



Press Release
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Hydrogen storage in salt caverns

HYPSTER project partners and experts unveil the results of four years of research and innovation

On 6 December, close to 200 people attended the 2nd workshop of the HypSTER (Hydrogen Pilot Storage for large Ecosystem Replication) project, which presented the results of the various research projects carried out since 2021. At the workshop, a number of lessons and results were made public concerning the storage of hydrogen in a salt cavern.

Definition of inputs and output specs & identification of the different cyclic tests to conduct (Inovyn – Storengy – ERM)

The work package investigated different sources of renewable energy (wind, solar PV and hydroelectric) available in the Auvergne Rhône-Alpes region (France), and tested assumptions around the sizing of the electrolyzers used to generate hydrogen. Hydrogen use cases were also examined (fuel cell vehicles, heating and industry). The data has been used to develop credible daily and seasonal storage demand profiles for the pilot hydrogen storage salt cavern (EZ53) at Storengy's Etrez storage site (France), as well as to assist in the design of cycling tests.

Meeting the European storage demand with industrial scale cavern design (ESK)

The aim of this work was to validate and adapt existing models and methodologies for salt caverns from the natural gas sector for hydrogen storage. The work carried out enabled the predictive modeling of the thermodynamic and geomechanical behaviour of the EZ53 salt cavern during the planned hydrogen tests. In addition, the results were used to evaluate configurations representing salt caverns across Europe regarding their behavior for industrial-scale hydrogen storage. Based on these results and an assessment of future hydrogen infrastructures and existing options for brine usage or disposal, the European potential for hydrogen storage in salt caverns was examined. The result is a substantial storage potential in Central and Western European countries such as Germany, France, the United Kingdom, the Netherlands and Denmark, compared with the storage demand expected over the next decades.

Demonstration of H2 storage and cycling in salt cavern (Storengy)

The objective is to demonstrate the feasibility of storing and cycling hydrogen in a salt cavern. A demonstrator was built on the EZ53 salt cavern, which is relatively small and therefore the right size for this experiment. A full well work-over took place in March 2023 to replace the existing leaching tubing with a new specifically designed completion. After a first successful well tightness test ran with nitrogen, a three-step well tightness test was carried-out with hydrogen. This test successfully demonstrated the tightness of the completion elements, the casing shoe and the cavern chimney to hydrogen. The next stage of the demonstrator, which will start very shortly, will be to carry out 100 pressure cycles of roughly 3 tons of hydrogen in the cavern over a three-month period and assess the impact of the cycling on the cavern stability.



Techno-economic assessment and roadmap towards replication in the EU (ERM)

ERM, with the support of the HyPSTER partners, conducted an assessment of the costs of developing and operating a hydrogen salt cavern. The technical and economic analysis showed that salt caverns could offer a low-cost storage solution for large-scale low-carbon hydrogen. In addition, ERM is also supporting Storengy and the HyPSTER partners by helping to coordinate the project and the consortium and by providing strategic support.

Controlling the risks around an underground hydrogen storage site (Ineris)

Several rigorous analyses were carried out to ensure the environmental and operational safety of hydrogen storage in EZ53 salt caverns, setting the stage for future scalability across Europe. The project conducts comprehensive risk and environmental impact assessments to identify potential hazards and safety barriers for the pilot experiment. Advanced numerical modeling refines risk quantifications for worst-case scenarios like mechanical cavern instability and well blowouts. Collaboration with French authorities (DREAL) resulted in the approval of a comprehensive safety plan, with all permits obtained by summer 2022. The project also focuses on learning from the pilot risk management, reviewing European regulations, and providing recommendations for standards across Europe.

Potential microbial hydrogen consumption during hydrogen storage (Equinor)

Analysis of samples from EZ53 salt cavern shows that the cavern contains living microbes that can consume hydrogen. However, the nutrients available to these microbes are limited and their growth is slow. There is a risk of low rates of microbial hydrogen consumption and sulfide generation. Microbial activity should thus be monitored and addition of compounds that can act as nutrient should be avoided as this can increase microbial activity.

Next steps

Perspective was discussed during the workshop through 2 round tables. The first round table highlighted the key elements for bringing producers and consumers together, while addressing the regulatory framework that needs to be established at European and national levels. The second one provided an overview of the various European hydrogen storage projects, highlighting the learnings, the technical challenges and the benefits for the ecosystems.

About the project

<https://hypster-project.eu/>



About the partners

Storengy

This subsidiary of ENGIE is one of the world leaders in underground natural gas storage. Drawing on 70 years of experience, Storengy designs, develops and operates storage facilities and offers its customers innovative products. The company owns 21 natural gas storage sites with a total capacity of 136 TWh in France, Germany and the United Kingdom. Storengy is also a key player in renewable gases (biomethane, hydrogen, synthetic gas). With respect to hydrogen, Storengy is a member of France Hydrogen (formerly AFHYPAC), as well as the association Hydrogen Europe. www.storengy.com

Armines-École Polytechnique

Armines is the largest private contractual research structure in France. Under the supervision of the Ministry of Industry, it is supported by 48 research centres, including the École polytechnique, for which it is a federating operator. The École polytechnique is France's number-one institution associating research, education and innovation at the highest scientific and technological level. With its 23 laboratories, the École Polytechnique's Research Centre works at the frontiers of knowledge on major interdisciplinary scientific, technological and societal issues. www.armines.net www.polytechnique.edu

INOVYN

Founded on 1st July 2015 as a part of INEOS, INOVYN is one of the three world leaders in vinyl manufacturing. With a turnover of more than 3.5 billion euros, INOVYN has more than 4,300 employees with manufacturing, sales and marketing activities in ten European countries. INOVYN's portfolio includes a wide range of advanced products such as organic chlorine derivatives, chlor-alkali, general purpose vinyl, specialty vinyl, sulfur chemicals, salt, and electrochemical and vinyl technologies. The annual production volume amounts to more than 40 million tonnes. www.inovyn.com

ESK

ESK GmbH is a renowned engineering company for energy storage and systems services and has successfully completed national and international projects for many years. Its team of highly qualified engineers and geoscientists has extensive experience and know-how in the fields of aquifer and salt cavern storage technologies. In total, ESK has 80 employees in Holzwickede and Freiberg, as well as in its Leipzig and Stassfurt offices, in Germany. www.esk-projects.com

ERM

ERM is the business of sustainability.

As the largest global pure play sustainability consultancy, ERM partners with the world's leading organizations, creating innovative solutions to sustainability challenges and unlocking commercial opportunities that meet the needs of today while preserving opportunities for future generations.

ERM's diverse team of 8,000+ world-class experts in over 150 offices in 40 countries and territories supports clients across the breadth of their organizations to operationalize sustainability. Through ERM's deep technical expertise, clients are well-positioned to address their environmental, health, safety, risk, and social issues. ERM calls this capability its "boots to boardroom" approach - a comprehensive service model that allows ERM to develop strategic and technical solutions that advance objectives on the ground or at the executive level.

<https://www.erm.com/>



Ineris

Ineris (Institut national de l'environnement industriel et des risques) is a public industrial and commercial establishment under the supervision of the Ministry of Ecological Transition. This institute conducts research activities on behalf of public authorities, industrial operators and public bodies in the fields of assessment, prevention and control of risks linked to industrial activities, particularly in underground environments. Over the years, Ineris has developed solid expertise in the field of environmental risk assessment related to underground storage activities. The institute has large-scale laboratories for tests involving hydrogen. Their expertise is based on experimental skills (especially in situ) in the fields of digital modelling and risk assessment methods in health, safety and the environment. <https://www.ineris.fr/fr>

AXELERA Auvergne-Rhône-Alpes

AXELERA is the reference cluster of the chemical and environmental sectors in the French region Auvergne-Rhône-Alpes. In France and internationally, it supports the development and innovation of actors involved in the controlled management of environmental materials and resources, for a sustainable development of territories. The cluster is committed to developing chemical solutions for the industry and territories, competitive and eco-efficient processes, technologies to preserve and restore natural resources, circular management of different materials, water, air, soil and energy. www.axelera.org.

Brouard Consulting

Brouard Consulting is an engineering firm specialising in underground storage founded in 1999 and operating worldwide. This company is providing expertise to the HyPSTER project by performing digital calculations to accurately simulate the thermodynamic behaviour of salt caverns and control the mechanical stability of the surrounding rock. <http://www.brouard-consulting.com>

Equinor

Equinor is an international energy company committed to long-term value creation in a low-carbon future. Our purpose is to turn natural resources into energy for people and progress for society. Equinor's portfolio of projects encompasses oil and gas, renewables and low-carbon solutions, with an ambition of becoming a net-zero energy company by 2050. Equinor is the leading operator on the Norwegian continental shelf. We are present in around 30 countries worldwide. www.equinor.com



EUROPEAN PARTNERSHIP



Co-funded by the European Union

Clean Hydrogen Partnership

Clean Hydrogen Partnership succeeds to the Fuel Cells and Hydrogen Joint Undertaking (FCH JU). Its aim is to strengthen and integrate the European Union's research and innovation capacities in order to accelerate the development and improvement of advanced clean hydrogen applications which are ready to be commercialised, especially in the energy, transport, building and final industrial usage sectors, while strengthening the competitiveness of the Union's decarbonised hydrogen value chain. This institution's three partners are the European Commission, the fuel cell and hydrogen industry (represented by Hydrogen Europe) and the community of researchers, which is represented by Hydrogen Europe Research.

<https://www.clean-hydrogen.europa.eu>



A company of ENGIE



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