

# HyUSPRe

## Hydrogen Underground Storage in Porous Reservoirs



### E-Newsletter #3



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## Welcome by the Coordinators

This is the third newsletter of HyUSPRe and we can state with pride that the consortium successfully finished the first project year. Early September the consortium gathered at the University in Edinburgh, for the first time face-to-face, to discuss first year achievements and to look forward to the research program of the second year. The project is largely in line with what we promised in the proposal, we produced a number of informative reports and consortium partners are visible on various conferences and workshops. And: we are happy to have 10 industrial partners onboard supporting us with their in-kind contributions, experience, and active participation in challenging discussions.

It feels good that HyUSPRe is able to contribute to the development and implementation of an underground energy storage technology that certainly will become very important in securing energy supply in Europe on the medium- to long-term. Looking at the recent turmoil on the global energy markets, and the persisting challenges with supplying the world's growing population with sufficient energy in a sustainable manner to mitigate climate change, the role of hydrogen as a clean energy carrier that can be safely stored in large quantities in the underground will become very important. HyUSPRe's research results will add a significant body of knowledge to the storage of hydrogen in underground porous reservoirs that will contribute to establishing its techno-economic feasibility and de-risking its implementation in Europe.

This e-newsletter introduces a couple of recently published research reports of the HyUSPRe consortium. Among them an atlas (in the form of an ArcGIS storymap) of hydrogen storage capacity in existing gas storages in porous reservoirs in Europe that we can warmly recommend. Don't miss the webinar that Andrew Cavanagh and Hamid Yousefi will give on 15 December (click on the image to register).

**Hydrogen storage potential  
of existing European gas  
storage sites in depleted gas  
fields and aquifers**

Andrew Cavanagh  
(Univ. of Edinburgh)

Hamid Yousefi  
(TNO)



Thursday 15 December,  
2022, 16.00-17.00 CET

Enjoy reading!

Holger Cremer, TNO, consortium manager  
Remco Groenenberg, TNO, lead scientist

## About HyUSPRe

### Hydrogen Underground Storage in Porous Reservoirs

The HyUSPRe project researches the feasibility and potential of implementing large-scale underground geological storage for renewable hydrogen in Europe. This includes the identification of suitable porous reservoirs for hydrogen storage, and technical and economic assessments of the feasibility of implementing large-scale storage in these reservoirs to support the European energy transition to net zero emissions by 2050. The project will address specific technical issues and risks regarding storage in porous reservoirs and conduct an economic analysis to facilitate the decision-making process regarding the development of a portfolio of potential field pilots. A techno-economic assessment, accompanied by environmental, social, and regulatory perspectives on implementation will allow for the

development of a roadmap for widespread hydrogen storage by 2050, indicating the role of large-scale hydrogen storage in achieving a zero-emissions energy system in the EU by 2050.

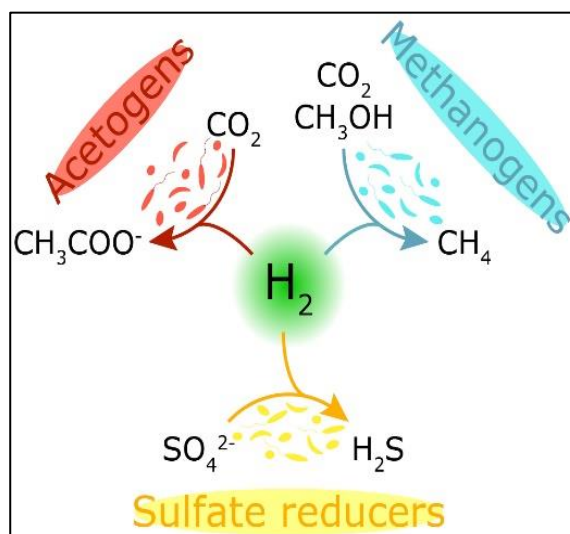
This project has two specific objectives. Objective 1 concerns the assessment of the technical feasibility, associated risks, and the potential of large-scale underground hydrogen storage in porous reservoirs for Europe. HyUSPRe will establish the important geochemical, microbiological, flow, and transport processes in porous reservoirs in the presence of hydrogen via a combination of laboratory-scale experiments and integrated modelling; and establish more accurate cost estimates to identify the potential business case for hydrogen storage in porous reservoirs. Suitable storage sites will be identified, and their hydrogen storage potential will be assessed. Objective 2 concerns the development of a roadmap for the deployment of geological hydrogen storage up to 2050. The proximity of storage sites to large renewable energy infrastructure and the amount of renewable energy that can be buffered versus time varying demands will be evaluated. This will form a basis for developing future scenario roadmaps and preparing for demonstrations.

## Research reports in the spotlight

### Viability of microbial metabolisms in subsurface hydrogen storages

The microbiology team of HyUSPRe recently provided a literature-based overview of microbial metabolisms, hydrogen consuming microbial communities, and their viability under hydrogen storage conditions. Furthermore, [the report](#), available on the HyUSPRe website, presents first results of a series of incubation experiments.

As there is a wide range of microbial organisms being capable to live on hydrogen i.e., to oxidize hydrogen, hydrogenotrophic microbial metabolisms could be a serious process affecting hydrogen subsurface storage. It is therefore important to study the living conditions and impacts of microbial communities in subsurface storages. The study compactly summarizes how gas composition, temperature, pressure, salinity and pH could impact the growth of microbial communities in subsurface storages.

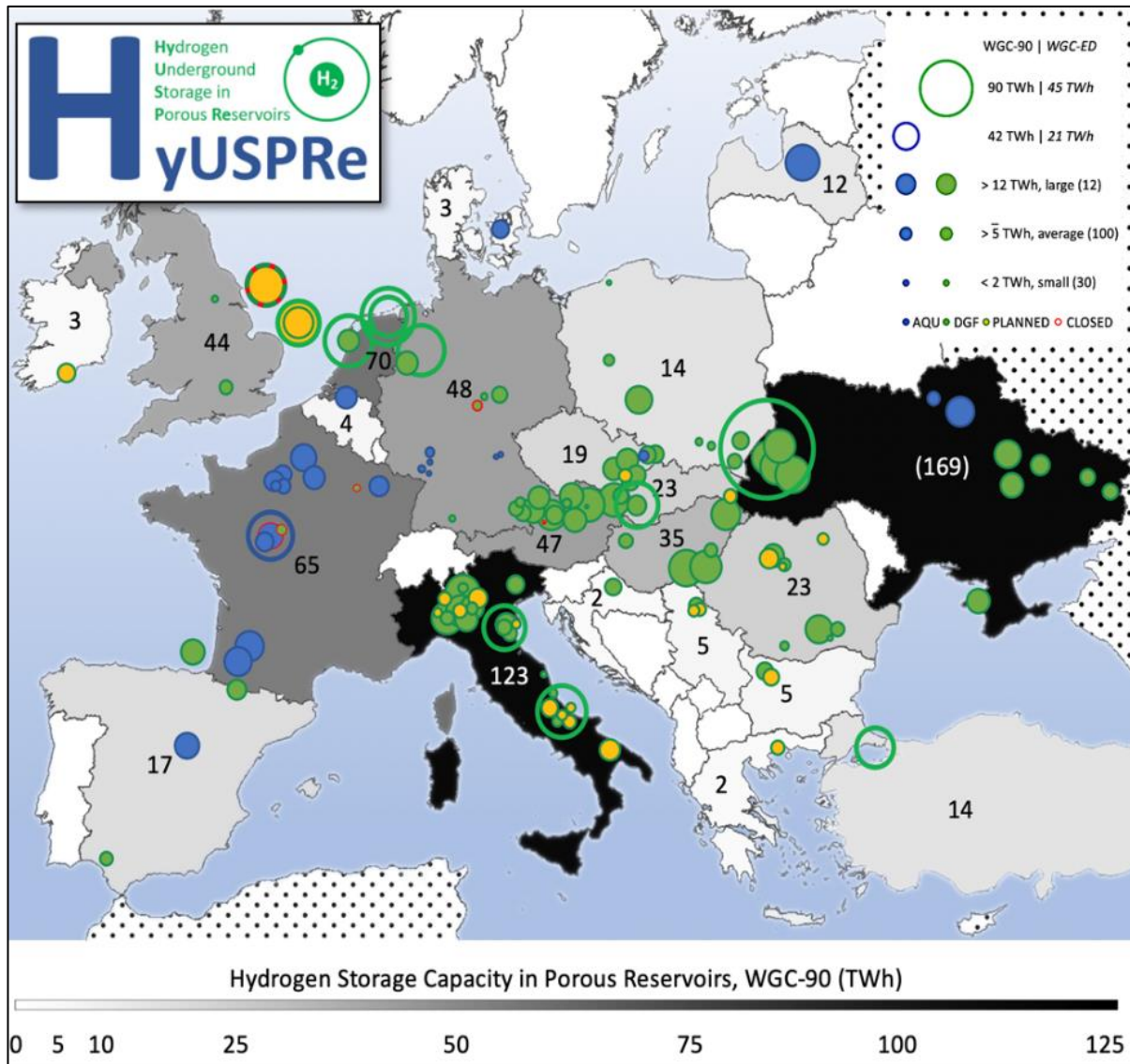


*Main hydrogenotrophic microbial metabolisms in subsurface hydrogen storages.*

### Visit the atlas of European UHS potential

In October, the HyUSPRe team published an [atlas](#) (in the form of an ArcGIS storymap) of hydrogen storage capacity in existing gas storages in porous reservoirs in Europe. The storymap illustrates in a compact and visually attractive way the location and potential of hydrogen storage in subsurface reservoirs. The story starts with a summarizing view on Europe and then looks separately closer to the four European regions Northwest, Central, Northern and Southern Europe. An additional [explaining report](#) is available on the HyUSPRe website.





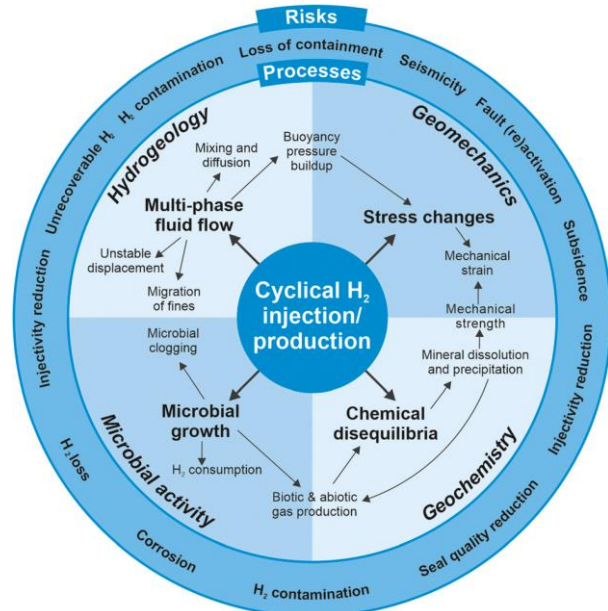
Subsurface (porous reservoirs) gas storage sites and capacities for Europe. More detailed information can be found in the [storymap](#) and [this report](#).

## Mineral reaction rates with hydrogen

The University of Edinburgh prepared a summary of published work on the geochemical reactivity of hydrogen during subsurface storage in porous reservoirs. The study also pays attention to a number of specific reactions such as the hydrogen-induced pyrite reduction, hydrogen-induced redox reactions or calcite dissolution under hydrogen influence. Experimental studies and data are also summarized in an Excel database. Curious? – Download the report and database [here](#).

## Modelling approach to assess performance, integrity and durability of hydrogen underground storage

A team guided by Clausthal University of Technology has studied an integrated approach to obtain input parameters from experimental results of physical, chemical, and microbiological effects during hydrogen storage in porous subsurface rocks in order to develop numerical models that can predict the impact of these effects on the hydrogen storage operation. Relevant effects studied and proven on laboratory scale will be implemented into the open source reservoir simulator [DuMu<sup>x</sup>](#). For benchmarking purposes of the DuMu<sup>x</sup> code, also other open-source and commercial reservoir software has been tested. Integrated modelling, combining laboratory experiments with numerical simulations will lead to a better understanding of relevant processes related to underground hydrogen storage. More information can be gathered from the recently [published report](#).



*Processes and risks related to hydrogen storage in porous rocks (from Heinemann et al. 2021, Energy Environ. Sci., 14, 853, DOI: 10.1039/d0ee03536j).*

## HyUSPRe mid-term meeting in Edinburgh

The HyUSPRe consortium gathered on 31<sup>st</sup> August and 1<sup>st</sup> September 2022 at the University of Edinburgh for its mid-term meeting after the first project year. This was the first face-to-face meeting of the team as the kick-off meeting in 2021 had to be organized online due to the Covid-19 pandemic. All 17 consortium partners were represented at the meeting. The HyUSPRe consortium gathered on 31<sup>st</sup> August and 1<sup>st</sup> September 2022 at the University of Edinburgh for its mid-term meeting after the first project year. This was the first face-to-face meeting of the team as the kick-off meeting in 2021 had to be organized online due to the Covid-19 pandemic. All 17 consortium partners were represented at the meeting.

The organizing team of Katriona Edlmann and Mark Wilkinson built a nice program starting with an extended network lunch, laboratory tours and dinner on the first day. We got the opportunity for a labs walk and could see the various experimental facilities contributing to the HyUSPRe program. The second day was dedicated to discuss status, progress and future plans and challenges of the HyUSPRe research program. After the first year we could conclude that HyUSPRe is on track but another 15 months of challenging research and hopefully valuable results are lying ahead of us.

Thanks Edinburgh team for a well-organized mid-term meeting!



*The HyUSPRe consortium in front of the University of Edinburgh's Grant Institute.*

## HyUSPRe event attendance

### 1<sup>st</sup> International Summer School on UHS at TU Delft

11-14 July 2022, the TU Delft's Department of Geoscience and Engineering organized the [1<sup>st</sup> International Summer School on Underground Hydrogen Storage](#) under the umbrella of task 42 on UHS of the IEA's technology collaboration programme. Subscribing participants were offered a varied program with three days fully packed with topical presentations and discussions. You can see the program with titles and speakers [here](#). The fourth day colleagues visited the natural gas storage facility of Energystock in Zuidwending where the HyStock pilot project was (and is). A couple of partners from HyUSPRe were actively involved in this summer school.

### Hydrogen TCP-Task42 UHS workshop on 17-18 November 2022

17-18 November 2022, several representatives HyUSPRe partner representatives participated in the first Hydrogen TCP-Task42 Underground Hydrogen Storage Workshop. Organized by TNO, the coordinator of the task, and kindly hosted by the Clean Hydrogen Joint Undertaking in Brussels, the workshop provided a perfect setting for engagement, a nice evening program on the first day and great discussions during the two workshop days to advance on the Technology Monitoring Report in UHS that will be published in 2023 and discuss the 2023 workplan. For more information on Hydrogen TCP-Task42, please see the [website of the Hydrogen TCP](#).



## BGR workshop on 23 November 2022

The German Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) organized an online workshop entitled Geosciences – Enabling Underground Hydrogen storage. The workshop, lasting the whole day from 9 am until 4 pm, offered a large selection of contributions on the topics Research networks, Storage potential and Pilot storage projects, Lab research on fluid transport processes and modelling, and Geochemistry and Microbiology lab research. Four HyUSPRe colleagues contributed to the workshop: Remco Groenenberg (TNO), Ali Hassanpouryouzband (Univ. Edinburgh), Birger Hagemann (TU Clausthal) and Bart Lomans (WUR, Shell). [Click here](#) to look back at the program.

## European Hydrogen Week and Clean Hydrogen Partnership annual programme review days, 24-28 October 2022

The European Hydrogen week started with the [Hydrogen Europe's Flagship Event and Expo](#) on 24-25 October, followed by a set of panel discussions on the [European Clean Hydrogen Partnership Forum](#) on 26 October. On 27 and 28 October, the EU Research Days and Programme Review gave an overview on the tremendous number of hydrogen-related research projects co-funded by the CH Partnership. Have a look at the [programme](#) and visit the website of each project that presented itself during the programme review.

## Meet the Scientist | Engineer

In this newsletter edition HyUSPRe's project manager and lead scientist get the stage to introduce themselves to the readership.

### Remco Groenenberg, TNO

My name is Remco Groenenberg and I am the scientific lead for subsurface energy storage at TNO, the Geological Survey of the Netherlands. I studied Geology in Utrecht back in the nineties, where I specialized in sedimentology and tectonics, and graduated with a thesis on modelling of the influence of tectonics on sedimentary processes and how this is reflected in the stratigraphy of sedimentary basins. After my graduation, I worked for 5 years in IT, developing reservoir modeling and well planing software for oil and gas companies. Realizing though that my heart lay (and lies) in Earth Science, not in software development, I decided to do a PhD in Applied Earth Sciences at the Geotechnology department of Delft University of Technology, where I successfully defended my dissertation in 2007. After several postdoc assignments in Delft on turbidite reservoir characterization, CO<sub>2</sub> storage, and geothermal energy, I joined the Mining Technology dept. of AkzoNobel (today called Nobian) in 2011 to work on solution mining of salt and development of storage projects in salt caverns (natural gas, compressed air, hydrogen, oil). At the time, the interest in hydrogen and realization of its potential future role in decarbonizing (part of) our energy use was only just emerging, and among others I was involved in the well-known HyUnder project on underground hydrogen storage, which can be seen as the predecessor of HyUSPRe. After another side-step into IT, taking up the challenge to lead a team of software developers and domain experts to develop



an in-house software application for basin modeling for an oil and gas major, I joined TNO in 2018. My current activities include acquisition of contract R&D work, scientific oversight, and geoscience consultancy in the field of subsurface energy storage, energy system integration, and re-use of energy industry assets and infrastructure to accelerate the energy transition. I am (and have always been) very passionate about the subsurface, and highly motivated to help organizations and society to exploit it in a safe, sustainable, and profitable manner. Working together with colleagues in research and industry on projects like HyUSPRe, that aim to advance the readiness of technologies that use the subsurface to contribute to decarbonization, I find very motivating and rewarding. It brings me great pleasure and gives me a lot of energy!

## Holger Cremer, TNO

My name is Holger Cremer and I am project and program manager at TNO, the Geological Survey of the Netherlands. Long time ago I studied biology with focus on paleobiology and a diplomé thesis on Triassic reef sponges. After a PhD on siliceous algae in the Arctic Ocean at the GEOMAR Helmholtz Centre for Ocean Research in Kiel and two postdoc periods at the Alfred Wegener Institute for Polar and Marine Research in Potsdam and Utrecht University, I landed at TNO in Utrecht. There, after having worked a short period as geobiologist, I switched to professional project management. Initially in the oil & gas and CO<sub>2</sub> storage domain, later I mainly guided research projects related to geothermal and heat storage, recently also hydrogen storage. My focus clearly lies on national and international (EU) research projects and programs where partners from academia, applied research, industry and the public sector work together on a joint goal. Working with colleagues from different countries and cultures, and with different backgrounds, research visions and working styles is interesting, thrilling and often energizing, sometimes also energy-draining. Special value of being a project manager is gaining a broad overview on themes that are relevant for society. After almost 18 years and dozens of projects at TNO I am still a project manager with heart and soul.



## Workshops & Conferences

- [World Hydrogen Summit 2023](#)  
The summit takes place in Rotterdam, The Netherlands, from 9-11 May 2023, with ca. 8.000 expected visitors.
- [European Hydrogen Week 2023](#)  
The fourth edition of the European Hydrogen Week will take place on 20-24 November 2023.



## HyUSPRe Consortium & Funding



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of EDINBURGH



TU Clausthal



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### Disclaimer

This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the HyUSPRe consortium shall not be liable for any errors or omissions, however caused.

### More Information

Visit the [HyUSPRe website](https://www.HyUSPRe.eu) to learn more about the project. Inquiries should be addressed to [pr-vvh2020hyuspre@tno.nl](mailto:pr-vvh2020hyuspre@tno.nl).