HPC- Hydrogen Pilot Cavern (Krummhörn, GER)

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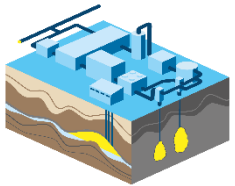
Hystories – final conference,
Paris, 25th May 2023

Uniper Energy Storage – at a glance

= 9 x  4 x  > 80 TWh 

Energy Storage

Gas Storage facilities in GER, UK & AUT

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 a **great potential** for storing hydrogen in Europe.

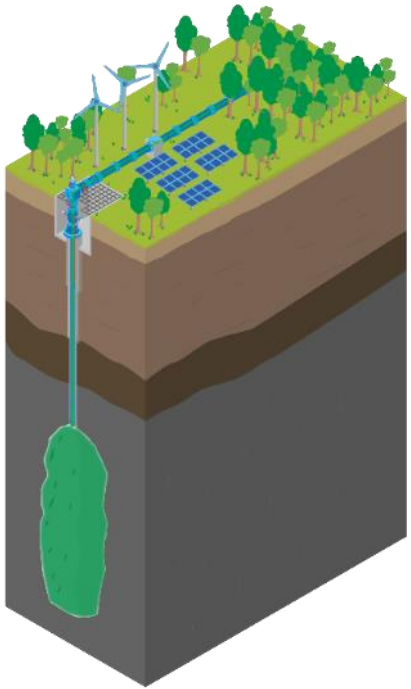
Security of supply:

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.

HPC- Hydrogen Pilot Cavern



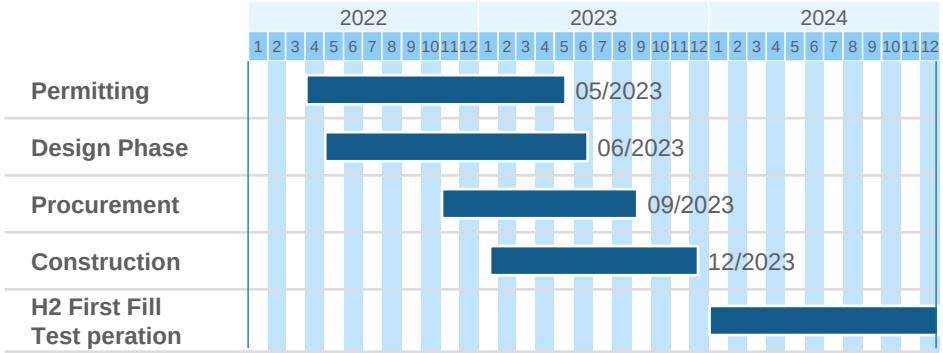
Hydrogen

Uniper Energy Storage GmbH will build an H2 pilot cavern at its site Krummhörn until 2024 to demonstrate and 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

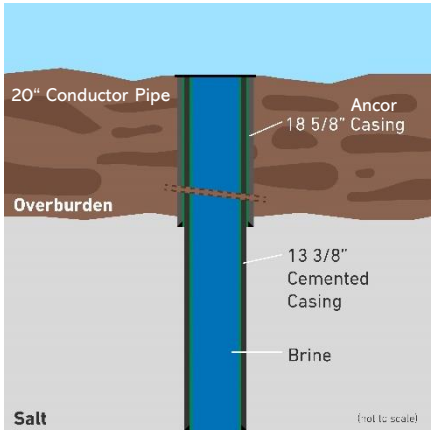


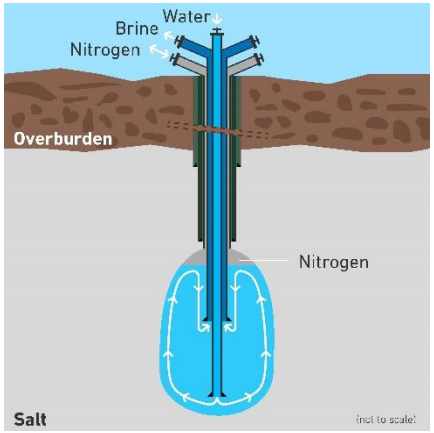
Project Key Data

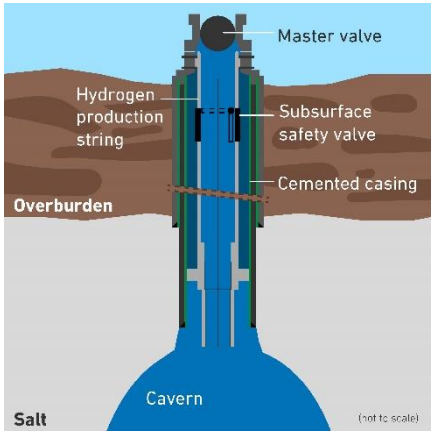
- Geom. Cavern Volume: 1 000 m³
- Pressure Regime: 70 – 270 bar
- H2 Capacity: 200 000 nm³ = 700 MWh
- H2 Working Gas Capacity: 150 000 nm³ = 500 MWh
- Max. Flow Rate: 1 200 nm³/h

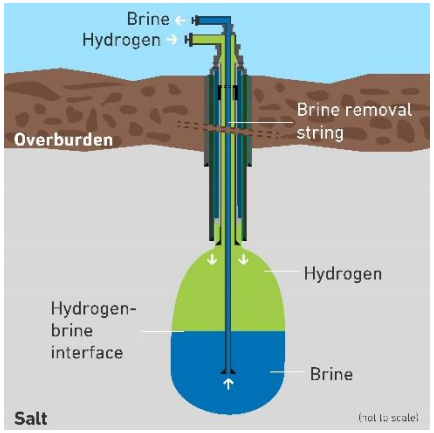
Technical project phases

Existing Borewell	Leaching Phase	Cavern H2 Completion	H2 First Fill









Investigation of existing well – cased hole

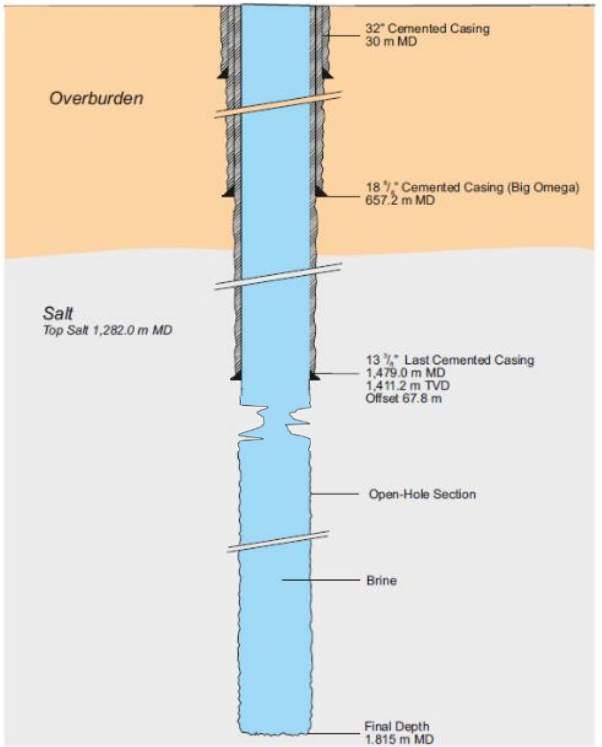
Cased hole section

- 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 leaching phase.

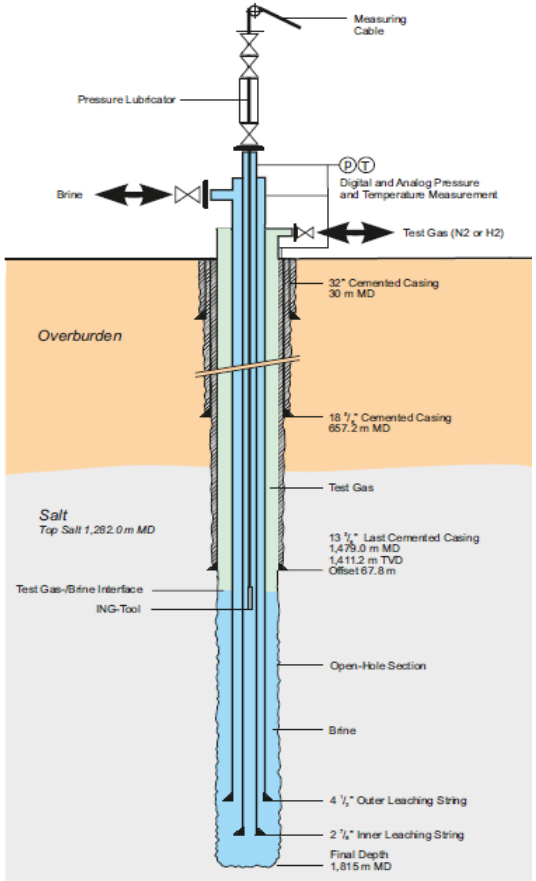
- Analog tightness test with test medium hydrogen* to;
  - Verify H2 readiness of second barrier
  - Verify H2 integrity of casing shoe area
  - Provide first indication for cavern´s suitability for hydrogen storage.

ongoing

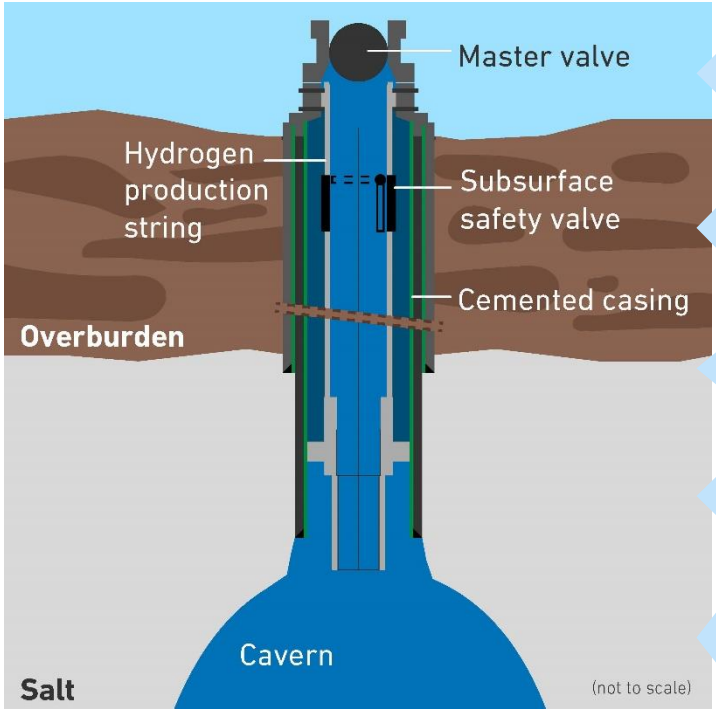
*** Test Procedure and criteria verified by third party.**

DNV

- Previous HAZOP / operational training for handling 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 behavior in different operating scenarios.
- Checking / calibrating the operating simulation software.

Rock Mechanics
- Testing of different pressure regimes and injection -/ withdrawal cycles.
- Cavern contour control by sonar survey.

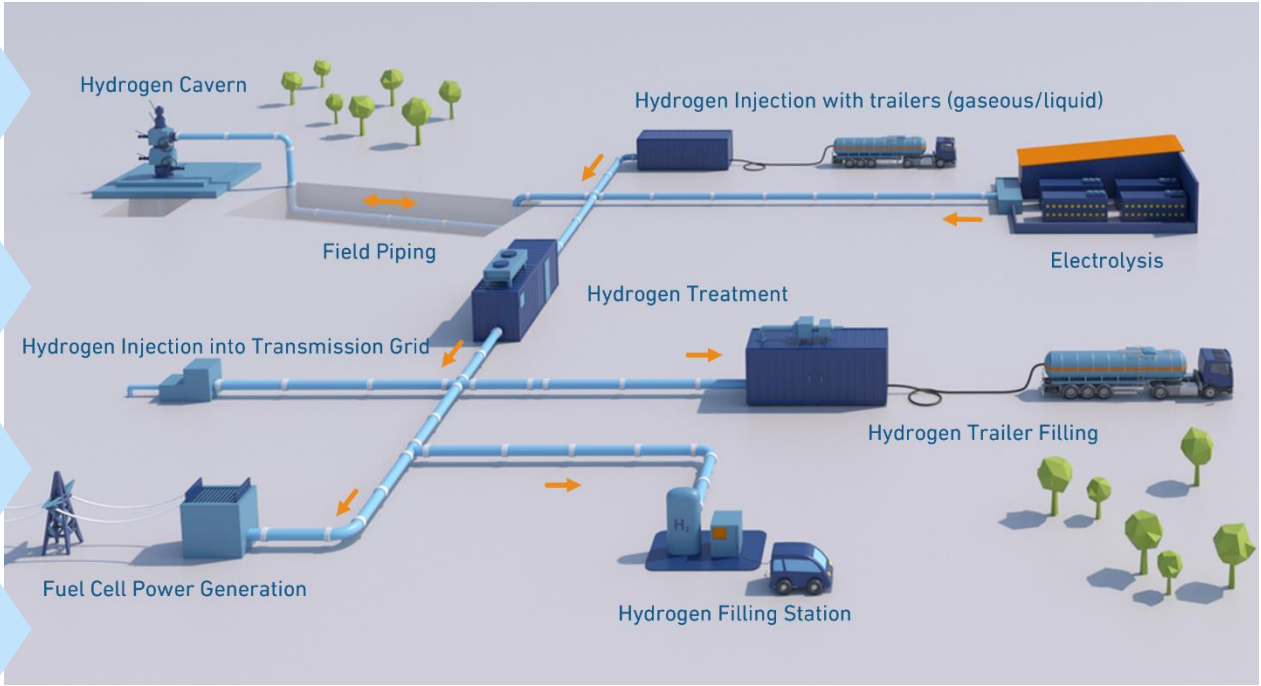
Surface installations

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 filling station (partnership).

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



Thank you!

For further questions, please contact:

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https://www.uniper.energy/energy-storage-uniper