TCP-Task 42 – Underground Hydrogen Storage Newsletter

August 2024

Editorial

Dear Reader,

Time flies and in the meantime we have entered the last six months of our three-year journey for TCP-Task42. Over these past years, we have seen major advancements in the development of Underground Hydrogen Storage (UHS), which is now globally recognized as a key technology for enabling and securing the future clean energy system. Both nationally and internationally, key stakeholders and research programs are actively developing insights and roadmaps to support UHS deployment while universities and research institutes are rapidly unravelling the fundamental science behind hydrogen storage in underground formations, and major industry players are steadily advancing with the development and operation of much-needed pilot and demonstration projects. The latest progression was shared during the 3rd edition of the annual International Summer School on Underground Hydrogen Storage that took place at the University of Edinburgh last month. One of the quotes that resonated from this event was to "get on with it".

While we are entering the final phase of TCP-Task42, it is surely not a time to just sit back and relax. A lot of exciting events are still planned and, of course, we will conclude with a final report by the end of this year. Since end of 2023 we have been inviting key organizations to our monthly webinars, letting them share the latest proceedings on UHS projects with the TCP-Task42 community. There is a line-up of new webinars for the coming months and we are anticipating some great new insights including what is happening with UHS in Morocco. Also, our subtasks are wrapping up their activities while summarizing the main conclusions on the state of art. On 30 September and 1 October, the TCP-Task42 group will once again convene for the annual technical meeting, this time in Madrid. This year's meeting will be hosted by Enagás, Trinity Energy and Repsol and will focus on wrapping up the final TCP-Task42 report which presents our latest insights and conclusions on developing UHS with confidence. Secondly the community will discuss the future outlook beyond 2024 and how we can continue or extend further collaboration and exchange of knowledge and experiences. We are also preparing for an online external stakeholder webinar on 27 November, which presents the final task outcomes and future outlooks.

In this newsletter we will present the highlights on what has been going on over the past 6 months and what can be expected until end of 2024. We have also included an interview with the core team which is having an important role to develop our final report.

We hope you enjoy reading our letter. In case you have a question or any input for us then please contact TCP-Task42's coordinator via the email address IEA-TCP-UHS@tno.nl.

Key UHS projects featured in recent TCP-Tas42 Webinars

Since December last year, we have invited seven organizations to our webinar series to present their latest proceedings and achievements to the TCP-Task42 community. The focus is on real developments in the field and these insights and discussions are an important contribution to determining the state of confidence in UHS development which is under investigation for TCP-Task42's final report. In general, the outcomes of the webinars show that UHS has a great momentum and is on track for commercial deployment by 2030. Below you will find a brief recap of the projects and topics presented.

- Pūhiko Nukutū: a green hydrogen geostorage battery in Taranaki, New Zealand:
  The University of Canterbury - New Zealand presented, together with an external consultant and on behalf of their project consortium, the technical evaluation of 18 prospective sedimentary reservoirs in the Taranaki region of New Zealand, which are reduced to a subset of possible sites for further investigation. This work is part of the Pūhiko Nukutū research project funded by the New Zealand Ministry of Business, Innovation and Employment and runs from 2022 to 2027.

- RougH2 project - Redeveloping the Rough gas field for Hydrogen Storage
  Centrica and two of its partners gave an overview of the Rough UHS project, as well as an update on subsurface technical evaluation activities (so far) from 3D model building to development plan forecasting. The evaluation was going to be used to produce a Field Development Plan for hydrogen storage operations and enabled the project to progress into Front End Engineering Design phase later in 2024.

- Unlocking the Underground: Balancing the Promise of Hydrogen with Rock Stability
  Prof. Klaus Regenauer from Curtin University (Australia) delved into the known effects of hydrogen on rock strength, showcasing both concerns and potential mitigation strategies. By understanding the complex interplay of rock type, hydrogen pressure, temperature, and exposure duration, one can unlock the true potential of underground hydrogen storage while maintaining rock stability and ensuring a clean energy future.

- Wind-Hydrogen Project: Hydrogen Underground Storage in depleted gas reservoirs
  Hychico (Argentina) presented the main results of its 2016 initiated UHS program and challenges to be addressed in future pilot projects. The current program involved multiple stages with different hydrogen and natural gas injection-withdrawal cycles in a depleted gas reservoir. This site is near a Hydrogen Plant taking the advantage of the enormous wind power potential to produce "green" Hydrogen.

- H2CAST Etzel: Transition of two existing salt caverns for hydrogen storage
  The presentation of Storag Etzel (Germany) addressed the development of subsurface storage facilities for hydrogen with the H2CAST Etzel STORAG Project, and which are intended to advance the research and development of large-scale underground hydrogen storage and at the same time prove the suitability of the salt caverns in Etzel as large-volume hydrogen storage facilities.

- H2eart Project: The role of Underground Hydrogen Storage in Europe
  Global consulting firm Guidehouse addressed the results from the recently published H2eart project report, highlighting that Large-scale Underground Hydrogen Storage is a key component to unlock the required flexibility in Europe, and connect electricity and gas systems for the benefit of the energy transition. European storage operators have already initiated 9 TWh of capacity by 2030 and plan to reach 22 TWh capacity by 2040. A dedicated EU Hydrogen Storage Strategy focusing on project acceleration, large investments and targeted policy measures is needed to fulfil the estimated 45 TWh of H2 storage required by 2030.
- SHASTA Program: Subsurface Hydrogen Assessment, Storage and Technology Acceleration
  Various speakers from Department of Energy and US National Laboratories presented highlights from the ongoing US SHASTA Program on assessing and progressing underground hydrogen storage. The topics included i) Risk Mitigation, Operations and Recommended Practices, ii) a hydrogen Field-scale Test Plan, iii) Regional Case Studies for UHS and iv) Local and Regional-Scale Techno-Economic Analysis.

External stakeholder webinar, 27 November, 2024

As referred to in our Editorial, TCP-Task42 is progressing towards the publication of its final outcomes by December of this year and our experts are currently summarizing the insights and recommendations to help UHS getting off the ground and leverage the progresses made by industry, R&D and governments. In addition to this, our community is reflecting on the 3-year journey we have made together and looking ahead to embark on new opportunities for continued collaboration and leveraging UHS development.

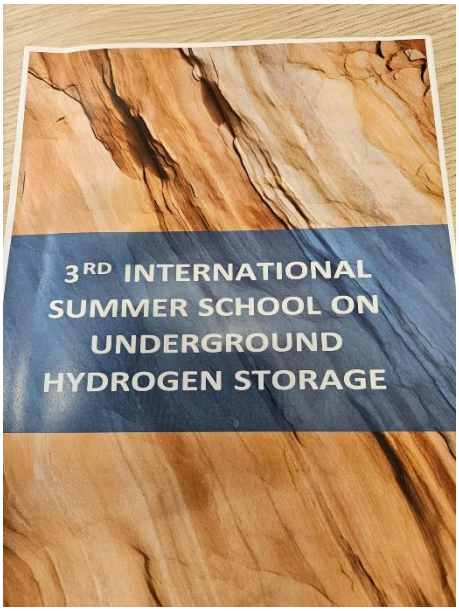
On 27 November we would like to engage with key stakeholders in an external webinar where we would like to give everyone a comprehensive preview of the messages and contents to be presented in TCP-Task42's final report. Are we ready to develop UHS projects and how far have the latest research and the past experiences in gas production and underground gas storage brought us? What is really needed to get past the final barriers and how can we cash in on the results from the growing list of pilot and demonstration projects? This webinar (also consisting of a panel discussion) will offer all stakeholders the possibility to get familiar with the results from TCP-Task42 and to engage in discussions on what are the most critical steps to bring UHS to a commercial and socially acceptable status. These insights will help us to shape the future ideas and agenda for the next years.

Participation in the webinar is free of costs and if you are interested in joining us online in the webinar of 27 November between 1.30 and 3.00 p.m. CET, then please take the opportunity to register via the following registration link and which will provide you automatically with the MS Teams details of the webinar.

Successful 3rd edition of the International Summer School on UHS

From 8 to 12 July 2024 the third edition of the International Summer School on UHS took place at the University of Edinburgh, United Kingdom. Like the previous two ones organized by the Department of Geoscience & Engineering of Delft University of Technology, it was again a huge success. This time the event had 130 in-person participants from all over the world; quite a few of them came over from more than 10 different European countries whereas attendance from outside Europe concerned participants from Australia, USA, China and New Zealand. The audience was further complemented by online participants from across the globe.

This community consisting of PhD students, scientists from top universities and research institutes, and industry professionals in hydrogen development, dived into the latest topics and developments, among which those on microbiology, site screening, monitoring, storage integrity and long-term performance and interactions in complex underground systems. There was a strong focus on actual developments in UHS projects and national/international studies, which reflects the momentum towards realization of UHS. Knowledge was shared via numerous presentations followed by Q&A and discussion sessions. In addition, each attendee was given the opportunity to present his or her research (or actual project) on UHS during a dedicated poster session with a total of 29 contributions. The experience of the participants was further enhanced via the organization of several cultural events, like a traditional Scottish ceilidh dancing and whisky tasting, and the arrangements of a few exciting field trips to hydrogen facilities and geological sites.



It is great to see that for the upcoming years 2025 and 2026 the organization of this Summer School is being continued. This will mean that the community will keep on getting together on an annual basis. Next stop for the community will be mid next year in Copenhagen and where the Danish Technical University is going to host the 4th edition and with the exact timing to be announced.

Meet our core team members

A spotlight in this newsletter is put on our three core team members and who have an important role, together with our lead and co-lead, in the completion of the TCP-Task42 final report. These members are GTI Energy's representative Shadi Salahshoor, Eddy Kuperus from Gasunie and Jacqui Sutton representative for Lochard Energy. Let's learn more from them via three questions on their involvement in Underground Hydrogen Storage (UHS), the specific interest in the completion of TCP-Task42, and on their outlook for 2030.

Can you tell us more about your background, and your role and expertise on the topic of Underground Hydrogen Storage?

Shadi: I am currently the Senior Program Manager for Low-Carbon Energy Solutions at GTI Energy. I serve as the Principal Investigator and Executive Director of one of our hydrogen-focused collaboratives, SUSTAIN H2 (Subsurface Storage Technological Advancements & Innovation for Hydrogen). Recognizing the critical need for collaboration between research, industry, and regulators, we initiated SUSTAIN H2 to drive the development of the technology and operational frameworks necessary for commercial UHS deployment.

I have been with GTI Energy for five years, working across various functions in low-carbon technology development and piloting. My background is in petroleum reservoir engineering, with a bachelor's, master's, and Ph.D. in Petroleum Engineering. Before joining GTI Energy, I spent several years in the upstream sector, focusing on research, engineering, consulting, and advising.

My journey has fuelled my passion for innovative energy solutions, and I am excited about the potential of UHS to revolutionize energy storage. Energy innovations are constantly shaping and reshaping our systems, but we cannot understand how these systems will operate tomorrow without understanding how they work today and in the past. To make energy transitions as successful as possible, it is crucial to leverage the vast resources, capital, skills, and experience of the oil and gas industry. This holistic approach will ensure that we can effectively transition to a low-carbon future while utilizing our existing energy resources and infrastructure.

Eddy: I work as Business Development Manager Hydrogen Storage at Gasunie. My professional background is petroleum engineering, and over the past three decades I have worked in various positions in the oil and gas industry in different disciplines such as subsurface engineering, project management, business development and operations. Over the past 15 years my work was primarily focused on underground gas storage in porous media and in salt caverns, but I also had the opportunity to work on CCS and hydrogen storage (UHS) projects.

In my current position, I am responsible for initiating and realizing hydrogen storage projects in the Netherlands and Germany. Moreover, I lead the H2Cast pilot project for Gasunie, as well as the technical workstream in a large-scale hydrogen storage project in Germany.

Jacqui: For the past 5 years, I have been supporting Lochard Energy's Underground Gas Storage (UGS) operations, in particular, the subsurface aspects of a dynamic operation. The Iona Gas Storage Facility is classified as Critical Infrastructure in Australia and is an important facility in supporting winter peak energy demands and grid stability via gas fired power generation.

Prior to this, I have close to two decades of experience working in exploration, development and production in integrated Oil and Gas companies. My background is petroleum engineering, and my main focus has been integrating subsurface data, reservoir characterization and simulation modelling, integrating from subsurface through to facilities production. I have worked with geoscientists, drilling and completions engineers right across to asset and operations engineers at processing facilities to ensure smooth operations. Cross-functional collaboration and learning is an area which I am passionate about and in which I have high focus, as I see that the more each part of the system understands their role and influence of others, the better we can work together to achieve the best solutions.

On the topic of Underground Hydrogen Storage, I have practical experience in operating underground natural gas storage facilities, and there are many parallels with UHS. I have a good understanding about the suitability of a reservoir for the purposes of UHS, but I am also learning a lot from all the research about the challenges UHS may bring. In particular, I see the microbial and geochemical aspects associated with UHS as a focus-area. Understanding how UHS may differ from UGS and the flow-on effect of the subsurface through to facilities is an area I hope to be able to also contribute to.

What would you consider as aspects of importance for your organization to be addressed with the conclusion of TCP-Task42 and finalization of deliverables by the end of 2024?

Eddy: Hydrogen will play an important role in our future fossil-free energy system, and large-scale hydrogen storage will be indispensable to make the total energy system work. The energy transition and combatting climate change is a global challenge, and success lies in sharing knowledge and experience. We consider the expertise gained from UGS in salt caverns basis for development of UHS. By the end of 2024 it is of importance the TCP-Task 42 would report on what is known in UHS, on the remaining uncertainties and the research programs and put this in perspective.

Jacqui: Let me continue to what Eddy is saying that a reliable and accurate summary of the current 'state-of-play' for UHS world-wide & shared key learnings from completed studies would be useful. TCP-Task42's Technology Monitor Report published in April 2023 has provided this. In addition, to be able to understand where the gaps are in having confidence in UHS versus UGS will be important. We see the continuation of pilot projects as being crucial to be able to demonstrate the technical feasibility as these will calibrate research insights into real operating scenarios. An expert view (from researchers, operators and regulators) as to how to transition/include regulatory aspects from UGS to UHS will be vital, recognizing that UHS in porous media is still a relatively new technology, and it will take time, as well as collaboration with all parties to fully realize the potential of this technology.

Shadi: Being part of TCP-Task42 has provided GTI Energy with an unparalleled opportunity to collaborate with over 40 organizations worldwide on shaping the future of hydrogen storage technologies. The Technology Monitoring Report provided a wealth of information on the current state of hydrogen storage technology, identifying existing gaps—operationally, technically, and scientifically. It also underscored the critical need for validations through pilot projects across

different porous media formations. The conversations and insights gained from my engagements with TCP-Task42 have only reinforced my optimism about the promise and potential of large-scale hydrogen storage. I have seen firsthand that we are not just envisioning the demonstration of underground hydrogen storage technology as a safe and cost-effective long-duration energy storage solution, but we are actively building it by leveraging our existing knowledge and by collaborating across industries, organizations, and borders! Our discussions highlighted the necessity for a clear evaluation of "confidence levels" in various technologies as we scale up and transition from UGS to UHS. The outcomes from this process are invaluable for us to effectively communicate the key remaining uncertainties and propose solutions that will bolster confidence in the broader adoption of underground hydrogen storage.

> When we would look at 2030, in what areas should we then have made the biggest leap in terms of “building confidence in UHS”?

Jacqui: Looking to 2030, there are three areas we see as requiring biggest leaps. The first one concerns subsurface technical feasibility, being the advancement of Technology Readiness Level towards level 9+, with confirmation via demonstration projects, establishment and confirmation of safety and reliability which translates to Licence to Operate. Regulatory reform is the second area and which means development and maturation of legislation to allow UHS to become an integrated part of the energy system. And the last area deals with the social licence, the advancement of Societal Embeddedness Level towards 4+; informing and educating about hydrogen safety in general and the role UHS could play to support the energy transition.

Shadi: Looking ahead to 2030, building confidence in UHS will hinge on demonstrating its technical, economic, and societal benefits in different regions. UHS development must progress alongside production, infrastructure, and consumer demand to establish a fully integrated, reliable, and resilient system. The greatest advancement will come from the timely engagement of operators and the industry’s collective commitment to overcoming technical challenges. The complexity of building large-scale UHS infrastructure necessitates immediate discussions, strategic planning, and collaborative efforts to realize the vision of an integrated low-carbon energy system by 2030. We need to make efforts to refine screening and site selection methods, enhance monitoring technologies, address regulatory frameworks, and build technical capability. These coordinated efforts will be pivotal in advancing UHS and achieving sustainable energy goals effectively by 2030 and beyond.

Eddy: When we look at 2030 the hydrogen market has taken off and is growing, transport systems connecting hydrogen production facilities and hydrogen consumers are in operation and expanding. The first commercially operated underground hydrogen storage facilities are operational, monitoring and reporting systems are in place and design standards are accepted. With growing demand, more large-scale hydrogen storage technologies such as porous media are under development. The biggest leap to be made relates to communication on the advantages of energy transition in general, and the role of hydrogen in particular. As also addressed by Jacqui, for UHS we have to be clear on our activities, the effect of our activities on safety and environment, the knowns and unknowns and on mitigations when things should not work out as expected.