An Overview of Gas Cavern Construction and its Energy Requirements

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DEEP.KBB

UKES2024
UK Energy Storage Conference

DEEP.KBB

DEEP.KBB GmbH

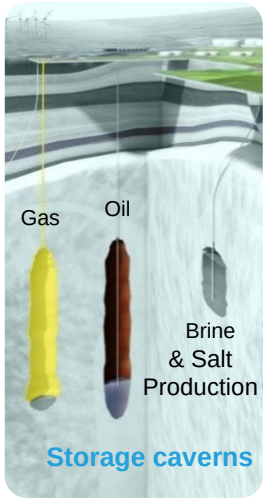
50+3 Years — Experience

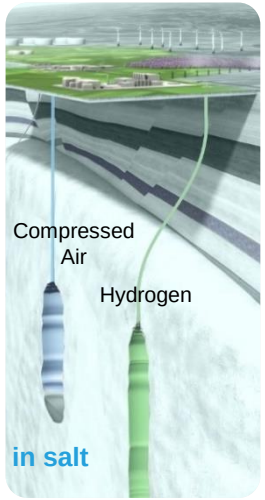
Approx. **110** — Employees

H2 READY!

DEEP.KBB is an independent engineering company specialized in subsurface technology with long-term and international experience for the engineering, construction and operation of underground storage facilities as well as for brine and salt extraction wells and P&A projects.

INNOVATIVE ENERGY STORAGE.





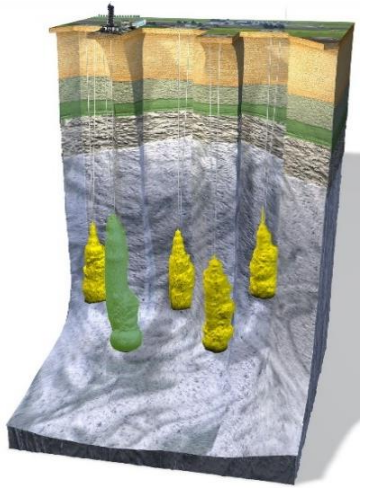
- Consulting
- Engineering
- Project Management
- Rock Mechanical Expertise
- Salt Geology & 3D Modelling
- Construction

DIN EN ISO 9001:2015 | DIN EN ISO 14001:2015 | SCC** Job Safety

HYDROGEN FOCUS

- Long-term Involvement in Theoretical Aspects & papers
- Concept and Feasibility Studies
- Potential Studies / Site Screening
- Basic & Detailed Engineering
- Pre-FEED & FEED Studies
- Active Involvement in different Hydrogen Pilot Projects / R&D

uniper · hystock power to hydrogen · Green Hydrogen Hub DENMARK · H_2CAST Etzel



DEEP.KBB‘s Involvement in Gas Storage Projects

Participation at Worldwide Gas Storage Projects

STORAG Etzel (GER):

Cavern storage site since 1997 with 49 gas cavern storages and 24 crude oil storages. Approx. 3,900 Mio. m³ working gas volume.

www.storage-etzel.de

Gasunie Zuidwending (NL):

Cavern storage site since 2004 with 5 gas cavern storages and a total working gas volume of approx. 600 Mio. m³ working gas volume.

www.gasunie.nl/en/gas-infrastructure/gas-storage

REN Carriço (PT):

Cavern storage site since 1999 with 6 gas cavern storages and a total working gas volume of approx. 360 Mio. m³.

www.ign.ren.pt

DEEP.KBB‘s Involvement in Hydrogen Projects

Participation at Recent Pilot Projects

STORAG Etzel (GER):

Demonstration project of the feasibility of large-volume underground storage of hydrogen and check of suitability of the salt caverns in Etzel for hydrogen storage

https://h2cast.com/

HyStock / Gasunie (NL):

Pilot hydrogen storage operation at cavern Zuidwending A8

https://www.hystock.nl/

Uniper Krummhörn (GER):

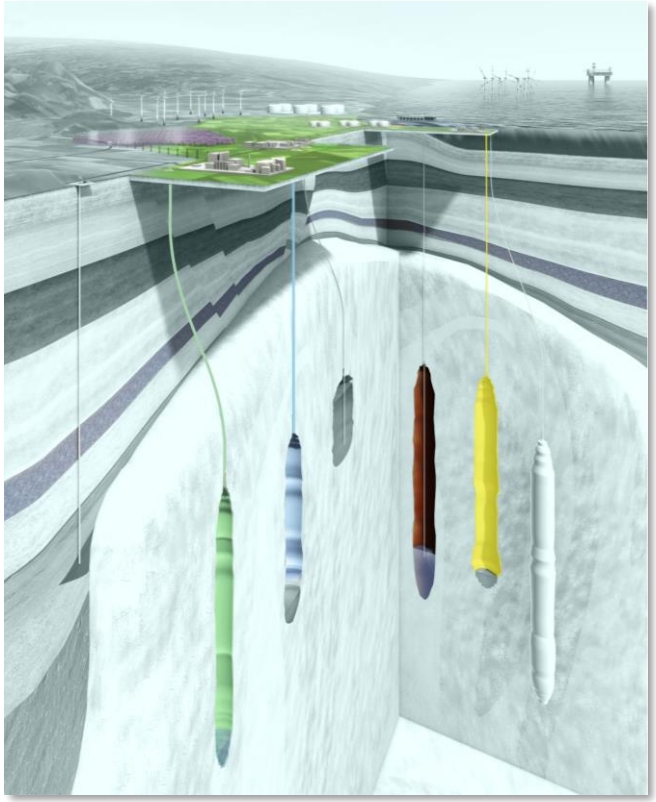
The HPC Krummhörn project aims to test the construction and operation of a 100% hydrogen storage facility under real conditions.

https://www.uniper.energy/hydrogen-pilot-cavern

Overview On Development Steps for Gas Cavern Construction

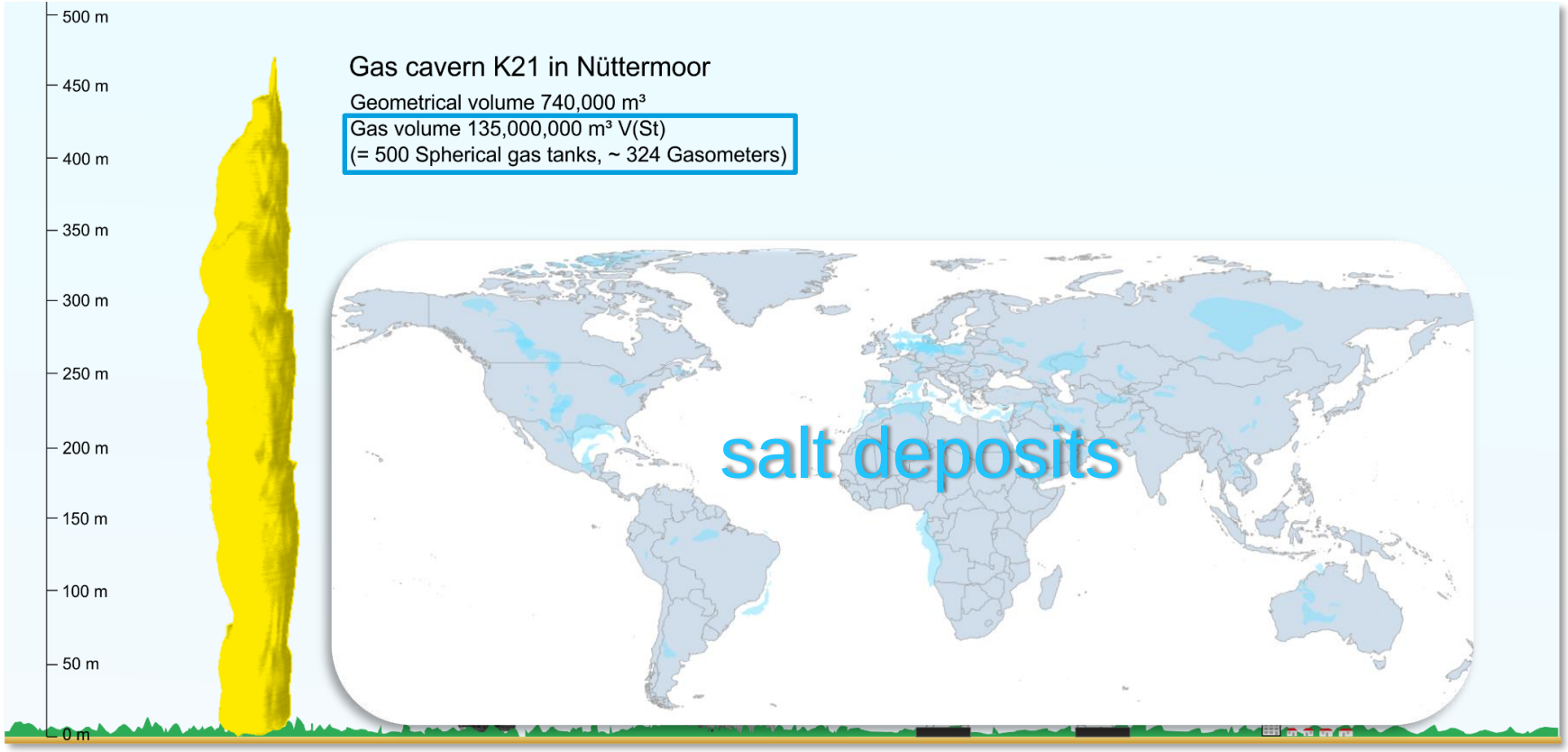
Overview on Development Steps for Gas Caverns
Salt Caverns

- caverns to store oil, gas, hydrogen and chemicals
- built in **impermeable** layers of salt
- **bedded** salt or salt **structures** as diapirs, pillows, salt walls, etc.
- volume for gas storage cavern is typically around **500,000 m³** (up to ~1 Mio. m³)
- favourable **depth** and **thickness** of salt



Overview on Development Steps for Gas Caverns

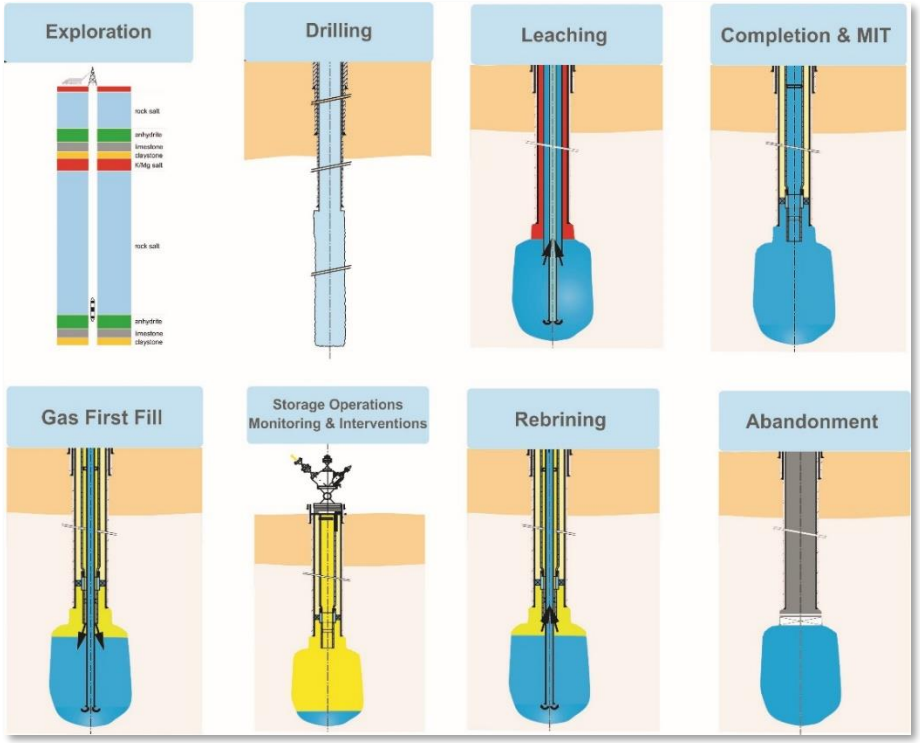
Dimensions of a Gas Cavern



Overview on Development Steps for Gas Caverns

Life Cycle of a Cavern Storage Project

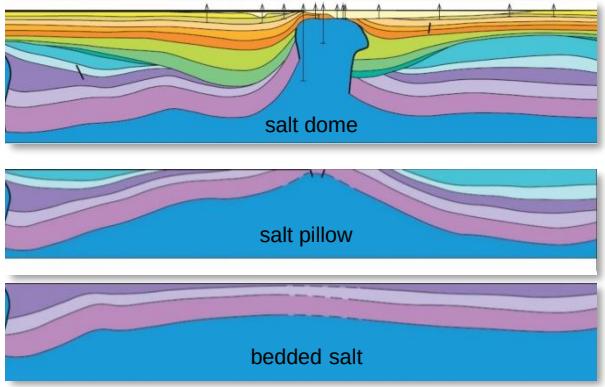
i. Geological exploration and engineering
ii. Drilling and constructions on surface
iii. Solution mining
iv. Completion and gas first fill
v. Storage operation
vi. Abandonment

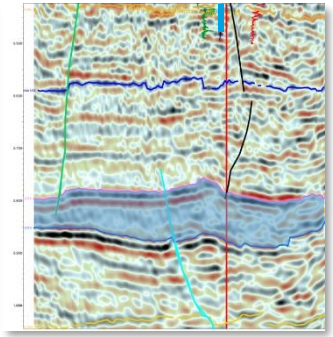


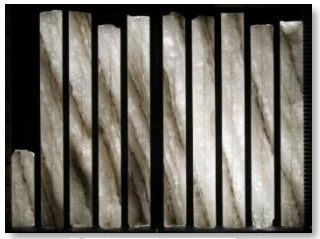
Overview on Development Steps for Gas Cavern

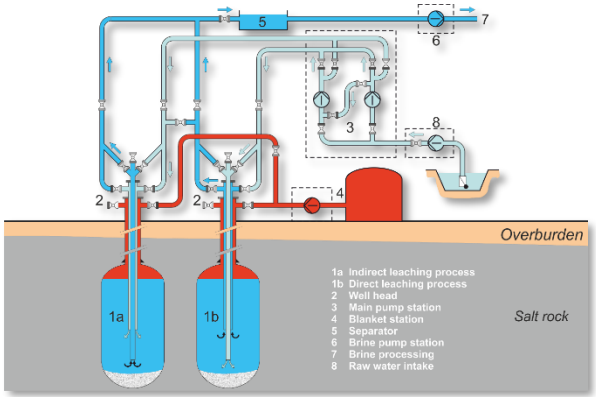
i. Geological Exploration and Engineering

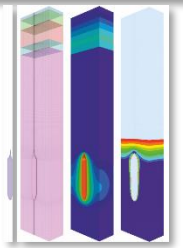
- geological exploration
  - from surface (gravimetry, seismic survey, electromagnetics)
  - from wells (cutting analysis, core analysis, geophysical wireline logging, bromide analysis, GPR)
- engineering (basic design, rock mechanical assessment)
- permissions and licencing





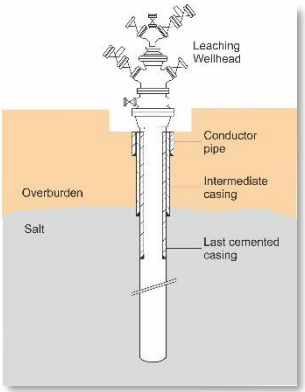






Overview on Development Steps for Gas Caverns
ii. Drilling and Constructions on Surface

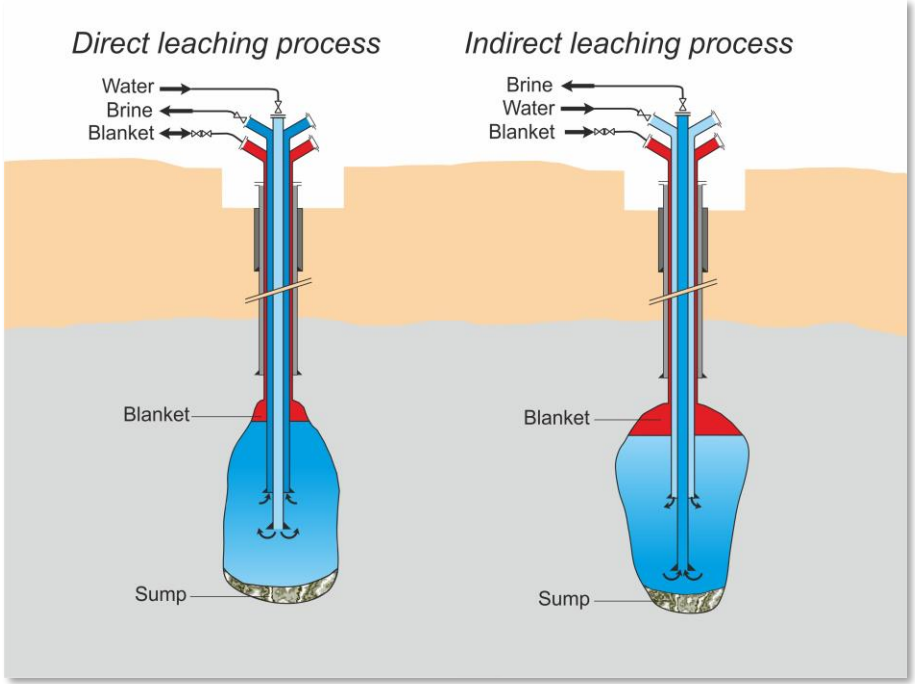
- drilling
  - cavern pad construction
  - drilling operation
  - borehole completion (cementation, casing)
  - well head assembly and leaching strings
  - Mechanical Integrity Test (MIT)
- leaching facility
  - pipelines, pumps, valves, compressors, etc.
- gas plant
  - compressors, pipelines, adsorber, etc.



Overview on Development Steps for Gas Caverns

iii. Solution Mining

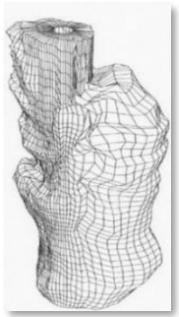
- fresh water is injected direct/indirect with Q = 50 - 350 m³/h
- brine is produced through inner/outer string
- blanket medium (e.g. oil, nitrogen, air) protects the roof section
- 1 m³ cavern volume requires ~ 7 - 8 m³ freshwater

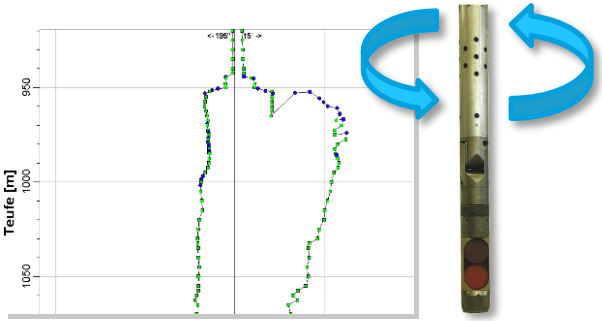


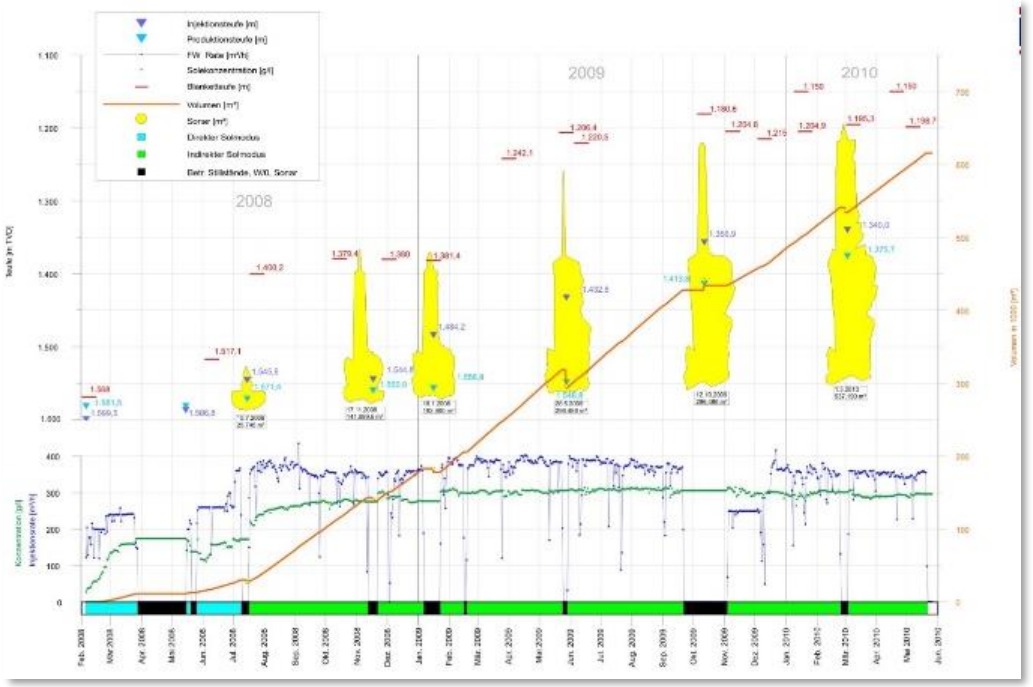
Overview on Development Steps for Gas Caverns
iii. Solution Mining

- workover for sonar survey and shift of injection depth (e.g. perforation, cutting)

- history matching for cavern shape development



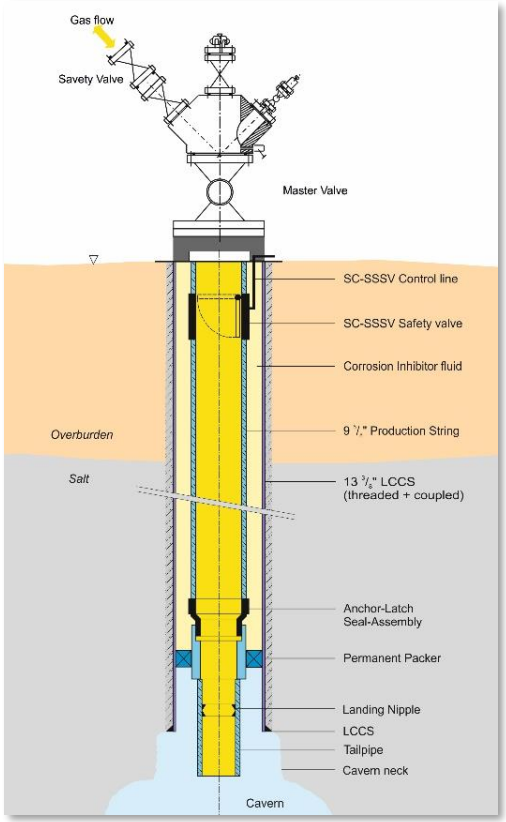


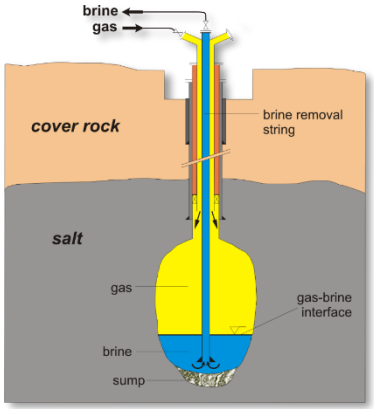


Overview on Development Steps for Gas Caverns

iv. Completion and Gas First Fill

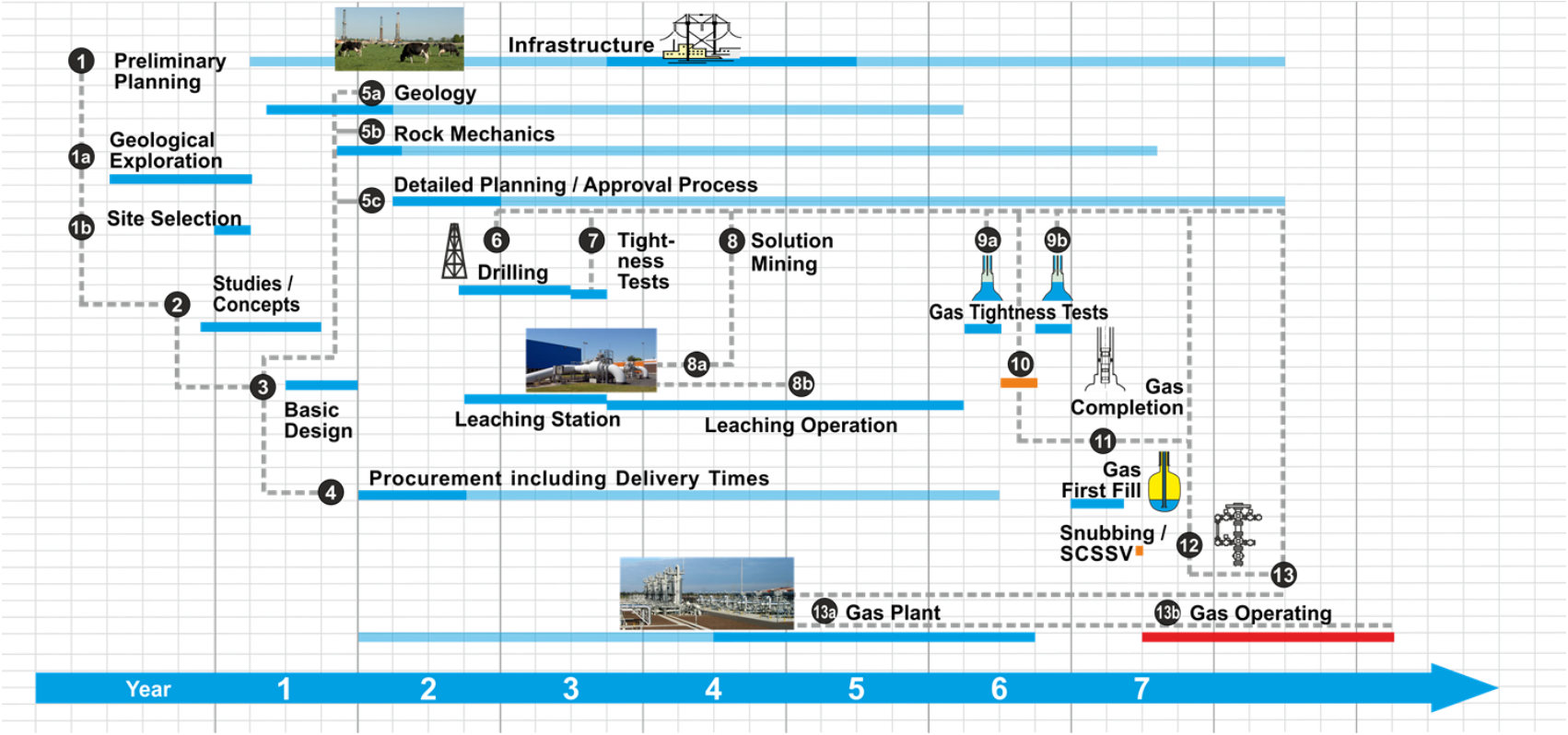
- completion for operation and gas first fill (wellhead, SSSV, packer, etc.)
- MIT
- debrining and first gas fill
- snubbing out debrining string
- storage operation





Overview on Development Steps for Gas Caverns

Generic Flow Chart of a Cavern Storage Project



Energy Consumption During Gas Cavern Construction

Energy Consumption During Gas Cavern Construction

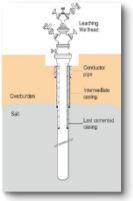
Some Influencing Factors

Energy Consumption

- **+**

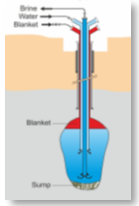
drilling

- lithology (hardness)
- length (depth)
- well dimension



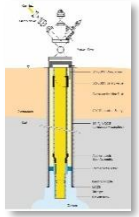
leaching

- cavern volume
- cavern depth
- leaching pipe coating
- compressor efficiency



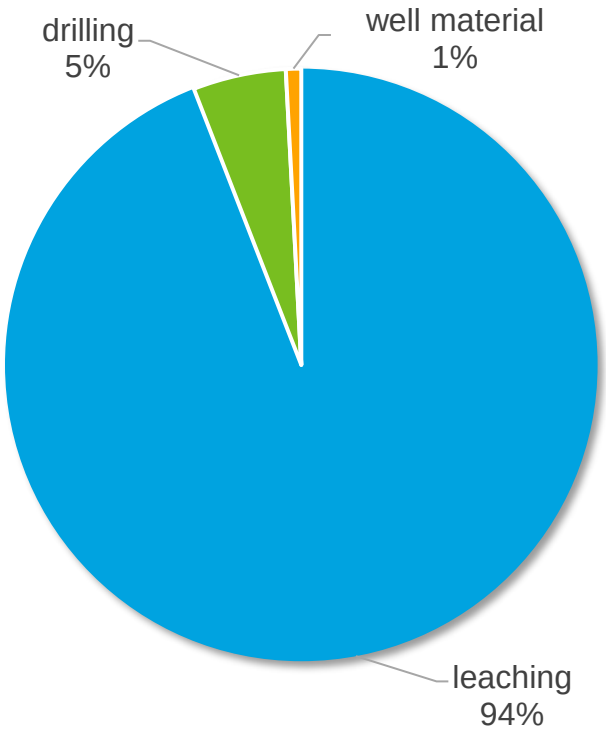
well material

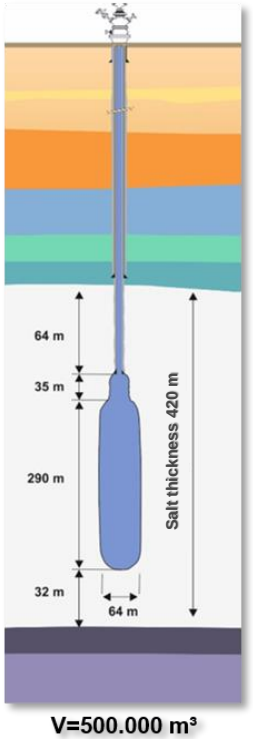
- cavern depth / well dimension



Energy Consumption During Gas Cavern Construction
Exemplary Gas Cavern

- cavern parameters
  - cavern roof ~ 1,000 m
  - cavern volume 500.000 m³
- energy consumption
  - leaching ~ 18.000 – 28.000 MWh
  - 5% for drilling
  - 1% for well material
- energy content per cavern
  - natural gas ~ **0.7 TWh**
  - hydrogen ~ **0.2 TWh**





largest amount of energy for leaching phase!

Thank you for your ATTENTION!

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