIA Targets Achievement Index = (Total amount of 2030 SRIA Targets achieved / Total amount of 2030 SRIA Targets considered*) x 100. *(#4: degradation rate, current density, OPEX and CAPEX).	100% for AEL and PEM, 75% for SOEL, and at least 50% for AEMEL, and PCCEL.	-	
	Development of uniform data formats that can potentially be used for machine learning and big data processing to identify and correlate cause and effect of degradation phenomena.	% Data Standardization Index = (Total amount of datapoint included in the standard dataset / Total number of variables available) x 100.	80	-	
	Assessment of the improved durability on the lifecycle impact of the selected technologies.	% Lifecycle impact analysis Index = (Total amount of LCA performed in the project / Total number LCA expected*) x 100. * (#5)	100	-	

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SUSTAINCELL

SUSTAINCELL: DURABLE AND SUSTAINABLE COMPONENT SUPPLY CHAIN FOR HIGH PERFORMANCE FUEL CELLS AND ELECTROLYSERS

Project ID	101101479
PRR 2025	Pillar 8 - Strategic Research Challenge
Call Topic	HORIZON-JTI-CLEANH$_2$-2022-07-01
Project Total Costs	9 993 652.00
Clean H$_2$ JU Max. Contribution	9 993 652.00
Project Period	01-01-2023 - 31-12-2028
Coordinator Beneficiary	SINTEF AS, NO
Beneficiaries	UNIVERSITE DE MONTPELLIER, TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, HAUTE ECOLE SPECIALISEE DE SUISSE OCCIDENTALE, FUNDACION TECNALIA RESEARCH and INNOVATION, ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE, FORSCHUNGSZENTRUM JULICH GMBH, DEUTSCHES ZENTRUM FUR LUFT - UND RAUMFAHRT EV, DANMARKS TEKNISKE UNIVERSITET, COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS

https://sustaincell.eu/

PROJECT AND GENERAL OBJECTIVES

SUSTAINCELL aims to support European industry in developing next-generation electrolyser and fuel cell technologies by developing a sustainable European supply chain of materials, components and cells. This will be based on scientific breakthrough innovations, eco-design guidelines and environmentally-friendly manufacturing routes.

SUSTAINCELL focuses on developing new critical-raw-material (CRM)-lean and/or CRM-free materials and architectures, aiming to maximise functionalities and durability while decreasing CRM content per unit cell. The new flexible and scalable processing routes will exhibit higher productivity, reduced utilities consumption and reduced greenhouse gas emissions. The project will also develop enhanced recovery and treatment processes for optimising recovery and reuse of platinum group metals / CRMs and ionomers extracted from end-of-life stacks and production processes.

NON-QUANTITATIVE OBJECTIVES

- Harvesting and expanding European knowledge and know-how on the identification, substitution, recovery and recycling strategies and value chains, of critical raw materials.
- Ensuring the replacement and/or reduction of critical raw materials per unit cell using eco-friendly processing methods.
- Increasing the yield of ionomer and critical raw materials recovered from used cells and membrane electrode assemblies and from scrap and waste, by recycling.
- Contributing to the development of EU harmonised protocols.
- Validating new solutions in terms of gain in performance and durability at single cell level.
- Demonstrating the sustainability of at least three innovative solutions for each technology.
- Maximising the impact, uptake and acceptance of SUSTAINCELL results by developing strategies for dissemination to, communication with and exploitation by academia, industries, policy makers, non-governmental organisations and the public.
- Establishing a suitable toolbox for efficient risk management and knowledge sharing between partners.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

Materials and processes for critical raw material reduction in high temperature electrolysers:

- Thinned Ni-3YSZ electrodes with 50% less NiO using $MgAl_2O_4$ and Al_2O_3 additives showing increased mechanical strength.
- Ni-free, REE-lean perovskite electrodes (LST and LSCM) showing comparable performance to Ni-based cermets.
- LSF-based electrodes with YSZ backbones showing improved polarisation resistance (ca 50%).
- PBSCF nanofiber electrodes for PCCELs showing reduced Co/REE use and improved porosity and performance (ca 93–97%).
- Exploration of photonic annealing for rapid electrode sintering.

CRM Reduction in LT Electrolysers:

- Novel AEMs and CEMs developed showing stable performance and good conductivity (up to 0.07 S/cm).
- pPIM ionomers showing higher oxygen diffusion and PEMFC performance versus Nafion.
- Ni@C-N HOR catalysts and Ni-MOF based HER catalysts showing optimised activity and stability.

Innovation & Testing:

- A robotic catalyst discovery platform was built at DTU using ML-guided synthesis and testing.
- Round-robin testing protocols were harmonised among partners for AEMEL cells.

PRR 2025 PILLAR
Srategic Research Challenge

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- Photonic annealing, flame spray pyrolysis, and dip-coating enabled scalable electrode production.

Recycling & Sustainability:

- Testing of critical raw materials separation from end-of-life high temperature cells through physical disintegration methods (ball milling, hydrogen decrepitation).
- Life cycle analysis and techno-economic assessments identified environmental hotspots and critical raw material use across even electrolysis/FC technologies.
- A benchmark report mapped critical raw materials usage, with outreach to industry and RTD groups.

FUTURE STEPS AND PLANS

- Amplify interaction with external stakeholders and dissemination activities through setting up the advisory board of the project.
- Organise joint seminars and workshops with European and international projects addressing similar research topics and/or focusing on the development of SUSTAINCELL technologies.
- Pursue research activities and validate performance of new materials and components at cell level.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?
Project's own objectives	CAPEX	€/kW	@ 100 MW [AEL 400 €/kW, AEMEL 300 €/kW, PEMEL 500 €/kW, SOEL 520 €/kW], @ 500 kWe, PEMFC 900 €/kW]	
	PEMFC electrical efficiency, non-recoverable CRM loading, degradation rate	%	~56% (% LHV H_2), 0.01 mg/Wel, 0.2%/1 000 h	