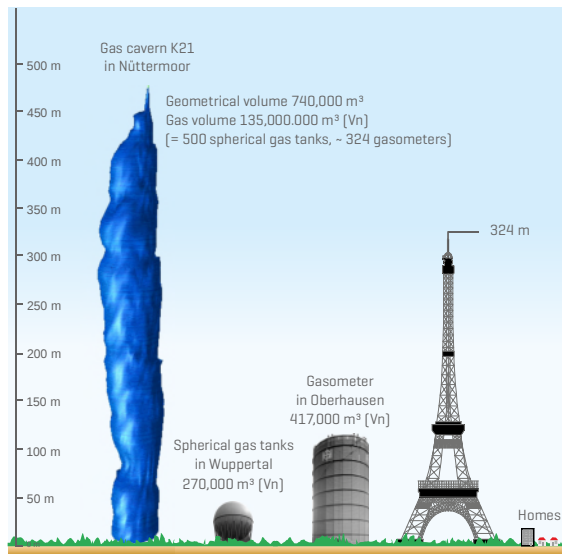


## CAVERNS AS STORAGE SYSTEMS

Man-made cavities in salt rock can be used efficiently, sustainably and economically for storing energy sources. Cavern storage is a safe technology because salt has ideal physical properties to form a permanently impermeable barrier against liquid and gaseous hydrocarbons, compressed air and hydrogen. Compared with other storage options, caverns offer greater flexibility and require less surface space.

## DIMENSIONS OF A GAS STORAGE CAVERN



Since every project has unique requirements, our solutions are tailor-made. We design and build caverns in depths of more than 2,000 meters and with volumes of up to one million cubic meters. In addition, DEEP.KBB develops innovative solutions including offshore caverns and caverns with dual access boreholes.

## DEEP.KBB GmbH

Proven Competence

DEEP.KBB specializes in engineering and geoscientific services, providing consulting, planning, construction and operation of underground energy storage facilities, as well as brine and salt extraction. As a complete supplier in these fields, DEEP.KBB covers the entire range of services. With extensive expertise in deep drilling and completion technologies, geology, rock mechanics and reservoir engineering, DEEP.KBB is qualified not only for underground storage systems, but also for a wide range of underground projects.



# DEEP.KBB

### Office Bad Zwischenahn

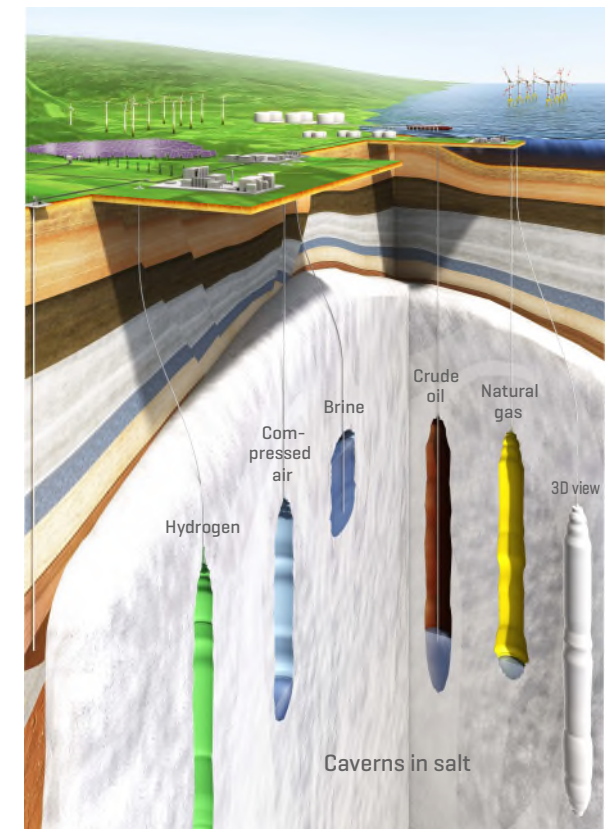
Eyhauser Allee 2a  
26160 Bad Zwischenahn  
Germany  
E-mail: [info@deep-kbb.de](mailto:info@deep-kbb.de)  
Phone: +49 4403 9322-0

### Office Hannover

Baumschulenallee 16  
30625 Hannover  
Germany  
E-mail: [info@deep-kbb.de](mailto:info@deep-kbb.de)  
Phone: +49 511 542817-0



## CAVERNS IN SALT CONSTRUCTION & UTILISATION



## INNOVATIVE ENERGY STORAGE.

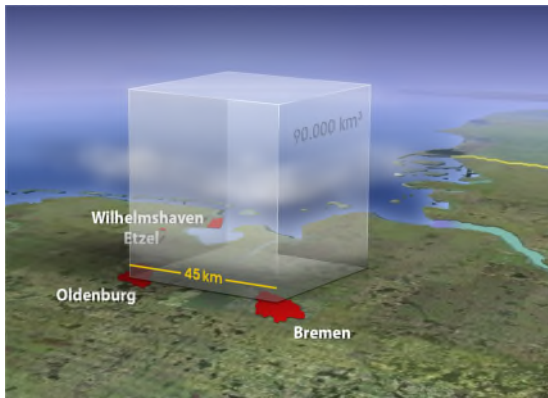
DEEP.KBB GmbH | <https://deep-kbb.de> | [info@deep-kbb.de](mailto:info@deep-kbb.de)

## SALT - THE BASIS FOR CAVERNS

Salt, also recognized as rock salt, occurs in solid form worldwide as a sedimentary rock. It was formed by the evaporation of highly saline seas, often resulting in extensive sedimentary layers.

The largest salt deposits are found in northern Germany. They were formed around 250 million years ago in the geological period known as Zechstein Age. These salt deposits vary in size, in some they have been pushed upward into so-called salt domes due to the pressure of massive overlying sediment layers.

A rough estimate of the total volume of these salt deposits in northern Germany indicates more than 80,000 cubic kilometers. If shaped into a cube, this would result in sides approximately 45 km long.



Salt is extracted either through mining or leaching. In addition to traditional mining, salt leaching is a key method used to create underground cavities known as caverns. This controlled process dissolves the salt, leaving behind hollow spaces. Caverns have been used for storage purposes for more than half a century. Salt domes are ideal for creating storage caverns. These formations are especially common in northern Germany, with some extending to depths of over 3 km.

## CAVERN PLANNING

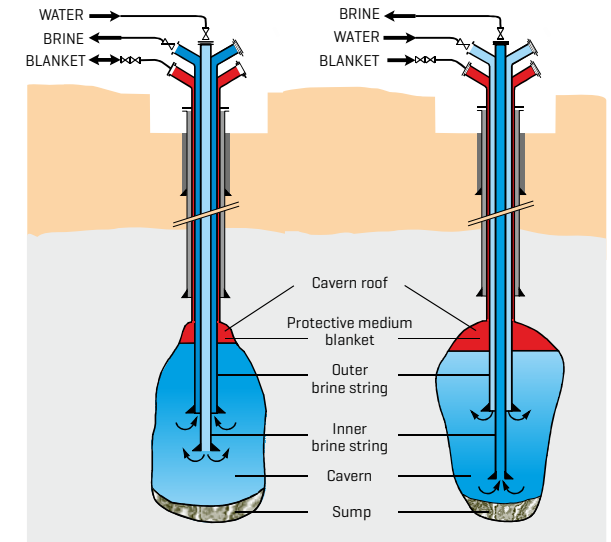
The starting point and basis of all our investigations and calculations are always the geological conditions on site. Only after a thorough analysis of these conditions we can start designing a tailor-made cavern. Ultimately, the cavern must be both safe to construct and economical to operate. That is why our geoscientists and engineers at DEEP.KBB work closely together - from the first planning step to completion of the cavity. They employ state-of-the-art 3D modelling techniques to interpret the geological environment and simulate the development of the cavern.



Like any building, a cavern also requires a sound structural design. To achieve this, we collaborate with independent rockmechanics laboratories and professional surveyors. The results of their laboratory analyses are incorporated into computer simulations that model the optimal production and operation of the cavern. Based on these simulations, an expert opinion is developed providing recommendations for cavern operation.

## CAVERN LEACHING

To begin the leaching process, wells are drilled down to the bottom of the planned cavern, then pipes [casings] are cemented into place. Next, a dual-pipe system - two casing pipelines, one inside the other - is installed. The desired cavern shape is achieved using two different leaching processes [direct and indirect], or a combination of both methods. Leaching dissolves around 1 m<sup>3</sup> of salt per 8 m<sup>3</sup> of water. Insoluble components settle at the cavern floor [cavern sump]. A protective medium [blanket] is injected prior to leaching in order to protect the upper part of the cavern [cavern roof area]. After the two brine strings have been replaced by the gas or product delivery pipeline, the cavern can be filled for the first time and used for storage.



### DIRECT LEACHING

Water is injected through the inner pipe while brine drains via the surrounding ring space. This quickly forms a cavity in the lower part of the cavern.

### INDIRECT LEACHING

Water is injected via the inner ring space, while brine drains through the inner pipe. This high-concentration method quickly forms a cavity in the upper cavern area.