European Hydrogen Week

//EU HYDROGEN RESEARCH DAYS

15-16 NOVEMBER

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HyUSPRe

Hydrogen Underground Storage in Porous Reservoirs

Hydrogen Underground Storage in Porous Reservoirs HyUSPRe

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Project Overview

- Call year: 2020
- Call topic: Underground storage of renewable hydrogen in depleted gas fields and other geological stores - FCH-02-5-2020
- Call type: Research and Innovation Action (RIA)
- Project dates: 1 October 2022 – 30 June 2024
- % stage of implementation 01/11/2023: 75%
- Total project budget: € 3 714 850,-
- Clean Hydrogen Partnership max. contribution: € 2,499,850,-
- Other financial contribution: € 1,215,000,-

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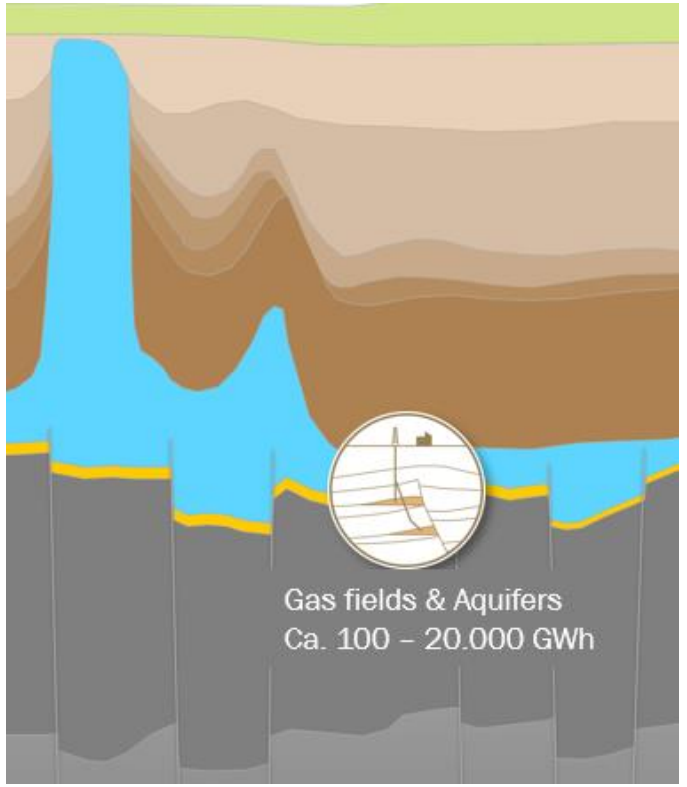
Project Summary

https://www.ieahydrogen.org/download/17/task-reports/7067/task42_uhs_technologymonitoringreport.pdf

Objectives

- Assessing the **technical feasibility**, **risks**, and **potential** of large-scale **underground hydrogen storage** (UHS) in **porous reservoirs** in **Europe.**
  - Geochemical, geomechanical, microbiological, flow and transport processes
  - Accurate cost estimates and identifying the business cases
  - Suitable stores and quantifying their storage potential
- Developing a **roadmap** for **deployment** of **UHS** up to **2050**
  - Mapping the proximity of potential storage reservoirs to RE infrastructure
  - Evaluating amounts of RE to be buffered versus time-varying demands
  - Developing future scenarios and roadmap for Europe-wide implementation



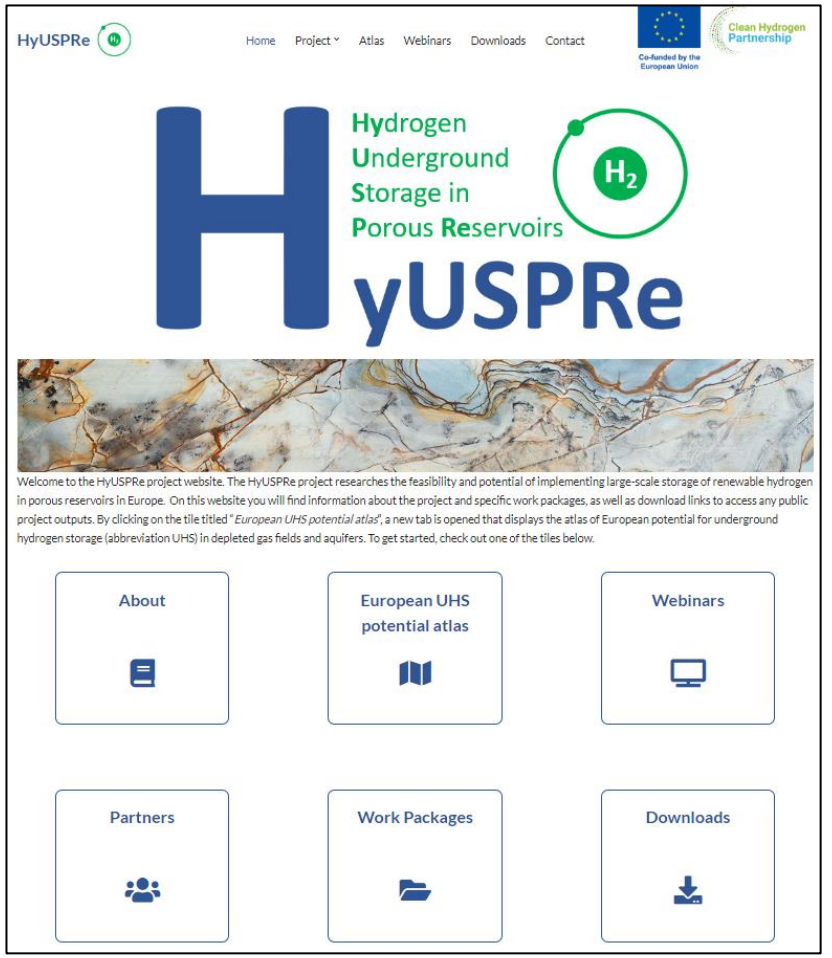
source: Hydrogen TCP - Technology Monitor Report

Expected Impact

- **Show** that **UHS** has **potential**, and potential **risks** can be responsibly **managed**, by **raising TRL** from **3 to 5**, making it ready for piloting

Highlights of Project Status

- **52 deliverables promised**, of which 31 achieved until now
- **3 external webinars organized,** 2 more in 11-2023 and Q1-2024
- **4 e-Newsletters** published
- **3 consortium meetings held**, final conference planned for May ‘24
- **All** (public) **deliverables published** on [HyUSPRe website]

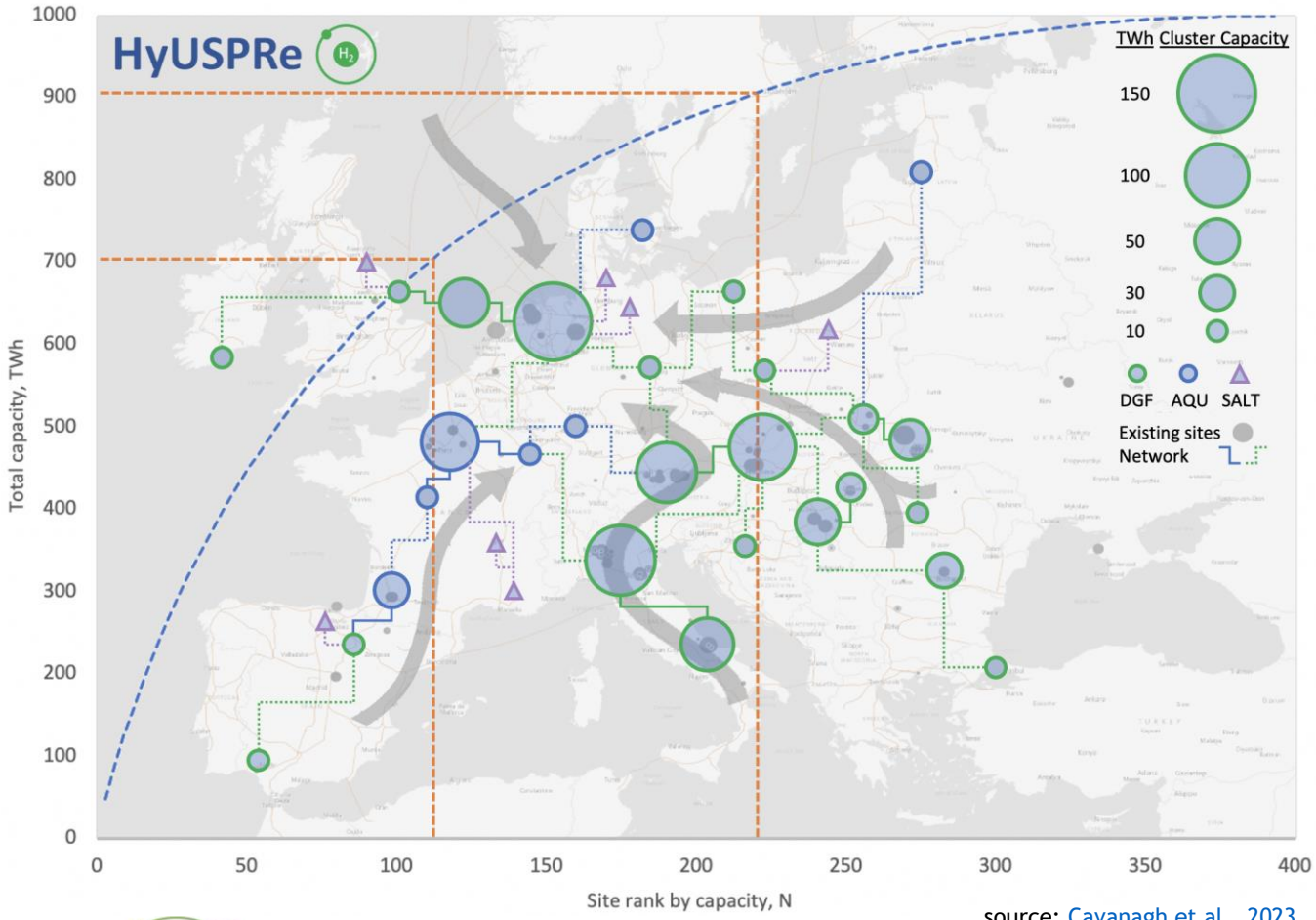


Highlights of Project Progress

- **Quantified hydrogen storage potential** of existing UGS sites in porous reservoirs in Europe, mapped their proximity to areas of supply and demand and infrastructure, and developed a vision on roll-out of hydrogen storage infrastructure to meet projected future demand for storage.
- **Experimental studies of geochemical and microbiological reactions with hydrogen** under geological storage conditions that improved our understanding of their relevance for derisking hydrogen storage in reservoirs.
- **Integrated modelling approach** for the overall performance, integrity and durability assessment at the reservoir and near-wellbore scale, and applied models enhanced in HyUSPRe in case studies of representative partner sites.

European H_2 storage potential

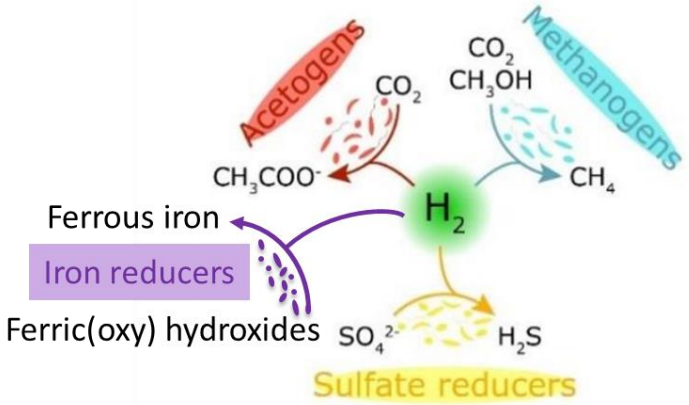
- Renewable H_2 production potential (10's of PWh) far exceeds projected future demand (1-5 PWh)
- H_2 **storage potential** in existing gas storages (reservoirs) in Europe when converted ≈ **300-450 TWh**
- **Large potential** in gasfields and aquifers in identified storage clusters **to develop additional capacity** to meet storage needs.
- Published in HyUSPRe atlas of European H_2 storage potential (in porous reservoirs)



source: Cavanagh et al., 2023

Geo- and Biochemical Reactions with H_2

- Published literature review of **window of viability** of different **microbial metabolisms** relevant for **H_2 storage**
  - T and salinity are the most constraining factors
- **Experiments** performed on **samples** of **partner sites**
  - Redefine known window of viability for sulfate reducers to combination of at least > 65°C, and >2 M NaCl
- Assessed **risk** of **H_2S generation** from **reaction** with **pyrite**
  - Pressure, temperature, pH, grain size influence reactivity
  - H_2S produced at 120°C and higher, no H_2S measured at 40°C, 80°C (yet) inconclusive
- Published **database** of **mineral reaction rates with H_2**



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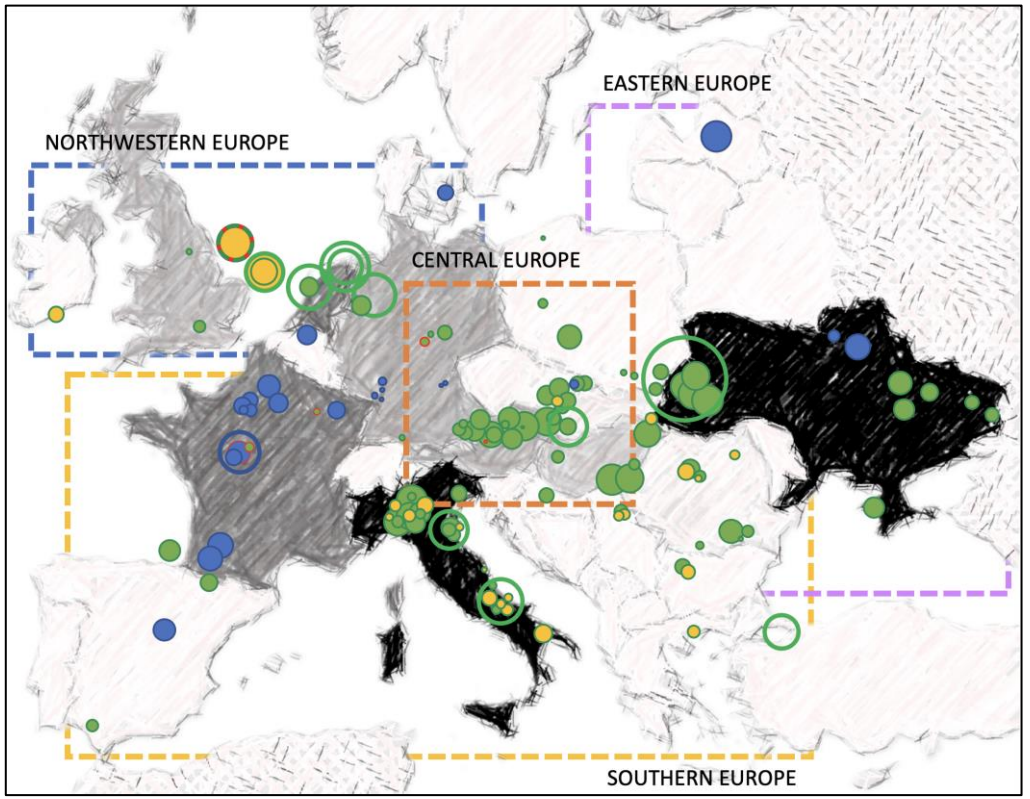
Modeling, Case Studies and Guidelines

- **Developed an integrated modelling approach** for the overall performance, integrity and durability assessment at the reservoir and near-wellbore scale
- **Implemented and tested** open-source reservoir simulator DuMu^x **code enhancements** for **bio-reactive transport modeling**
- **Applying** (and benchmarking) of DuMu^x and selected other **simulators** in **case studies of 3 partner sites.**
- **Formulating** a set of **guidelines for** the decision making process & **assessing reservoir and site suitability.**



Risks, Challenges and Lessons Learned

- **Complexity of experimental work in laboratories easily underestimated:**
  - For example, unforeseen complications with equipment and methods for HP/HT reaction experiments involving hydrogen and H_2S at high pH leading to delays
  - Mitigated by applying protective coatings, and using multiple (complementary) detection methods
  - Acknowledge that experimental work relies (also) on learning-by-doing and progressive insight

- **Be aware of risk of delay due to dependencies between work streams:**
  - For example, delay in provisioning of experimental data to be used as input for modeling
  - Mitigated by implementing batch-wise provisioning and using (placeholder) data (literature)

- **Delay in hiring of (academic) staff by universities:**
  - Common practice to start hiring process after project start, takes time, leads to early delays

- **It really helps to have a project book with rules, guidelines, practical info etc.**

Exploitation Plan/Expected Impact

Exploitation

- **Online HyUSPRe atlas** (and database) visualizing potential storage sites and their performance metrics to be exploited in site screening studies.
- **New experimental data** on reactions of hydrogen with rocks, fluids, and microbes in reservoirs and flow behaviour of hydrogen under operational storage conditions to be exploited for improved site-specific modeling
- **New algorithms, models and software code** for simulating flow, geochemical and microbiological processes in reservoirs to be exploited for derisking.

Impact

- Show that **underground hydrogen storage has potentia**l, and that potential risks can be responsibly managed, by raising the TRL from 3 to 5.
- **Prepare the deployment of pilots and demonstrations in Europe.**
- Develop a **H_2 vision and roadmap** towards realizing full-scale underground hydrogen storage in reservoirs in Europe in 2050.
- Various **scientific papers** in open access journals

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Thank You for Listening!

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