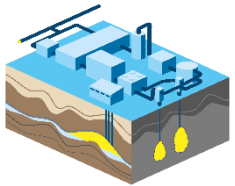
H2 Pilot Cavern (Krummhörn, GER)

Hydrogen Storage in Caverns 2023,
The Geological Society,
London, 29th March 2023

Uniper Energy Storage – at a glance

= 9 x  4 x  > 80 TWh 

Energy Storage

Gas Storage facilities

Connected Market areas

Total gas storage capacity

Market leader:

We are the **largest gas storage operator in Germany** and one of the most efficient in Europe.

Energy transition:

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

Hydrogen:

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

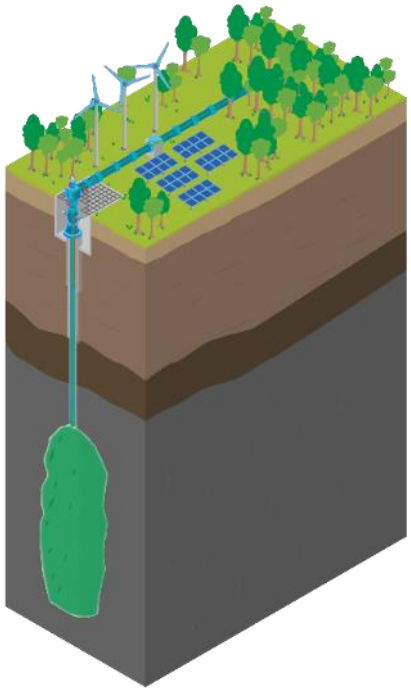
Security of supply:

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.

H2 pilot cavern



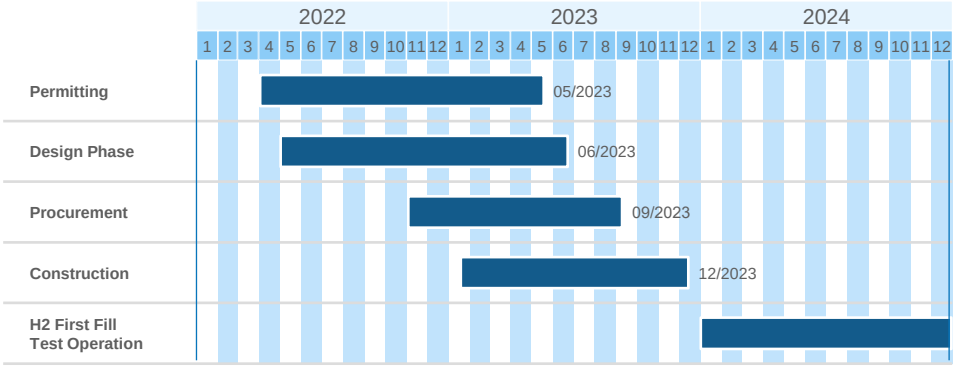
Hydrogen

Uniper Energy Storage GmbH intends to build an H2 pilot cavern and storage plant at its site Krummhörn until 2024 and to carry out a test phase to investigate hydrogen storage in a salt cavern.

Motivation for Uniper Energy Storage GmbH

- Testing of H2 storage operation and technology in a real environment at a demonstration plant
- Understanding of permitting process and requirements
- Investigation of materials, subsurface and surface installations and the functionality of individual components in H2 storage operation
- Development of a storage solution for green hydrogen on a commercial scale.

H2 pilot cavern – project key data

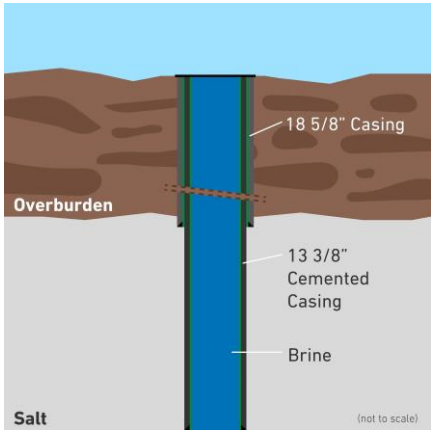


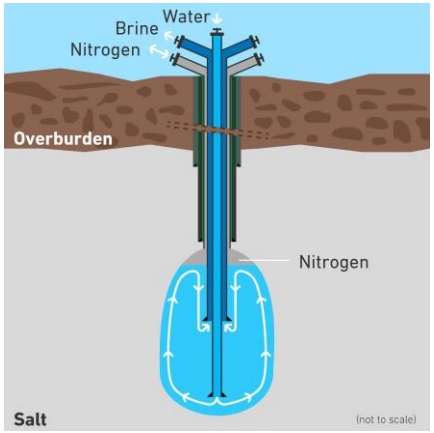
Project Key Data

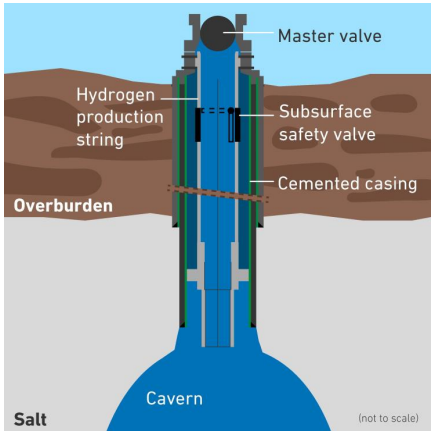
- Geom. Cavern Volume: 1 000 m³
- Pressure Regime: 70 – 270 bar
- H2 Capacity: 200 000 nm³ = 700 MWh
- H2 Working Gas Capacity: 150 000 nm³ = 500 MWh
- Max. Flow Rate: 1 200 nm³/h

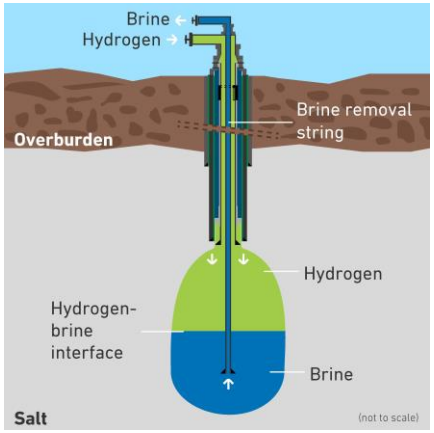
Technical project phases

Existing Borewell	Solution Mining	Cavern H2 Completion	H2 First Fill









Current works on site

Investigation of existing well – cased hole

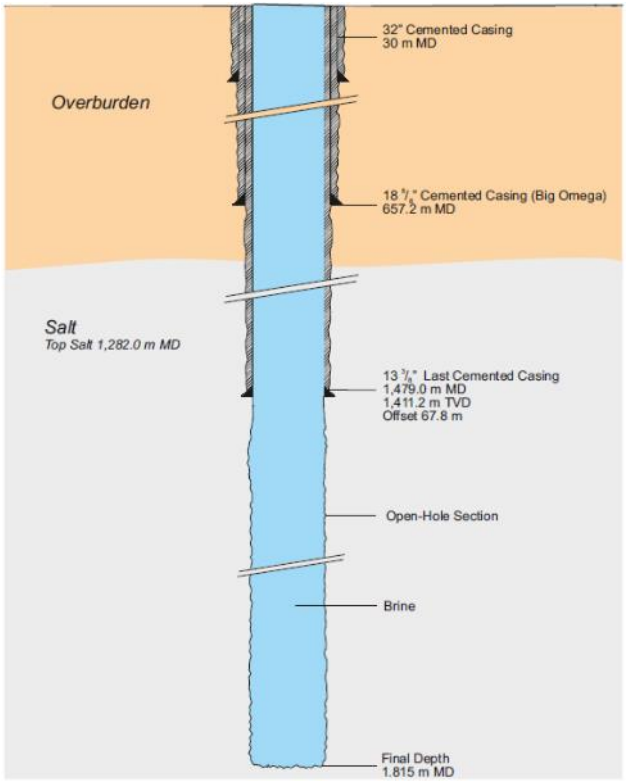
Cased hole section

- Inspection / exchange of wellhead components ☑
- Caliper Log: investigate casing geometry ☑
- USIT Log: investigate casing / cement quality ☑
- Laboratory investigation*: H2 readiness of cement ongoing
- Laboratory investigation*: H2 readiness of casing ongoing

*** Procedure and test performance verified by third party**

DNV

Investigation of the suitability of the last cemented casing as second barrier.



Investigation of existing well – open hole

Open hole section

- Re-drilling of open hole section to:
  - Re-access of the borehole
  - Obtain a uniform borehole width.
- Borehole survey.
- Install test* / leaching wellhead.
- Install test* / leaching tubings.

*** H2 readiness of test equipment proven.**

Two-stage gas tightness test

Gas tightness test

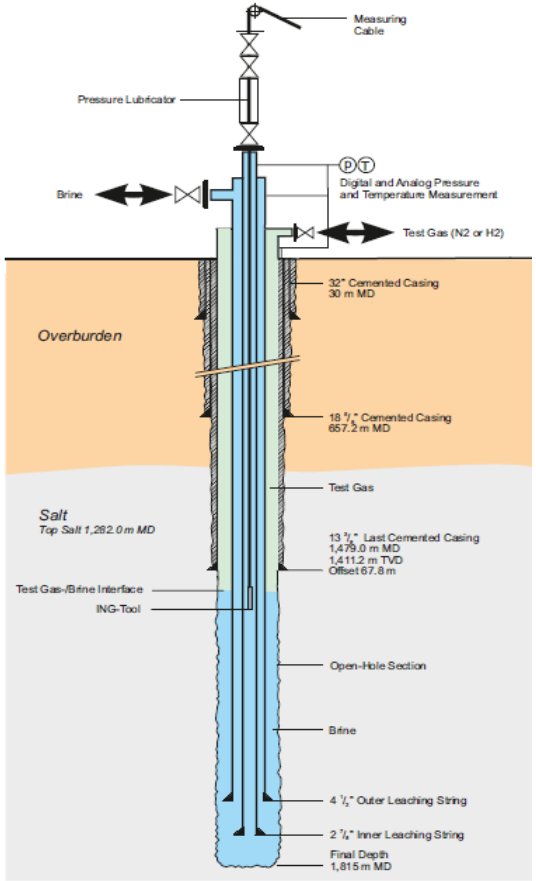
- Tightness test with In-situ-Balance method with test medium nitrogen to;
  - Verify integrity of second barrier
  - Verify integrity of casing shoe area
  - Provide basic requirements for solution mining phase.

- Analog tightness test with test medium hydrogen* to;
  - Verify H2 readiness of second barrier
  - Verify H2 integrity of casing shoe area
  - Provide first indication for cavern´s suitability for hydrogen storage.

*** Test Procedure and criteria verified by third party.**

DNV

- Previous HAZOP / operational training in the handling of hydrogen.



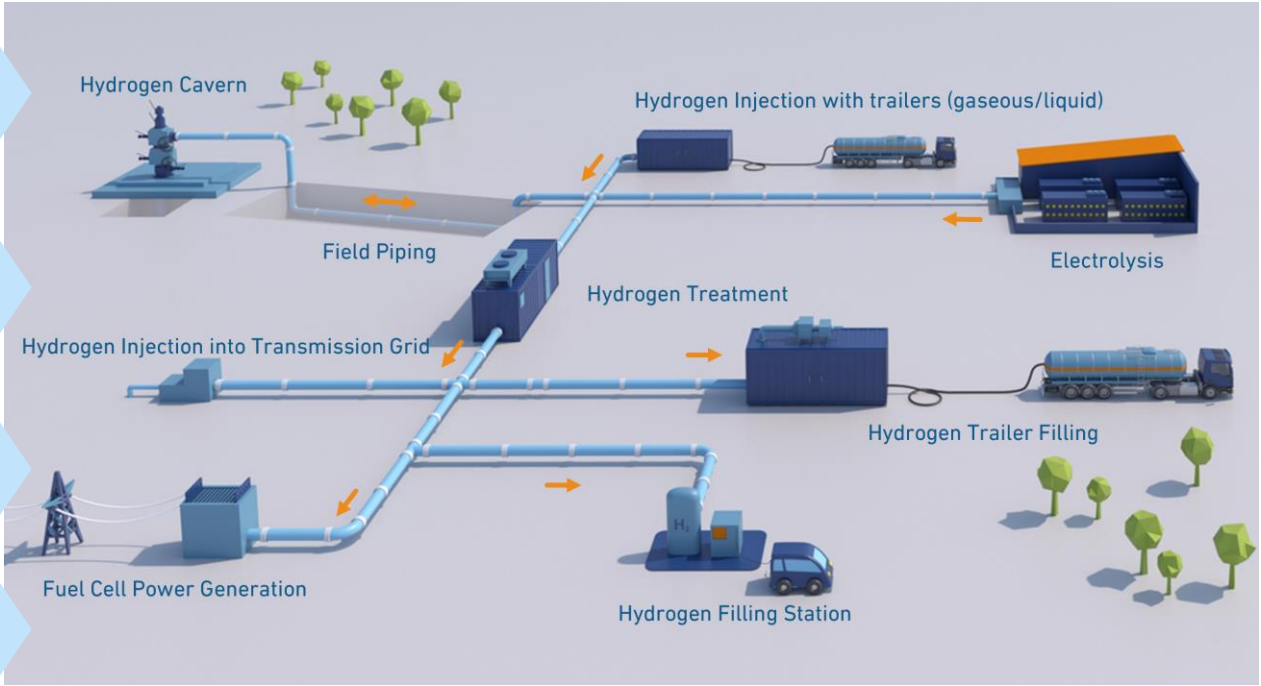
Surface installations

Hydrogen injection
- Supply of liquid hydrogen via truck, evaporation on site.
- Supply of gaseous hydrogen by electrolyzer (partnership), compression on site.

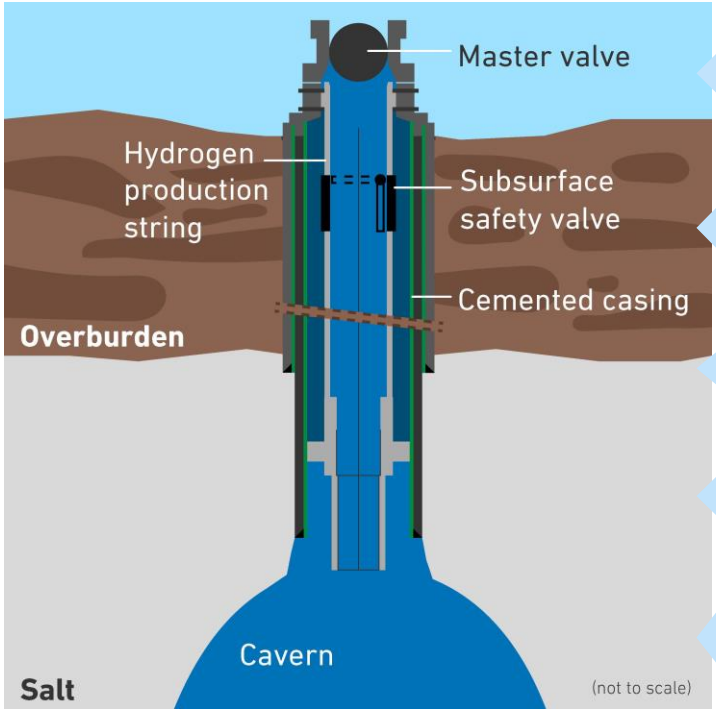
Hydrogen treatment
- On site hydrogen treatment to supply various end users.
- Test and comparison of different hydrogen drying technologies (partnership).

Hydrogen use cases
- Injection into transmission grid, liquefaction and filling, fuel cell power. generation and hydrogen fueling station (partnership).

Field piping
- Existing field pipeline must be qualified for the use of hydrogen.



H2 test operation, investigation program



Material tests for hydrogen readiness
- Investigation of subsurface installations.
- Investigation of casings / tubings, plastics, polymers (laboratory tests, tests in situ).
- Investigation of special subsurface components (Packer, SCSSSV, etc.).

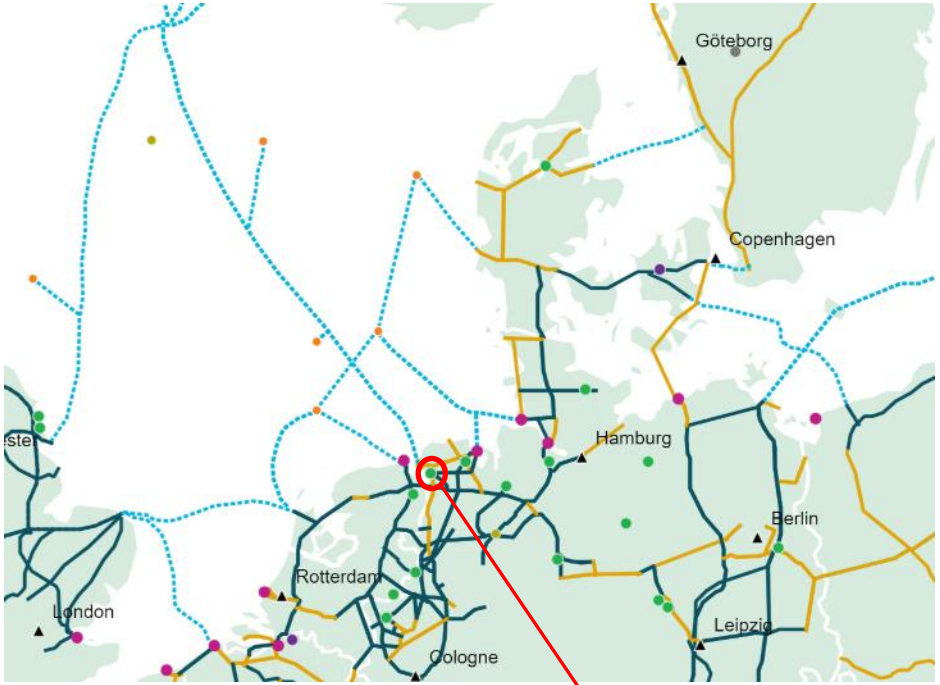
Services
- Application of typical E&P Services under hydrogen-atmosphere.
- Investigation of feasibility to perform services like surveys, snubbing-works, integrity tests, etc. in hydrogen caverns.

Quality of withdrawn hydrogen
- Determination of H2 quality during injection / after withdrawal.
- Investigation of chemical / microbial alternating effects of the hydrogen.

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

Rock Mechanics
- Hydrogen pilot cavern layout for test operations.
- Testing of different pressure regimes and injection -/ withdrawal cycles.
- Cavern contour control by sonar survey.

Krummhörn in the planned hydrogen infrastructure



Source: European Hydrogen Backbone

Strategic location

- Krummhörn is very good located to off-shore pipelines and the **European Hydrogen Backbone.**
- It belongs to Uniper´s **Energy Transformation Hub Northwest**, which combines Uniper's major projects geared towards supply security as well as hydrogen, which are underway in Wilhelmshaven and the surrounding area.

Thank you!

For further questions, please contact:

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