Uniper Energy Storage
Making Hydrogen Storage a Reality

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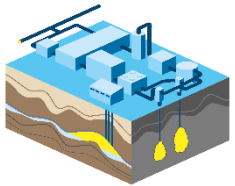
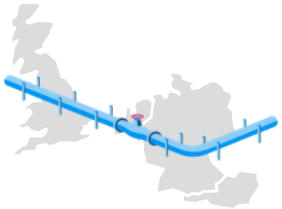
April 2025

Uniper Energy Storage – at a glance

Energy Storage = 9 x  Gas Storage facilities

4 x  Connected Market areas

> 80 TWh  Total gas storage capacity

Market leader:

We are the **largest gas storage operator in Germany**

Energy transition:

We are essential for the energy transition to **guarantee the necessary flexibility** for the renewable energy system.

Hydrogen:

Uniper Energy Storage has the **greatest potential in Europe** for storing hydrogen in caverns.

Security of supply:

Natural gas storage facilities are an **indispensable component** for security of supply - today and in the future.

Climate neutrality:

We are **proactively developing** our operations, our systems and our products towards climate neutrality.

Storage sites & hydrogen projects

Working Gas Volume

	in TWh
Cavern Storage GER / UK	41.4
Porous Rock Storage GER / AT	39.2
Total	80.6

Uniper has a long history of investigating geological storage and Hydrogen

Uniper Research Projects

- HyUnder (2012 – 2014)
- H2STORE (2012 – 2015)
- HyINTEGER (2016 – 2019)
- H2_ReacT (2020 – 2022)
- Bio-UGS (2020 – 2023)
- CABISABO (since 2019)
- Hystories (since 2020)
- HyUSPRe (since 2021)
- SAMUH2 (since 2021)
- H2-Readiness of Subsurface Steel (since 2022)
- DVGW, DGMK, BVEG, GSE
- …

Uniper Pilot Projects

Electro-lysis - Finalized

Metha-nation - Finalized

Porous Rocks - Ongoing

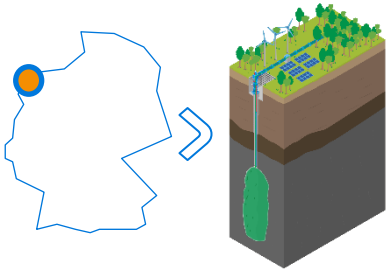
Caverns - Ongoing

- Done: Main technical components individually assessed
- Done: Safety, handling & reliability proven
- To Do: Interaction of components & partners & authorities
- To Do: Performance under commercial conditions

HPC Krummhörn – Key Facts

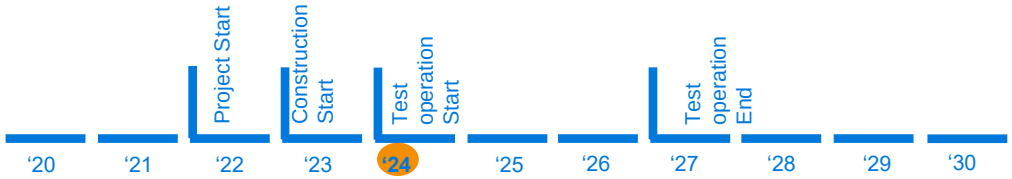
Hydrogen Pilot Cavern (HPC): Testing of hydrogen storage operation, technology and permitting in a real environment at a demonstration plant.

Development of a storage solution for green hydrogen on a commercial scale, also at other locations. Understanding of the approval procedures and requirements



3,000 m^3
Geometric Volume
(500,000 m^3H_2 @ 60 – 245 bar)

1,300 MWh
Working Gas Capacity
(370,000 m^3H_2 @ 1,500 m^3/h)



No commercial operation

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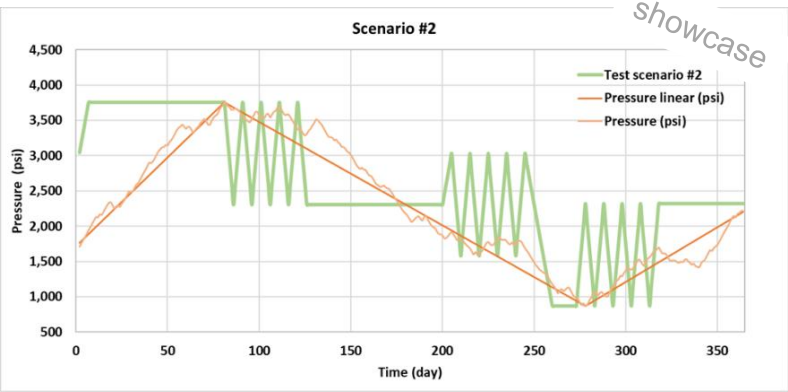
A test operation phase will follow, comprising a measurement & investigation program

Cavern storage



Material tests for hydrogen readiness

- Investigation of installation and steel (laboratory tests, tests in situ)
- Investigation of plastics, polymers (laboratory tests, tests in situ)
- Investigation of special components (packer, SCSSV, etc.)

Services

- Application of typical E&P Services under hydrogen-atmosphere
- Investigation of feasibility to perform services like surveys, snubbing-works, integrity tests, etc.

Quality of withdrawn hydrogen

- Determination of H2 quality during injection / after withdrawal
- Investigation of chemical / microbial effects

Thermodynamics, simulation of process parameters

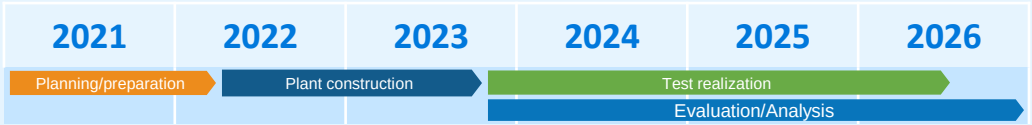
- Determination of the cavern temperature behaviour for different operating scenarios.
- Checking / calibrating the operating simulation software

Research project - HyStorage

Effect of H_2 in porous rock

Investigation of the influence of different hydrogen concentrations on porous rock layers.

Timetable



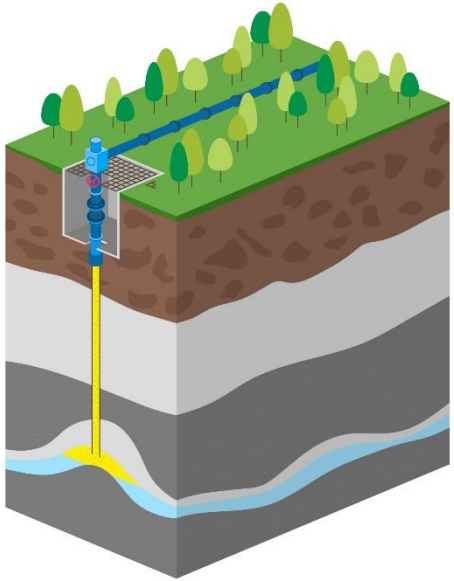
Research Questions

- Is it possible to store hydrogen in a porous rock formation ?
- Which processes are relevant in the operation of large-scale underground hydrogen storages?

HyStorage - Testing concept

Test scheme: 2 weeks injection – 3 months storage – 2 weeks withdrawal

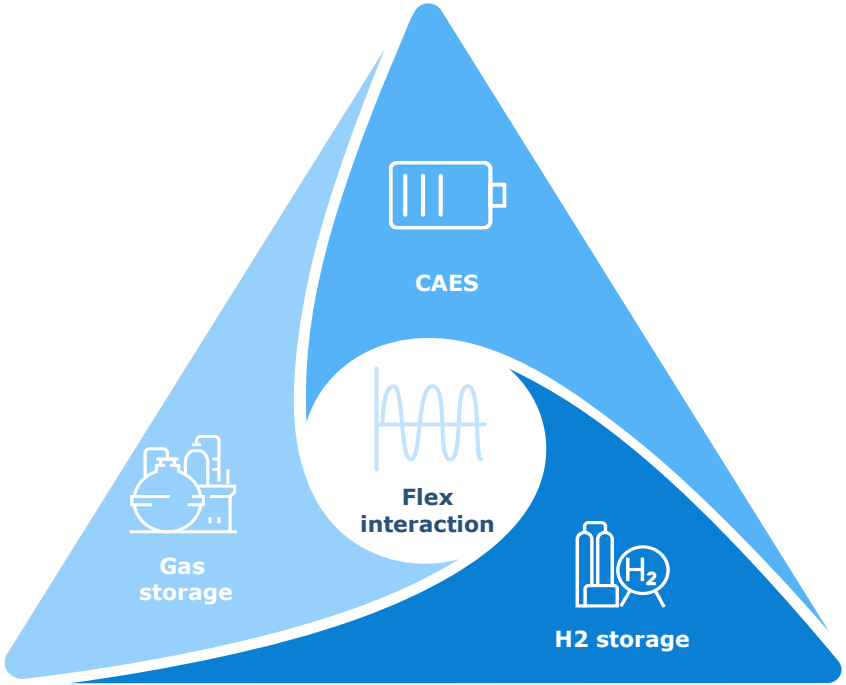
Test 1.1: Fundamental feasibility review	• Natural gas with **5 % H2**
Test 1.2: Validation of Test 1.1	• Natural gas with **5 % H2**
Test 2: Comparability with other international industrial applications	• Natural gas with **10 % H2**
Test 3: Preparation for future applications	• Natural gas with **25 % H2**



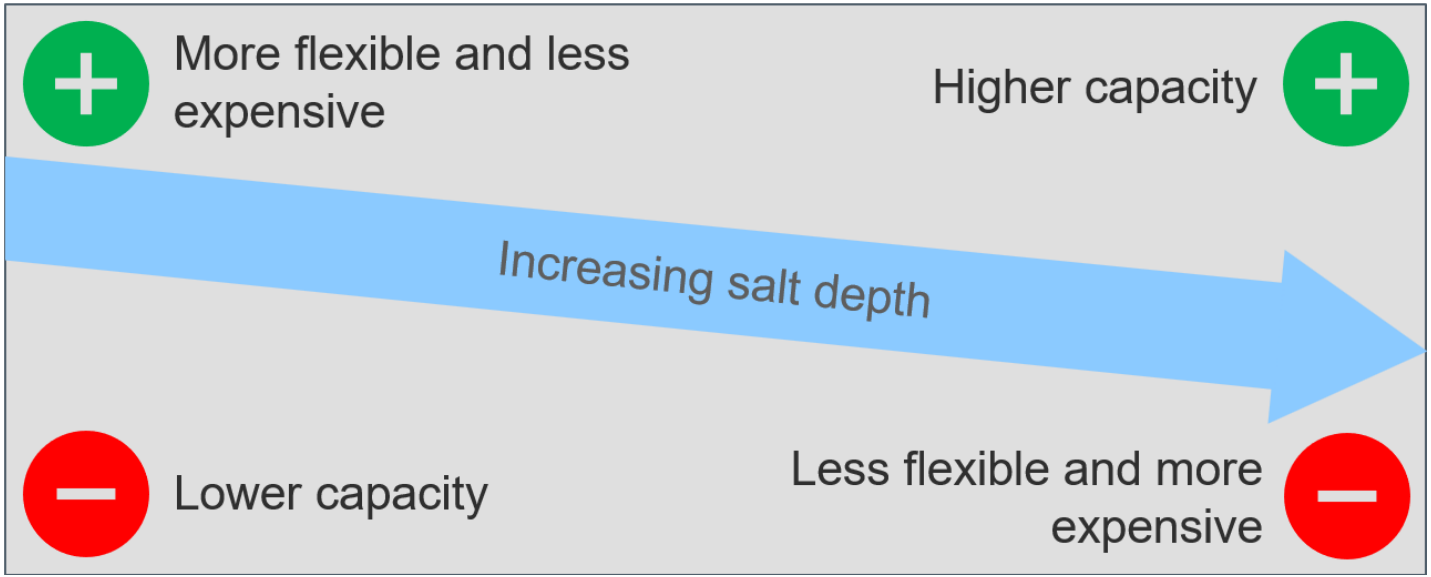
Results

- Phase 2 with 10% H2 in the natural gas mixture successfully withdrawn from the reservoir.
- 95% of the injected hydrogen recaptured.
- No significant microbial reactions observed.
- No incidents or obstacles during the production.
- Quality of reservoir model predictions very good

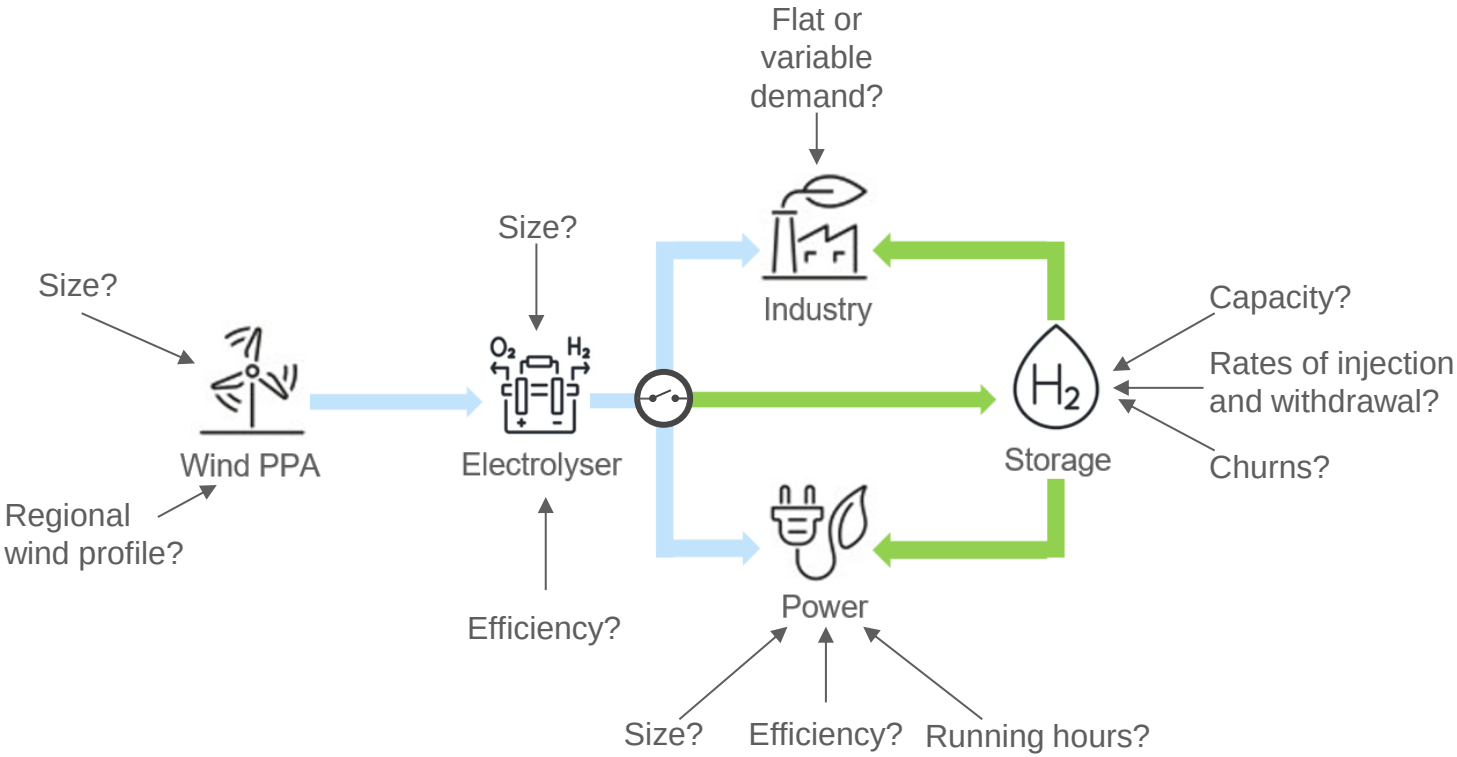
Salt Caverns Provide Flexibility and Security in all Scenarios



Linking Salt to the Storage Product



Linking the Storage Product to the Market



How do we make it happen?

- Maintain investor confidence in government support
- Future-proof storage products by prioritising flexibility and scalability
- A system-based approach for both hydrogen and green dispatchable power
- Mitigate both technical and DEVEX risks
- Fast-track consenting – including early co-operation with health and safety regulators

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