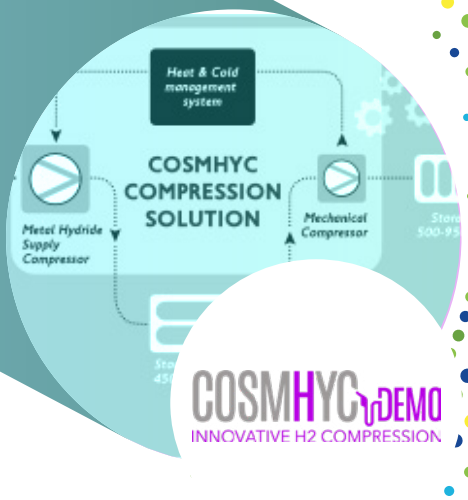
COSMHYC DEMO

COMBINED SOLUTION OF METAL HYDRIDE AND MECHANICAL COMPRESSORS: DEMONSTRATION IN THE HYSOPARC GREEN H2 MOBILITY PROJECT



Project ID	101007173
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-01-8-2020: Scale-up and demonstration of innovative hydrogen compressor technology for full-scale hydrogen refuelling station
Project total costs	EUR 3 773 858.75
Clean H_2 max. contribution	EUR 2 999 637.13
Project period	1/1/20 – 31/12/2023
Coordinator	Europäisches Institut für Energieforschung EDF – KIT EWIV, Germany
Beneficiaries	Communauté de Communes Touraine Vallée de L'Indre, Eifhytec, Mahytec SARL, Nel Hydrogen AS, Steinbeis Innovation gGmbH

https://cosmhyc.eu

PROJECT AND OBJECTIVES

To meet the demands of a growing hydrogen economy, new technologies in the hydrogen-refuelling infrastructure – including that of hydrogen compression – are necessary. In COSMHYC DEMO, the innovative COSMHYC compression solution, which combines a metal hydride and mechanical compressor, has been shown to be ready for commercial deployment. At the test site in France, a public hydrogen-refuelling station (HRS) will be installed for a variety of vehicles (e.g. vehicle fleets and garbage trucks). The hybrid compressor will be used to supply hydrogen at both 350 bars and 700 bars.

NON-QUANTITATIVE OBJECTIVES

- The project aims to increase public acceptance of hydrogen mobility. Integrating the new compressor in a community in which there have been previous hydrogen mobility activities and demonstration projects will be likely to increase overall acceptance.
- It also aims to include a smart gas hub for switching between storage, the HRS and the filling centre. A new gas panel has been designed and will allow for smart switching between the filling centre for trailers, on-site hydrogen supply storage and HRS.

PROGRESS AND MAIN ACHIEVEMENTS

- The site layout plan for the HRS and the integration concept of compressors were finalised.
- The selection and testing of ideal rare earth-free metal hydrides for all compression stages have been successfully completed.
- A risk assessment for on-site installation was completed.

FUTURE STEPS AND PLANS

- The HRS will be installed on site. The site plan is ready, but the work has been delayed owing to supply chain issues (receiving steel from Ukraine).
- The project will obtain authorisation to integrate the metal hydride compressor into the HRS. The environmental impact study is ongoing, and the project has held good exchanges with local authorities through the advisory committee.
- Long-term tests of the demonstrator will be conducted with the on-site vehicle fleet.

PDF ISBN 978-92-9246-397-7 doi:10.2843/12811 EG-09-22-414-EN-N

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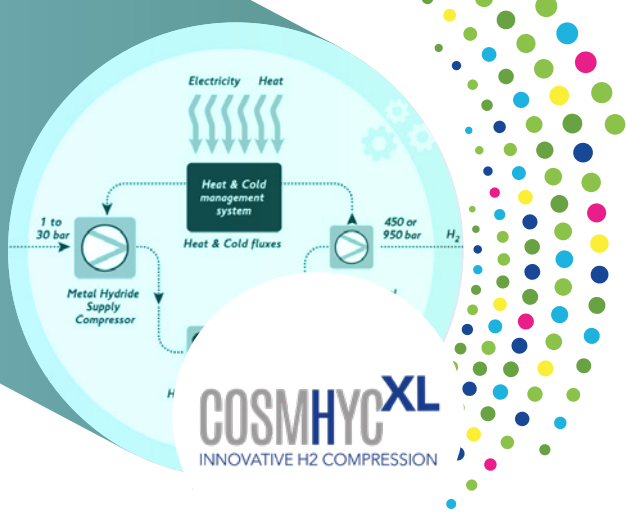
COSMHYC XL

COMBINED HYBRID SOLUTION OF METAL HYDRIDE AND MECHANICAL COMPRESSORS FOR EXTRA LARGE SCALE HYDROGEN REFUELLING STATIONS



Project ID	826182
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-01-7-2018: Improvement of innovative compression concepts for large scale transport applications
Project total costs	EUR 2 749 613.75
Clean H_2 max. contribution	EUR 2 749 613.75
Project period	1/1/2019 – 31/12/2021
Coordinator	Eifer -Europäisches Institut für Energieforschung EDF – KIT EWIV, Germany
Beneficiaries	Steinbeis 2i GmbH, Mahytec SARL, Nel Hydrogen AS, Ludwig-Bölkow-Systemtechnik GmbH

https://cosmhyc.eu

PROJECT AND OBJECTIVES

Hydrogen mobility is one of the most promising solutions for a sustainable energy transition in large-scale transport modes, including trucks, buses, trains and professional vehicle fleets. For these applications, a performant hydrogen-refuelling infrastructure is necessary, including hydrogen compressors able to meet challenging constraints in terms of flow rate and availability. COSMHYC XL aims to develop an innovative compression solution for extra-large hydrogen-refuelling stations, based on the combination of a metal hydride compressor and a mechanical compressor.

NON-QUANTITATIVE OBJECTIVES

- The project aims to create a hybrid system allowing different configurations. Ludwig-Bölkow-Systemtechnik shows that different refuelling applications require only slightly adapted configurations and intermediate storage capacities to minimise total costs.
- The project aims to increase reliability. The results of COSMHYC and the preliminary results of COSMHYC XL show that reliability can be strongly improved compared with that of SoA mechanical compressors.
- The project aims to undertake a cost of ownership assessment. There are ongoing dedicated activities within the project. The results of the previous COSMHYC project show that the target total cost of ownership can be achieved.

PROGRESS AND MAIN ACHIEVEMENTS

- A prototype of a dual-head mechanical compressor has been assembled and is operational; the compressor reaches 120 kg/h (two-stage) and 240 kg/h in duplex configuration.
- The metal hydride compressor set, including its major subsystems (e.g., thermal integration), and the control and monitoring system have been designed.
- The test site is ready for the commissioning of the metal hydride compressor prototype in a 20-foot container; all risk assessments were successfully performed and pre-certification is complete.

FUTURE STEPS AND PLANS

- The project will produce metal hydrides for all compression stages. This production is at an advanced stage.
- COSMHYC XL will integrate the innovative metal hydride compressor prototype. The container and the control and monitoring system are ready and the main subsystem is assembled; the metal hydride reactors will be completed shortly before integration in the prototype.
- The project will conduct long-term tests of the prototypes. The tests of the mechanical compressor are complete; the metal hydride compressor tests begin in early summer 2022. The testing protocol will validate the combination of the compression technologies.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Target achieved?	SoA result achieved to date (by others)	Year of SoA target
Project's own objective	Energy consumption	kWh/kg	6.18		8	2018
	Degradation	%/1 000 h	0.8		N/A	N/A
	Specific costs	k€/kg*day	1.47		3.7	2021
	Noise levels	dB	< 60		53.9	2021

PDF ISBN 978-92-9246-397-7 doi:10.2843/12811 EG-09-22-414-EN-N

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HIGGS

HYDROGEN IN GAS GRIDS: A SYSTEMATIC VALIDATION APPROACH AT VARIOUS ADMIXTURE LEVELS INTO HIGH-PRESSURE GRIDS

Project ID	875091
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02-5-2019: Systematic validation of the ability to inject hydrogen at various admixture levels into high-pressure gas networks in operational conditions
Project total costs	EUR 2 107 672.50
Clean H_2 max. contribution	EUR 2 107 672.50
Project period	1/1/2020 – 31/12/2022
Coordinator	Fundación para el Desarrollo de las Nuevas Tecnologías del Hidrógeno en Aragón, Spain
Beneficiaries	Ostschweizer Fachhochschule, Redexis Gas SA, European Research Institute for Gas and Energy Innovation, Hochschule für Technik Rapperswil, Deutscher Verein des Gas- und Wasserfaches EV – Technisch-wissenschaftlicher Verein, Fundación Tecnalia Research & Innovation

http://www.higgsproject.eu/

PROJECT AND OBJECTIVES

HIGGS aims to fill in the gaps in knowledge of the impact that high levels of H_2 could have on high-pressure natural gas infrastructure, its components and its management. To reach this goal, the project is developing a mapping of technical, legal and regulatory barriers and enablers; testing materials/components; completing techno-economic modelling; and preparing a set of conclusions as a pathway towards enabling the injection of hydrogen into high-pressure gas grids. The inventory of materials/equipment and the regulations, codes and standards (RCS) are mostly completed, tests are ongoing and the techno-economic model is under development.

NON-QUANTITATIVE OBJECTIVES

- The project aims to draw up RCS recommendations. The first screening has been completed, and the work is ongoing.
- A pathway for stepwise integration of hydrogen into the EU gas network is being drafted.
- The project aims to develop a techno-economic model and study of the roles of technologies for integrating H_2/CH_4 and sector coupling at EU level. This work has started with the Trans Europa Naturgas Pipeline and the Mittel-Europäische-Gasleitung Pipeline

PROGRESS AND MAIN ACHIEVEMENTS

- The testing platform has enabled dynamic and static tests to be carried out.
- The project has adapted the techno-economic model.
- A system has been created for separating low concentrations of hydrogen in natural gas.

FUTURE STEPS AND PLANS

- The project will complete all experimental campaigns in the testing platform and characterisation of materials before and after hydrogen exposure to evaluate the effect of the injection of this gas. The first experimental campaign has been completed.
- An experimental campaign with the gas separation prototype is ongoing.
- The RSC review at European and national levels was collected, reviewed and compiled in a comprehensive report comprising diagrams and graphs that are to be presented on the project website and used for presentations and papers. The first review was shared publicly.
- The project will finalise a baseline definition and studies of cases regarding hydrogen blending of natural gas. This will involve simulation of these cases and analysis of techno-economic aspects.
- Work has started with the Trans Europa Naturgas Pipeline and Mittel-Europäische-Gasleitung Pipeline. The project will develop and describe a pathway towards integrating hydrogen into the EU gas networks, including proposals at national level (EU-26+). This is ongoing work that will finish with the publication of four publicly available reports.
- The main and final report will be the pathway description, due to be delivered by the end of 2022. The results are intended to be used beyond the project period.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Blending percentage compatible with existing gas transmission networks	%	Technical compatibility of materials and equipment in transmission networks	Trials with 20 % hydrogen content	
	Readiness of gas transmission networks for H_2 distribution	%	Identify existing assets and their readiness for hydrogen transport	First inventory of the European grid	
	Techno-economic approach for grid repurposing	%	Model started	Model parameters defined in first internal deliverable	

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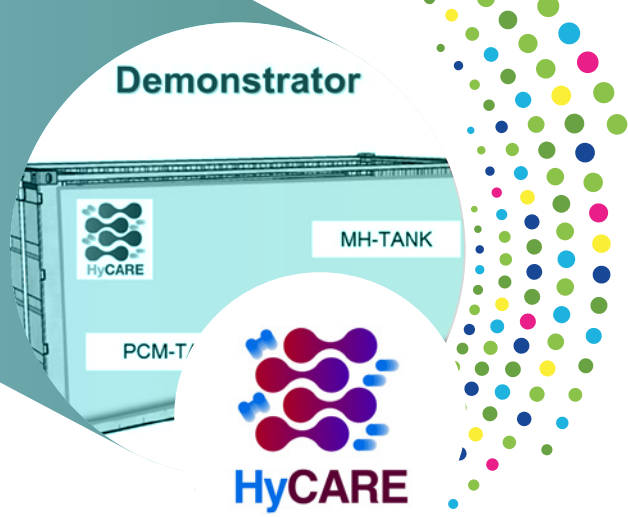

HYCARE

AN INNOVATIVE APPROACH FOR RENEWABLE ENERGY STORAGE BY A COMBINATION OF HYDROGEN CARRIERS AND HEAT STORAGE

Project ID	826352
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02-5-2018: Hydrogen carriers for stationary storage of excess renewable energy
Project total costs	EUR 1 999 230
Clean H_2 max. contribution	EUR 1 999 230
Project period	1/1/2019 – 31/12/2021
Coordinator	Università degli Studi di Torino, Italy
Beneficiaries	Stühff GmbH, Tecnodelta SRL, GKN Sinter Metals Engineering GmbH, Parco Scientifico Tecnologico per l'Ambiente – Environment Park Torino SpA, Institutt for Energiteknikk, Helmholtz-Zentrum Hereon GmbH, Fondazione Bruno Kessler, ENGIE, Centre national de la recherche scientifique

https://hycare-project.eu/

PROJECT AND OBJECTIVES

The main objective of the HyCARE project is the development of a prototype hydrogen storage tank using a solid-state hydrogen carrier on a large scale. The tank will be based on an innovative concept, joining hydrogen and heat storage, to improve the energy efficiency of the whole system. The developed tank will be joined with a PEM electrolyser as the hydrogen provider, and a PEM fuel cell as the hydrogen user at the ENGIE CRIGEN laboratory, located in Île-de-France. The system is under construction and will be tested by the end of 2022.

NON-QUANTITATIVE OBJECTIVES

- **Safety.** The project aims to achieve low temperatures and pressures for storing hydrogen using carriers.
- **Energy efficiency.** The project aims to improve the energy efficiency of hydrogen storage using heat storage via phase change materials (PCMs).

PROGRESS AND MAIN ACHIEVEMENTS

- The composition of the metal hydride has been defined and characterised. The PCM has been selected. Materials are available for the demonstrator.
- The metal hydride and PCM tank design have been finalised. A draft of the piping and instrumentation diagram of the demonstrator is available. A prototype system has been built and tested. The system is under construction.
- The site for the demonstrator has been prepared. The electrolyser and fuel cell have been commissioned and are being set up. The techno-economic and life cycle assessments have been organised. Dissemination and exploitation are active.

FUTURE STEPS AND PLANS

- The project will set up and test the final demonstrator. These activities are under way. The results are expected in December 2022.
- The obtained results will be analysed using techno-economic and life cycle assessments, and possible use of these results will be explored.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Volumetric capacity of H_2 carrier	kg of H_2 per unit of volume of carrier	N/A	Reversible capacity at 55 °C between 1 and 25 bars is less than 70	⚙
	Gravimetric capacity of H_2 carrier	% of H_2 weight in the carrier		Reversible capacity at 55 °C between 2 and 20 bars is 1.1	⚙
	Hydrogen storage capacity	Maximum amount of H_2 in kg that can be stored in the system		Estimated reversible capacity at 55 °C between 1 and 25 bars is 44	⚙
	Max. tank pressure	Pressure rating of the H_2 carrier tank in bars	< 50	40	✓
	Cyclability	Number of full cycles until reaching 2 % reduction in the gravimetric capacity of the H_2 carrier	250	250	✓

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HYGRID

FLEXIBLE HYBRID SEPARATION SYSTEM FOR H2 RECOVERY FROM NG GRIDS

Project ID	700355
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02.5-2015: Development of technology to separate hydrogen from low-concentration hydrogen streams
Project total costs	EUR 3 167 710
Clean H_2 max. contribution	EUR 2 527 710
Project period	1/5/2016 – 30/8/2021
Coordinator	Technische Universiteit Eindhoven, the Netherlands
Beneficiaries	Nortegas Energia Distribucion SA, HyGear Technology and Services BV, HyET Hydrogen BV, Quantis, HyGear Fuel Cell Systems BV, HyGear BV, Saes Getters SpA, Fundación Tecnalia Research & Innovation

http://www.hygrid-h2.eu/

PROJECT AND OBJECTIVES

The key objective of the HyGrid project was the design, scale-up and demonstration in industrially relevant conditions of a novel membrane-based hybrid technology for the direct separation of hydrogen from natural gas grids. The focus of the project was hydrogen separation through a combination of membranes, electrochemical separation and temperature swing adsorption to decrease the total cost of hydrogen recovery. The project targets a pure hydrogen separation system with a power of < 5 kWh/kg of H_2 and a cost of < 1.5 €/kgH_2. A pilot was designed for > 25 kg/day of hydrogen.

NON-QUANTITATIVE OBJECTIVES

The project aims to train PhD students. One student has already completed their PhD and found a job in a research centre to work on topics related to HyGrid.

PROGRESS AND MAIN ACHIEVEMENTS

- All prototype parts have been completed, installed/debugged and tested at TRL5.
- Two patent applications for membranes and systems for hydrogen separation have been granted.
- Several scientific papers on all components of the prototype have been published.

FUTURE STEPS AND PLANS

The project finished in 2021.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
AWP 2015	Pure hydrogen separation system with low power	kWh/kg H_2	5	5	✓
	Pure hydrogen separation system with low cost	€/kg of H_2	1.5	1.5	
	Prototype unit	TRL	5	5	
	Pure hydrogen production	kg/day	25	12	⚙

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HYPSTER

HYDROGEN PILOT STORAGE FOR LARGE ECOSYSTEM REPLICATION

Project ID	101006751
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02-7-2020: Cyclic testing of renewable hydrogen storage in a small salt cavern
Project total costs	EUR 15 514 301.73
Clean H_2 max. contribution	EUR 4 999 999
Project period	1/1/2021 – 31/12/2023
Coordinator	Storengy SAS, France
Beneficiaries	ESK GmbH, Element Energy, Storengy SA, Inovyn ChlorVinyls Limited, Axelera – Association Chimie-Environnement Lyon et Rhone-Alpes, Element Energy Limited, École Polytechnique, Institut National de l'Environnement Industriel et des Risques, Association pour la Recherche et le Développement des Methodes et Processus Industriels

https://hypster-project.eu/

PROJECT AND OBJECTIVES

HyPSTER aims to demonstrate the industrial-scale operation of cyclic hydrogen storage in salt caverns to support the emergence of the hydrogen energy economy in Europe in line with Hydrogen Europe's overall roadmapping. The cavern is located in Etrez in Auvergne-Rhône-Alpes in France. For the production of green hydrogen, the Etrez storage site will rely on local renewable energy sources and a 1 MW PEM electrolyser. In the long run, this facility will produce 400 kg of hydrogen per day (the equivalent of the consumption of 16 hydrogen buses).

PROGRESS AND MAIN ACHIEVEMENTS

- The subsurface materials for hydrogen salt cavern storage have been selected.
- Numerical simulation models for hydrogen storage in the salt cavern have been adapted.
- A risk analysis of underground hydrogen storage in the salt cavern has been performed.

FUTURE STEPS AND PLANS

- The project will construct the hydrogen production platform. Building of the H_2 production platform is due to commence in April 2022.
- The project will modify the EZ53 salt cavern. Workover of the EZ53 cavern is planned for November 2022.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Target achieved?
Project's own objectives	Electrolyser's power	MW	1	
	H_2 mass	kg	2 000	
	CAPEX	€/kg	450	
	OPEX	€/kg	1	

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HYSTOC

HYDROGEN SUPPLY AND TRANSPORTATION USING LIQUID ORGANIC HYDROGEN CARRIERS

Project ID	779694
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02-6-2017: Liquid organic hydrogen carrier
Project total costs	EUR 2 499 921.25
Clean H_2 max. contribution	EUR 2 499 921.25
Project period	1/1/2018 – 31/3/2022
Coordinator	Hydrogenious LOHC Technologies GmbH, Germany
Beneficiaries	HyGear Operations BV, Teknologian tutkimuskeskus VTT Oy, HyGear Technology and Services BV, Oy Woikoski AB, HyGear Fuel Cell Systems BV, HyGear BV, Friedrich-Alexander-Universität Erlangen-Nürnberg

https://hystoc.eu/

PROJECT AND OBJECTIVES

The HySTOC project will demonstrate the liquid organic hydrogen carrier (LOHC)-based distribution of high-purity hydrogen (ISO 14687-2:2021) to a customer (Teknologian tutkimuskeskus VTT) in Finland. The H_2 is produced in and provided from Kokkola, Finland, by the project partner Woikoski. The StorageBox was placed in Kokkola by the project partner Hydrogenious. Hydrogen is bound into an LOHC. The StorageBox is operated by Woikoski with remote support from HyGear. The hydrated material is transported to the project partner VTT in Espoo, Finland. The ReleaseBox was placed in Espoo by HyGear. In the dehydrogenation process of the ReleaseBox, hydrogen is released from the LOHC.

NON-QUANTITATIVE OBJECTIVES

- HySTOC aims to build further experience of the development, assembly, commissioning, operation, costs, etc. of the LOHC hydrogenation unit. It aims to provide input for upscaling and remote access.
- It aims to build further experience of the development, assembly, commissioning, operation, costs, etc. of the LOHC dehydrogenation unit. It aims to provide input for upscaling and remote access.
- It aims to build further experience of LOHC transport technologies.
- The project aims to improve the gas quality and reduce hydrogen loss.

PROGRESS AND MAIN ACHIEVEMENTS

- The StorageBox has been developed, built, assembled and commissioned. Currently, it is located in Kokkola and operated by project partners Woikoski and Hydrogenious.
- The ReleaseBox has been developed, built and assembled, and is almost ready to be commissioned. Currently, it is located in Espoo and final commissioning will be undertaken by VTT, HyGear and Hydrogenious.
- The pressure swing adsorption was developed.

FUTURE STEPS AND PLANS

The project finished in March 2022.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	**Reduction of hydrogen storage costs**				
	Absolute material costs of the StorageBox	€/(kg/d)	336 000	350 000	⚙
	Reduction of hydrogen release costs				
	Absolute material costs of the ReleaseBox	€/(kg/d)	400 000	380 000	✓
	Accessible to mobile applications				
	Hydrogen quality	–	ISO 14687-2:2012	ISO 14687-2:2012	✓
	Accessible to mobile applications				
	Operation time of the StorageBox	hours	2 160	2 167	✓
	Operation time of the ReleaseBox	hours	2 160	2 167	✓

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HYSTORIES

HYDROGEN STORAGE IN EUROPEAN SUBSURFACE

Project ID	101007176
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02-5-2020 – Underground storage of renewable hydrogen in depleted gas fields and other geological stores
Project total costs	EUR 2 499 911.75
Clean H_2 max. contribution	EUR 2 499 911.75
Project period	1/1/2021 – 31/12/2022
Coordinator	Geostock SAS, France
Beneficiaries	MicroPro GmbH, Norwegian Research Centre AS, UK Research and Innovation, Ludwig-Bölkow-Systemtechnik GmbH, Réseau d'excellence européen sur le stockage géologique de CO2, Geoinženiring družba za geološki inženiring DOO, Fundación para el Desarrollo de las Nuevas Tecnologías del Hidrógeno en Aragón, Sveuciliste u Zagrebu Rudarsko-geološko-naftni fakultet, Geologische Bundesanstalt, Universidade de Évora, Institut royal des sciences naturelles de Belgique, Instytut Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk, Ethniko Kentro Erevnas Kai Technologikis Anaptyxis, Geological Survey of Denmark and Greenland, Institutul Național de Cercetare-Dezvoltare Pentru Geologie si Geoecologie Marina-Geoecomar, Główny Instytut Górnictwa, Česká Geologická Služba, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Middle East Technical University, Tallinna Tehnikaülikool, Montanuniversität Leoben, Agencia Estatal Consejo Superior de Investigaciones Científicas, Helmholtz-Zentrum Potsdam – Deutsches GeoForschungsZentrum, Bureau de Recherches Géologiques et Minières

http://www.hystories.eu/

PROJECT AND OBJECTIVES

Although storing pure hydrogen in salt caverns has been practised in Europe since the 1970s, no pure hydrogen storage in depleted fields or aquifers has been undertaken. Hystories will deliver technical developments applicable to a vast range of future aquifer or depleted field sites, conduct techno-economic feasibility studies and provide insights into underground hydrogen storage for decision-makers in government and industry. The project stared on 1 January 2021 and is now 60 % complete.

PROGRESS AND MAIN ACHIEVEMENTS

- The project has made technological developments for pure hydrogen storage in depleted fields and aquifers.
- It has gained techno-economic insights on the development of underground storage of hydrogen.

FUTURE STEPS AND PLANS

- Hystories will catch up on the delayed implementation of the work; the focus is on completing this ambitious project on time.
- The main technical development analyses are complete: the key preliminary results have been obtained and the hydrogen storage needed by the European energy system has been identified. The remaining tasks related to the techno-economic assessments are ready to be carried out.
- The technical developments and techno-economic analyses are complete; the focus is on elaboration of the final implementation plan.

PRD 2022 PANEL
H2 Storage and Distribution

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HYUSPRE

HYDROGEN UNDERGROUND STORAGE IN POROUS RESERVOIRS

Project ID	101006632
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02-5-2020: Underground storage of renewable hydrogen in depleted gas fields and other geological stores
Project total costs	EUR 3 714 850
Clean H_2 max. contribution	EUR 2 499 850
Project period	1/10/2021 – 31/12/2023
Coordinator	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, the Netherlands
Beneficiaries	Centrica Storage Limited, Magyar Földgáztároló Zártkörűen Működő Részvénytársaság, NAFTA AS, Neptune Energy Hydrogen BV, Snam SpA, RAG Austria AG, Energie Beheer Nederland BV, Energieinstitut an der Johannes Kepler Universität Linz Verein, Equinor Energy AS, Shell Global Solutions International BV, Fondazione Bruno Kessler, Technische Universität Clausthal, University of Edinburgh, Forschungszentrum Jülich GmbH, Wageningen University

http://www.hyuspre.eu/

PROJECT AND OBJECTIVES

HyUSPRe studies the potential of large-scale hydrogen storage in porous reservoirs in Europe. This includes the identification of suitable geological storage reservoirs and a techno-economic feasibility assessment for hydrogen storage in these reservoirs. HyUSPRe addresses specific technical challenges regarding storage, and conducts an economic analysis to facilitate the decision-making process for the development of a portfolio of potential field pilots. The techno-economic assessment will allow for the development of a roadmap for widespread hydrogen storage towards 2050.

NON-QUANTITATIVE OBJECTIVES

- HyUSPRe aims to conduct a study assessing the potential match of hydrogen supply and demand sites, including the necessity of hydrogen to buffer time-varying renewable energy demands.
- The project aims to conduct a study on the potential of European hydrogen underground storage to facilitate a zero-emission energy system in 2050.

PROGRESS AND MAIN ACHIEVEMENTS

The project started on 1 October 2021.

FUTURE STEPS AND PLANS

It is expected that HyUSPRe will be executed in line with the plan for the project. The technical work has started. For the laboratory experiments, agreements have been made with industrial partners, and rock and fluid samples and data have been collected from them.

PDF ISBN 978-92-9246-397-7 doi:10.2843/12811 EG-09-22-414-EN-N

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SHERLOHCK

SUSTAINABLE AND COST-EFFICIENT CATALYST FOR HYDROGEN AND ENERGY STORAGE APPLICATIONS BASED ON LIQUID ORGANIC HYDROGEN CARRIERS: ECONOMIC VIABILITY FOR MARKET UPTAKE

Project ID	101007223
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-02-1-2020: Catalyst development for improved economic viability of LOHC technology
Project total costs	EUR 2 563 322.50
Clean H_2 max. contribution	EUR 2 563 322.50
Project period	1/1/2021 – 31/12/2023
Coordinator	Commissariat à l'énergie atomique et aux énergies alternatives, France
Beneficiaries	Kuwait Petroleum Research and Technology BV, Hydrogenious LOHC Technologies GmbH, Noordwes-Universiteit, Universidad Del País Vasco / Euskal Herriko Unibertsitatea, Evonik Operations GmbH, Friedrich-Alexander-Universität Erlangen-Nürnberg

https://sherlohck.eu/

PROJECT AND OBJECTIVES

Liquid organic hydrogen carriers (LOHCs) are attractive due to their ability to safely store large amounts of hydrogen (up to 7 % wt or 2 300 KWh/t) for a long time and to release pure hydrogen on demand. The project targets the development of (i) highly active and selective catalysts with partial/total substitution of platinum group metals (PGM), (ii) a novel catalytic system architecture, ranging from the catalyst to the heat exchanger, to minimise the internal heat loss and to increase the space–time yield; and (iii) novel catalyst testing, system validation and demonstration in the demonstration unit (> 10 kW, > 200 hours).

PROGRESS AND MAIN ACHIEVEMENTS

The project has standardised the test protocol.

FUTURE STEPS AND PLANS

- SherLOHCk will integrate the catalyst into the thermal conductive support. The design of the first conductive support is ongoing.
- Long-term testing in continuous operation (> 200 hours) has not started yet.
- Testing of the resistance of catalysts to different poisons has not started yet.
- The modelling of the reaction kinetics for the design of new reactors has started for the dehydrogenation reaction.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?	SoA result achieved to date (by others)	Year of SoA target
Project's own objectives	Catalyst productivity in dehydrogenation	g of H_2/g of catalyst/min	3	1.2		0.85	2022
	Degree of conversion	%	90	85		~ 100	
	Catalyst selectivity	%	99.8	98		~ 100	

PRD 2022 PANEL
H2 Storage and Distribution

PDF ISBN 978-92-9246-397-7 doi:10.2843/12811 EG-09-22-414-EN-N

Clean Hydrogen Partnership

Co-funded by the European Union

WINNER

WORLD-CLASS INNOVATIVE NOVEL NANOSCALE OPTIMISED ELECTRODES AND ELECTROLYTES FOR ELECTROCHEMICAL REACTION

Project ID	101007165
PRD 2022 Panel	2 – H2 storage and distribution
Call topic	FCH-03-1-2020: HT proton conducting ceramic materials for highly efficient and flexible operation
Project total costs	EUR 2 931 788.75
Clean H_2 max. contribution	EUR 2 931 788.75
Project period	1/1/2021 – 31/12/2023
Coordinator	Sintef AS, Norway
Beneficiaries	CoorsTek Membrane Sciences AS, Shell Global Solutions International BV, Aktiebolaget Sandvik Materials Technology, ENGIE, Universitetet i Oslo, Danmarks Tekniske Universitet, Agencia Estatal Consejo Superior de Investigaciones Científicas

http://www.sintef.no/projectweb/winner/

PROJECT AND OBJECTIVES

WINNER aims to develop an efficient and durable technology platform based on electrochemical proton-conducting ceramic (PCC) cells designed to unlock a path towards commercially viable production, extraction, purification and compression of hydrogen on a small to medium scale. WINNER uses three applications to achieve this: ammonia cracking, dehydrogenation of hydrocarbons and reversible steam electrolysis.

NON-QUANTITATIVE OBJECTIVES

WINNER aims to develop a multiscale multiphysics platform. The project is focusing on establishing a novel modelling platform combining atomistic modelling, electrochemistry, mechanical modelling, reactor modelling supported by artificial intelligence and enhanced experimental methodologies. The framework has been established and individual models are being developed. Preliminary versions of the resulting engineering models are available.

PROGRESS AND MAIN ACHIEVEMENTS

- WINNER has developed cells with state-of-the-art (SoA) materials for reversible steam electrolysis and for ammonia fuel cell to power or hydrogen.
- Process conditions have been identified and performance factors defined for each application.
- The engineering model has been developed for all three applications.

FUTURE STEPS AND PLANS

- Cells for the three applications will be further optimised. This will involve cells testing and material and architecture optimisation.
- WINNER will establish the life cycle assessment methodology, setting boundary conditions and defining relevant libraries.
- The project will establish concrete links between the various modelling scales, defining input and output parameters between each scale.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?	SoA result achieved to date (by others)	Year of SoA target
Project's own objectives and MAWP Addendum (2018–2020)	Levelised cost of the produced hydrogen	€/kg	5	N/A		> 6 based on GAMER technology with several scaling-up assumptions	2022
Project's own objectives	ASR of the cell	ohm.cm² at 650 °C	< 1	1.4	⚙	2.5	2022
	Round-trip efficiency of reversible steam electrolysis	% @ 650 °C	> 75	N/A		N/A	2019
	Faradaic efficiency	%	> 95	> 95	✓	> 90	2021

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