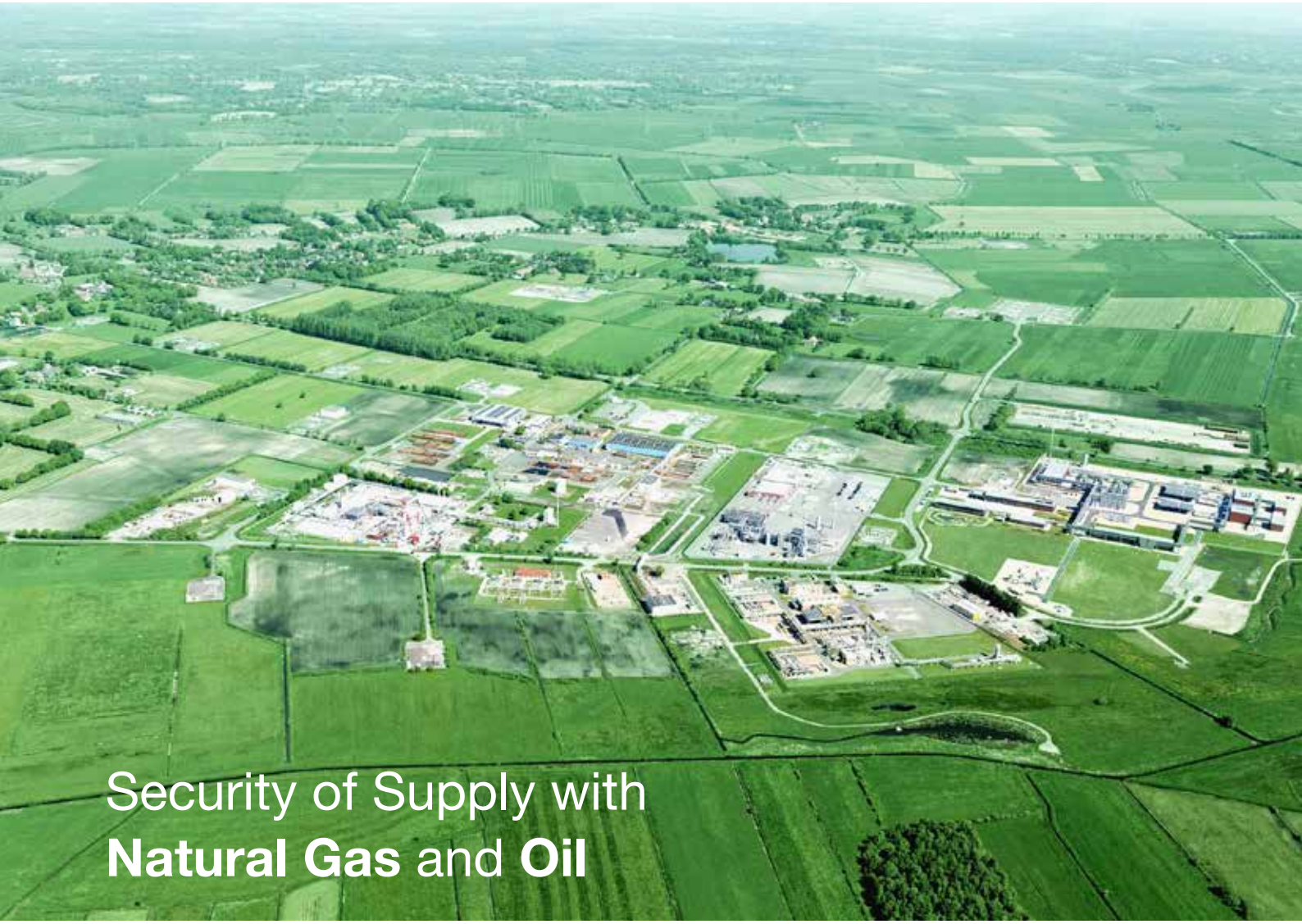
ETZEL
CAVERN STORAGE



Security of Supply with
Natural Gas and **Oil**

Welcome to the Etzel Cavern Storage

Helfried Goetz
Mayor of Friedeburg

Dear readers,

Friedeburg is centrally located in East Frisia, in the region between Ems and Jade, close to the North Sea and the East Frisian Islands. Mother Nature has been generous to the municipality of Friedeburg and has blessed it with forests, heathland, fenland, moorland, marshland, lush green meadows, many hedgerows and natural lakes. Friedeburg is popular for the local population and holidaymakers alike.

Jobs and a solid base of industry and a thriving economy are essential for a peaceful coexistence. Friedeburg is a strong business location. We have many successful businesses in our community – from international companies to sole trader business – forming the base for a healthy social climate.

Underneath the village of Etzel, which belongs to the municipality of Friedeburg, there is a salt dome which was formed more than 250 million years ago. This geological formation has been used since the 1970s to store crude oil and natural gas in underground caverns. STORAG ETZEL is the largest independent cavern storage company in Germany and builds, maintains and leases cavern storage volume. Its customers are major national and international energy companies as well as organisations entitled storing national crude oil reserves for various European countries.

STORAG ETZEL and its partners are important companies in the region. In addition to the jobs provided directly at the cavern site, local and regional companies take advantage of positive business relationships and long-term orders in connection with the energy site of Etzel.

Economic benefits are just one part of the big picture and we must take a holistic view and not lose sight of the people, nature and the environment. The operational expansions at the Etzel cavern site in recent years have had a significant impact on the landscape of our rural region. The respect for nature, sustainable handling and trustful relationships are essential for acceptance among the local people. A fundamental requirement for this are transparency and frank and open dialogue between all those involved.

I look to the future with confidence and hope for continuing good relations with our neighbours.

Kind regards,
Helfried Goetz
Mayor of Friedeburg

Detailed view of a cavern mesh

STORAG ETZEL: More than 45 years of oil and gas storage at Etzel

The Beginnings

Faced with the incipient merger of petroleum-exporting countries to form the OPEC cartel at the beginning of the 1960s, European countries with few own resources became aware of their dependence on oil as a major energy source. In 1970, this development led the German government to approve a plan to establish a federal crude oil reserve ("Bundesrohölreserve") which would provide sufficient supplies for 90 days in the event of a crisis.

STORAG ETZEL, which was a public enterprise under the name IVG at that time, was commissioned in 1971 to build the underground storage facility at Etzel for a capacity of 10 million tonnes of crude oil as a national stockpile and to operate the aboveground facilities on behalf of the Federal Government.

Following privatization in 1993, IVG acquired ownership of the cavern complex in 2005. In 2016, the long-established company was renamed **STORAG E**TZEL and became largely independent.

Saltcaverns in the deep subsurface: Advantages of the Etzel site

In the early 1970s, after a thorough exploration of the underground, the Etzel salt dome with its mushroom-shaped structure was chosen for the project. The local salt dome is about 12 kilometers long and five kilometers wide and extends from a depth of more than 4,000 meters to 750 meters below surface. Hardly anywhere else in Europe are the conditions so favorable for the construction of caverns.

The site was also chosen for its proximity to the North Sea and to the Niedersachsen jetty in Wilhelmshaven which is some 25 kilometres away and where the sea water pumps are installed. Here the water is taken from the sea in order to create the caverns by solution mining the Etzel salt. By this process brine is produced and is transferred back by pipeline into the North Sea. Wilhelmshaven is also the ideal location for the only deep-water port and oil hub of Germany where the crude oil arrives by tank vessels.

The initial plans envisaged 33 caverns with an average diameter of 35 metres and a height of up to 500 metres. The solution mining operation first started in the autumn 1973 after preparatory work on infrastructure, pipelines and pumping stations. Until 1978, the caverns have been filled to a volume of some 8 million m³.

The political decision to establish a strategic oil reserve was confirmed right as already in 1973, when the first oil crisis occurred as a result of a reduction in crude oil supply and a subsequent increase in oil prices. This led to an economic recession and temporary bans from driving on Sundays. The crude oil volumes stored at Etzel are part of Germany´s national reserve that safeguards a continuous supply of energy in case of future political crises or natural disasters in the oil-producing areas.

Increasing importance of natural gas in the energy mix

Since the 1980s, natural gas consumption in Germany has increased enormously, and long-term supply contracts have been concluded between gas producers and German energy suppliers. In order to be able to supply gas for instance in the event of pipeline problems, the Norwegian oil and gas producer Statoil signed a contract in 1992 to lease storage capacity at the Etzel site. Initially, nine existing caverns were converted to gas caverns with a working gas volume of more than 500 million Nm³. In 1993, in addition to the existing crude oil storage site, the Etzel Gas-Lager (EGL) with its surface facilities became operative and was integrated into the North European pipeline network in the following years. As technical service provider **STORAG E**TZEL is responsible for the operation of the EGL.

Between 1994 and 1998, the Etzel cavern storage was enlarged by six new oil caverns as the result that more Western European stockpiling associations entered into long-term lease contracts. A 7th oil storage cavern followed in 2004 – and the total oil

1970s

- Resolution on the set-up of the federal crude oil reserve
- 1971: IVG becomes a trustee for the German government
- Construction of the surface facilities in Etzel and long-distance pipelines to Wilhelmshaven
- Start of drilling operations for 33 oil caverns for long-term storage
- *First oil crisis and Sunday driving ban*
- *Second oil crisis*

1980s

- 1981: Completion of oil filling process with 8.5 million m³
- First oil storage contract with the German national petroleum stockpiling agency (EBV)
- 1986: Contract with Statoil for storage of natural gas in Etzel for the first time to ensure security of supply in Central Europe
- Conversion of oil caverns to gas operation
- *Fall of the Berlin Wall*

1990s

- 1993: Commissioning of the first gas storage facility: The Etzel Gas-Lager; construction of the Emden-Etzel Pipeline and initial filling of eight caverns with gas
- Privatization of IVG
- 1995: Connection of the Etzel Gas-Lager facility to the North Sea pipelines Europipe I and the NETRA supply network
- Other Western European stockpiling agencies enter into lease agreements: Building of additional oil caverns
- Site status 1998: 31 oil caverns, 9 gas caverns (560 million m³ of working gas)
- Discharge and sale of the German federal crude oil reserve followed by a corresponding increase of volume in stock by EBV

2000s

- Acquisition of the Etzel cavern facility from the German government in 2005
- Expansion of the EGL to include 10 conversion caverns (1.3 billion m³ of working gas)
- 2006: Start of planning of further expansion of the cavern site; introduction of the Bunde-Etzel Pipeline
- Demand for gas storage grows sharply due to EU-wide liberalisation of the gas market; development of Etzel from crude oil storage facility to one of the largest gas storage locations
- Launch of the cavern funds

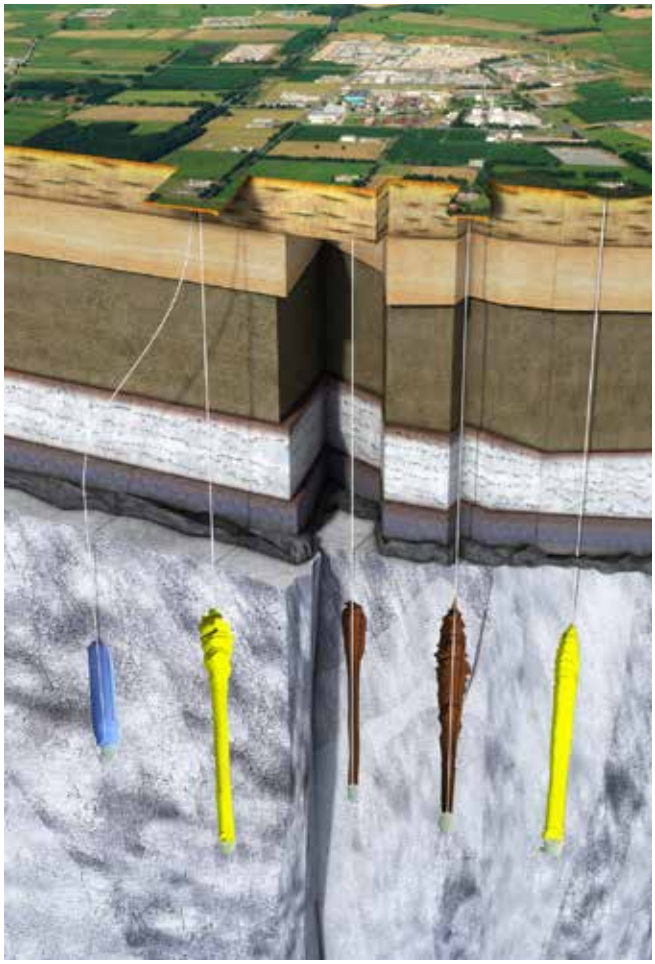
storage capacity reached again the original volume of 10 million m³. For the first time at Etzel these new caverns were developed by deviated wells and drilled from so-called cluster pads. This drilling technique became the standard for the expansion of the gas cavern field from 2007 onwards.

Expansion of the storage facility since 2006

The existing infrastructure and permits as well as the technical expertise on site were favorable factors during the expansion project of the Etzel storage facility that started in 2006. During the following years more than 30 new gas caverns were solution mined and brought into operation in the north field and three new gas surface facilities were built at the same time in the south field. As a result, the cavern facility in the middle of North Germany's energy hub evolved from crude oil storage to one of the major gas storage facilities in the world. In 2017 the 75 caverns provide a geometric storage volume of around 40 million m³ for the secure and environmental friendly storage of large quantities of oil and gas. A total of 99 caverns have been approved at the Etzel site.

Cavern owners

The caverns are owned by two cavern funds which were launched in 2008 and together they form the largest infrastructure funds in Germany. Investors come from the insurance business, pension funds and foundations. **STORAG E**TZEL is



Cutaway model of the Etzel cavern storage system

Infobox – the visitor centre at the storage location

the manager of the caverns as defined in German mining law and is responsible for the operation of the caverns and associated permitting. The company owns the entire infrastructure for the operation of oil storage caverns and caverns under construction.

Cavern tenants

STORAG ETZEL is one of Europe's largest crude oil storage companies with some 11 million m³ of crude oil in 24 caverns for long-term storage. The crude oil is available to stockpiling organizations of various European states in times of energy crisis. On the gas side the owners of the individual surface operational plants and the technical and commercial operators for the 51 gas caverns at the Etzel site are four consortia each comprising notable European gas supply companies.

Energy – supply – security

Today the function of the Etzel cavern storage site is not only to ensure Germany´s security of supply but also to support other EU countries energy demand. Thanks to its favorably location and excellent connection to oil and gas infrastructure it represents a model for European cooperation in actual practice. Underground storage has proven to be an extremely cost-effective, operationally safe, flexible and environmental-friendly way for energy bulk storage. Looking into the future: In addition to storing fossil fuels, like crude oil and natural gas, renewable energy can also be stored in caverns by transforming excess electricity into compressed air, hydrogen (H2) or synthetic natural gas (SNG = methane).

2017

- 10th anniversary of cavern expansion project one year after change of company name to **STORAG E**TZEL and relocation of the company headquarter to Etzel in 2016
- Commissioning of the last of 34 new caverns; expansion for the time being
- About 13,000 visitors to the information center since its official opening; 20th session of the Cavern Advisory Council
- Cavern inventory status 2017: 75 caverns (24 for oil, 51 for gas)

2010s

- Commissioning of three new gas operating facilities (EKB, FSG Crystal, ESE) and the Bunde-Etzel Pipeline in 2011/12; gas held in storage in Etzel by companies from Germany, Western Europe and Russia
- Gradual handover of the first new caverns to the tenants and initial filling with gas; construction of the new administration building
- Oil stockpiling for institutions from Germany, the Netherlands, Portugal and Belgium; over 10 million m³ of oil put into long-term storage
- Opening of the Etzel cavern visitor center and foundation of the Cavern Advisory Council in 2010
- Launch of the program for the long-term safeguarding of the existing pipelines in the southern field
- Complex status in 40th anniversary year 2011: 52 caverns (23 for oil, 29 for gas)
- *Energy turnaround in Germany towards renewable energies*

2020 - 2030

Perspective: Cavern storage of renewable energies in addition to oil and gas; when excessive electricity is transformed into hydrogen and synthetic natural gas using power-to-gas technology, bulk storage of these gases is feasible

Etzel cavern storage:

Aboveground and subsurface systems

Aboveground gas systems

Pipelines, valves, pressure gauges – looking from the outside to the aboveground gas facility appears to be quite complex but it is easy to follow the flow path of the natural through the station.

Putting natural gas in storage

Coming from the pipeline, the natural gas is led through separators to remove grit and tiny particles. Afterwards the quantity and quality of the natural gas are measured – the calorific value is then also known.

Piping systems transport the natural gas to the compressors where the pressure is increased as required. The compressor rating depends on the pressure difference between cavern and pipeline.

The compression causes the natural gas to heat up. This effect can also be observed when inflating a bicycle tyre with an air pump. Before the gas is put into the storage caverns the temperature has to be reduced to about 35°C . This is carried out by airfans in the gas cooling unit.

Once the natural gas has reached the correct temperature, it is routed to the designated cavern wells and stored underground. The pressure in the caverns ranges from about 60 - 200 bar depending on the filling status.

Taking natural gas out of storage

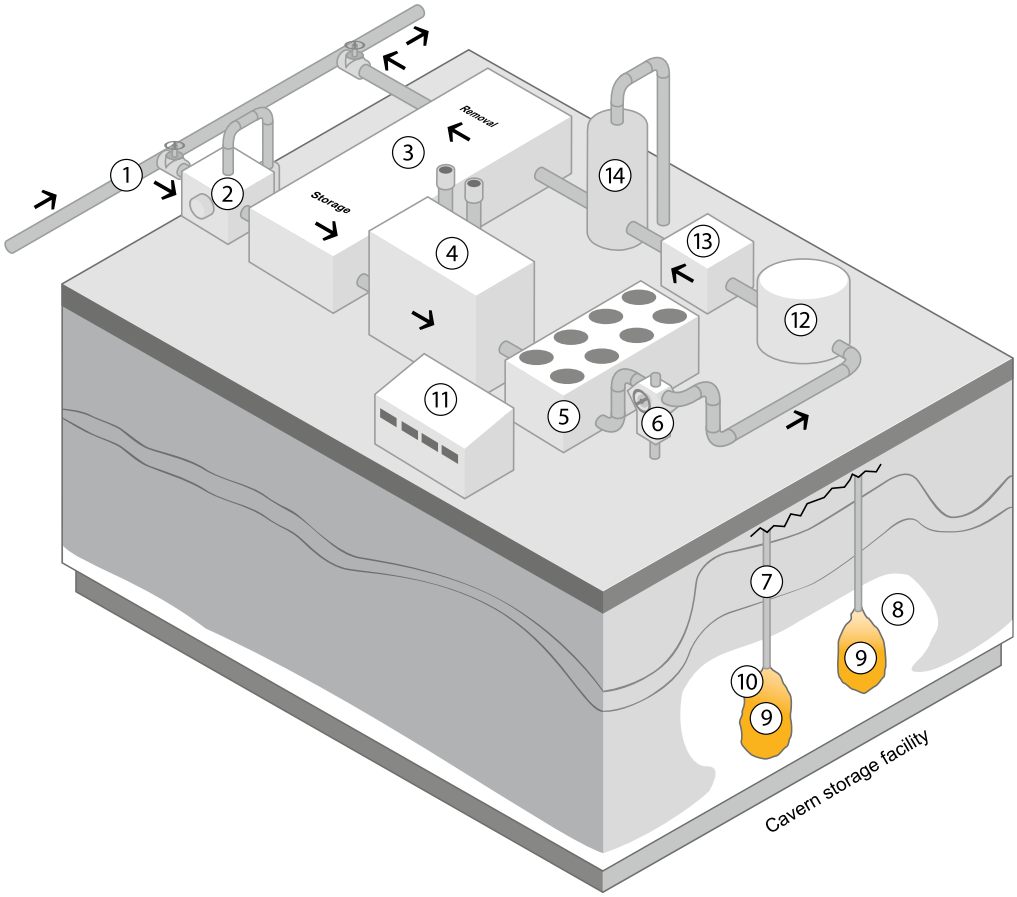
During withdrawal from the cavern the gas becomes cold when it loses pressure. To prevent icing heat is applied to the gas in heat exchangers.

Operational checks at an oil cavern wellhead

Moisture that had been absorbed during storage must be removed from the natural gas. This process takes place in the gas drying unit. Before the natural gas is fed into the pipeline at about 70 bar, the pressure must also be adjusted accordingly.

The natural gas finally passes through the measuring station, where the quality and quantity are measured again. Then the gas enters the large pipeline and is transported to the consumers.

Natural gas storage process



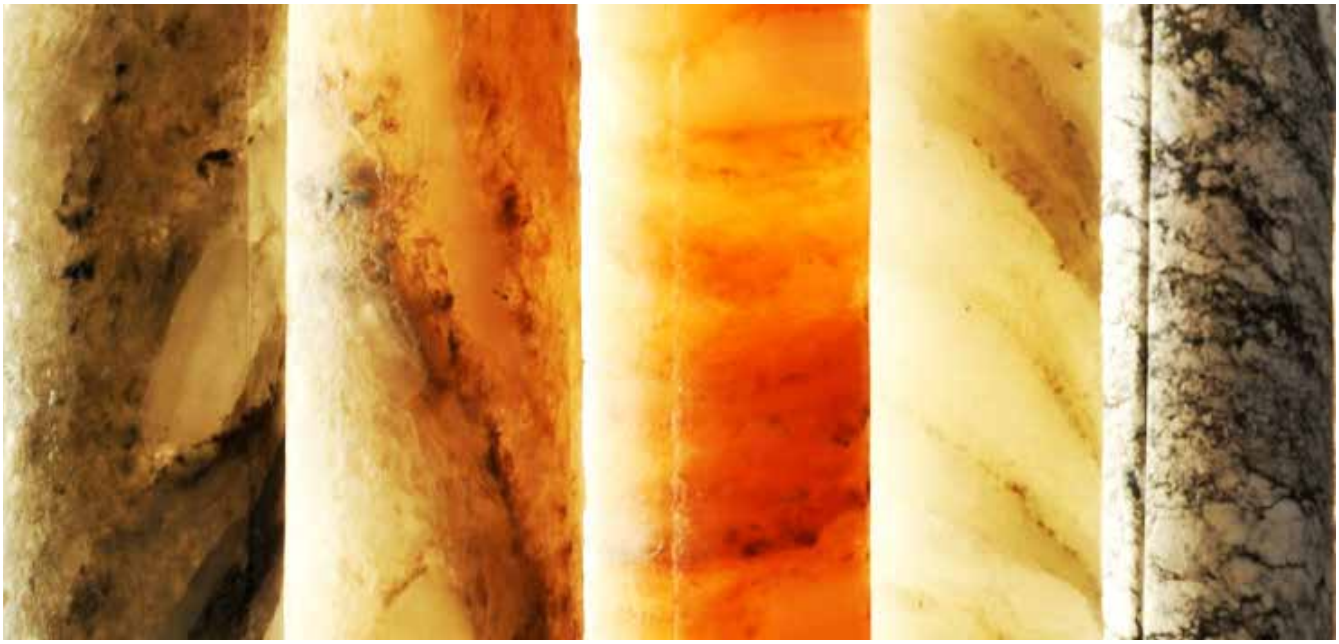
1 Transmission system
2 Filter
3 Measurement facility
4 Compressor
5 Cooler
6 Well head (on each borehole)
7 Borehole
8 Salt deposit
9 Caverns
10 Gas-tight surface layer/cavern wall
11 Control panel
12 Natural gas preheating
13 Pressure reduction
14 Drying

Our commitment:

- Responsibility for the security of people and the protection of the environment
- Guarantee of high level safety standards and application of best available technology
- Communication by supplying broad information and promoting a frank dialogue with our neighborhood
- Continuous improvement of all processes and technical solutions
- Good relationship and trustful cooperation with municipalities, authorities and service providers

The companies at the Etzel storage site

Animated picture of real caverns with boreholes drilled into the salt dome



Core material from the Etzel salt dome

What lies below the marshland and sandy soils of the North German Plain?

The history of the Etzel salt dome dates back around 250 million years when huge layers of salt were deposited and later covered by sediments. Today the salt dome extends from a depth of more than 4,000 metres up to 750 metres below the surface.

Below the most recent geological sediments in the Etzel area, marsh and moraine soils, older sands and clays of the Neogene and Palaeogene periods follow to the depth and finally marls and chalk layers of the Cretaceous period. The caprock, an anhydrite layer on top of the Etzel salt dome, starts from a depth of about 750 metres, and underneaththe huge folded salt rock strata from the Permian age appear.

Principle of Solution Mining

Due to its special chemical and physical properties, salt rock is ideal for cavern construction. Caverns are man-made cavities. The basic principle behind the construction of a cavern is that water is introduced into the salt dome through a borehole. The water dissolves the salt and brine is produced that is transported by a circulation process to the surface by a system of pipes installed in the borehole. The controlled process of solution mining takes often more than two years. Once the cavern has reached its final size, e.g. 500,000 m^3, the cavern well is completed for storage operation. Afterwards the caverns are filled with crude oil or natural gas for stockpiling or interim storage purposes.

Cavern construction

The first construction step in a cavern development project is preparing a cavern wellsite, installing a standpipe and drilling a deep borehole. A drill pipe string cuts through the sediment rock layers above the salt dome until it encounters salt rock at a depth of about 750 meters. The open borehole is then equipped with a set of two steel pipes (casings) which are cemented to the outside to form a stable and tight cavern well.

Drilling continues in the salt down to the planned final depth. After installation of two leaching pipes the drilling rig is dismantled. Subsequently the cavern head is mounted aboveground and the solution mining operation can begin. The Etzel caverns are located at depths range of 800 to 1,800 meters. They are 300 to 500 meters tall and reach up to 70 meters in diameter. The volume of a single cavern can therefore amount up to several 100,000 m^3. Natural gas is stored under pressure, so the available working gas volume can reach a multiple of the geometric volume of the cavern. It is noteworthy that modern directional drilling techniques allow the development of up to seven caverns from a single cluster site, thus helping to minimize land consumption.

Etzel cavern storage

Securing the supply with natural gas and crude oil for over 45 years

Operator of the cavern site:

1 STORAG ETZEL GmbH –
Manager of the caverns as defined in mining law and responsible for the operation of the Etzel cavern complex
Operator: STORAG ETZEL Service GmbH
Start of construction: 1971
Start of operation: 1974
Number of caverns: 75
(24 for crude oil, 51 for natural gas)
Oil storage capacity: 11 million m³
Gas storage capacity (total): > 4.2 billion m³
Development plan: 99 caverns approved in total
www.storag-etzel.de

Operator of the gas caverns:

2 Etzel Gas-Lager GmbH & Co. KG (EGL)
Consortium: Uniper Energy Storage GmbH, Equinor Storage Deutschland GmbH, Total Etzel-Gaslager GmbH
Operator: STORAG ETZEL Service GmbH
Start of construction: 1989
Start of operation: 1993
Extension: 2009-2012
Working gas volume: 1.2 billion m³
Caverns: 19 | **Compressors:** 3
www.uniper.energy/storage | www.equinorstorage.de

3 Etzel-Kavernenbetriebsgesellschaft mbH & Co. KG (EKB)
Consortium: BP Europa SE, Ørsted Speicher E GmbH, Gazprom Germania GmbH
Operator: Etzel-Kavernenbetriebsgesellschaft mbH & Co. KG
Start of construction: 2009
Start of operation: 2012
Working gas volume: 0.9 billion m³
Caverns: 9 | **Compressors:** 3
www.ekb-storage.de

Last revised: June 2018

4 Friedeburger Speicherbetriebsgesellschaft mbH “Crystal”
Consortium: EnBW Etzel Speicher GmbH, EDF Gas Deutschland GmbH
Operator: Friedeburger Speicherbetriebsgesellschaft mbH “Crystal”
Start of construction: 2009 |
Start of operation: 2012
Working gas volume: 0.4 billion m³
Caverns: 4 | **Compressors:** 2
www.enbw.com | www.edf.fr

5 ESE-Erdgasspeicher Etzel
Consortium: Uniper Energy Storage GmbH, OMV Gas Storage Germany GmbH, VNG Gasspeicher GmbH, Gas-Union GmbH
Operator: Uniper Energy Storage GmbH
Start of construction: 2010 |
Start of operation: In stages from 2012 to 2014
Working gas volume: 2 billion m³
Caverns: 19 | **Compressors:** 3
www.uniper.energy/storage

Energy storage in salt formations

Safe underground storage of energy resources

The Etzel Cavern Storage in the East Frisian municipality of Friedeburg (20 kilometers south-west of Wilhelmshaven) is used by four gas storage companies to cover peak consumption times and for interim storage of import deliveries. Also a considerable proportion of Germany's strategic crude oil reserves is safely stored here in the deep underground.

Strategic importance for energy supply

Since the mid 1970s when the caverns were put into operation as a crude oil storage facility Etzel has grown not only to become one of the largest underground storage facilities in Europe, but also an energy hub in northwest of Germany that is well integrated into the strategic pipeline network for oil and gas.

Its favorable geographical postion close to the North Sea and to the oil port at Wilhelmshaven as well as the excellent geological conditions in the Etzel salt dome make the location an unique storage site.

Storage site facts:

- 75 caverns currently in operation
- Cavern volume: 250,000 m³ - 800,000 m³
- Depth of the caverns in salt: 800 – 1,800 metres
- A standard oil cavern (500,000 m³) has the capacity of two supertankers
- The compressed gas from one cavern is capable to supply a town of 80,000 inhabitants for one year
- Around 200 highly qualified jobs are permanently available at the Etzel site
- In addition the operators of the facilities on site are retaining jobs by employing many local and regional companies for maintenance and service work.
- The site is connected to four national gas pipelines
- Investment volume of all companies since 2006 comprise an amount of some two billion euro
- Millions have been paid in local business tax for years for the cavern storage operations. Much of this is allocated to the county of Wittmund and to the state of Lower Saxony and thus benefits the local community

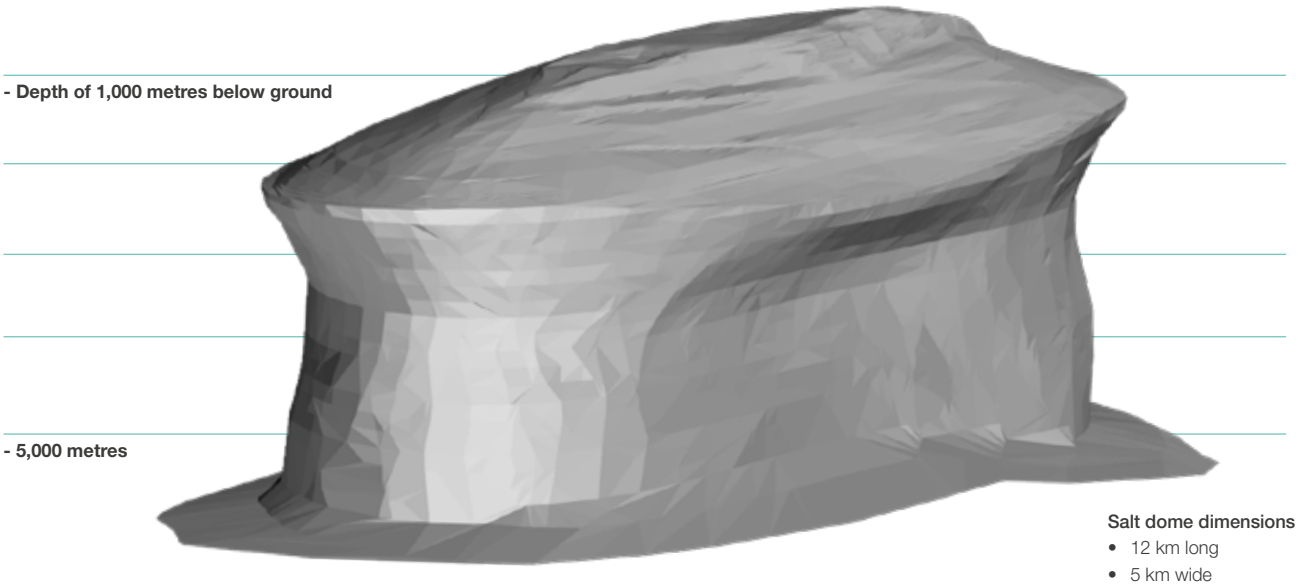
The origin of the **salt**

Salt, or rock salt as it is called by mineralogists, occurs naturally as sedimentary rock. It has formed throughout the world as salty seas have dried up, leaving very thick deposits in some cases. It is also known in professional circles as halite (Greek: Halo for salt and lithos for stone). The chemical formula is NaCl for sodium chloride. Slight quantities of other salts or other minerals determine the appearance and color of the salt. It is found in Central Europe in key historical places like Lüneburg and the Salzkammergut region in Austria.

The largest deposits in Germany are located in the north, in the area between the rivers Oder and the Ems. These salt deposits were formed about 250 million years ago in the Permian geological era. The pressure exerted by the younger sediment layers on top caused the underlying salt deposits to creep and push upwards, forming salt domes in some cases like at Etzel. The total volume of these rock salt deposits in northern Germany is estimated to be more than 90,000 km³. This would correspond to a huge cube with an edge length of about 45 kilometers.

Rock salt is a sedimentary rock – it has a crystalline structure and unique properties for energy storage

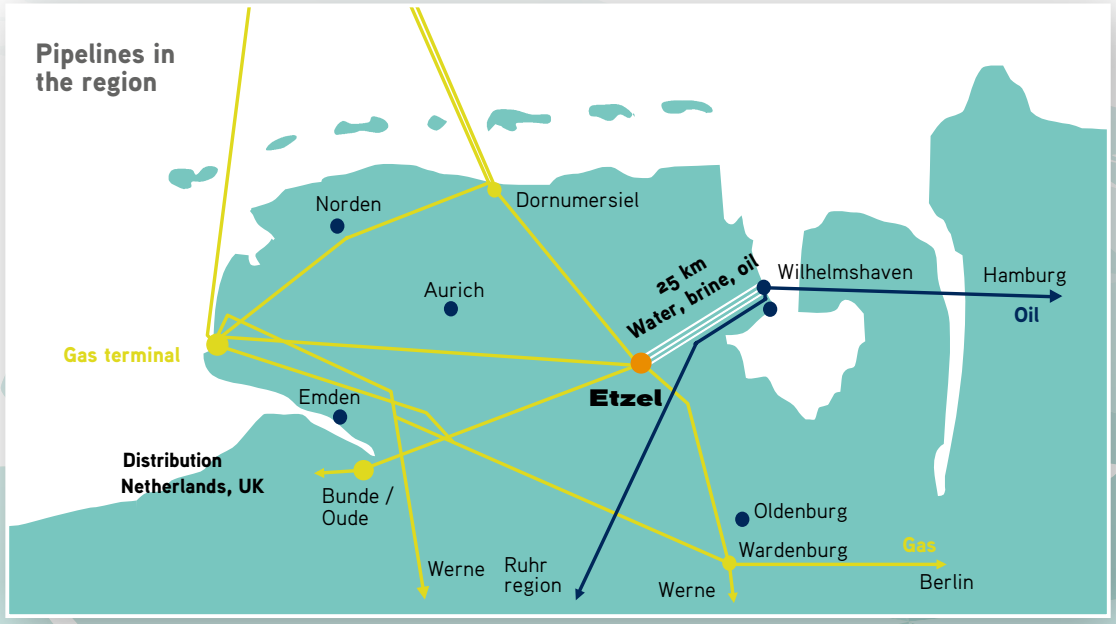
Three-dimensional model of the Etzel salt dome



Salt dome dimensions (approx.):

- 12 km long
- 5 km wide
- 4 km high

Energy supply logistics in the north-west



Hamburg

Bremen

THE ETZEL GAS-LAGER

There is a tradition of natural gas storage in Etzel. The Etzel Gas-Lager is making a reliable contribution to the security of supply for more than 25 years.

Natural gas has been arriving in East Frisia from Norway since 1977. After further reserves of gas were discovered in places like the Troll field, there were plans to increase supplies to Germany. In the mid-1980s, a group of Norwegian energy companies set out in search of a suitable storage facility for natural gas and found what they were looking for in the Etzel salt dome. Having been used as a strategic oil reservoir for many years, it was classified as particularly suitable from a geological and geographical point of view. As a result, it was the chosen location for a cavern storage facility for natural gas, the Etzel gas storage facility.

Between 1989 and 1991, nine oil caverns were converted into gas storage installations. At the same time, the operating equipment for the Etzel Gas-Lager was built. In 1993, the Etzel Gas-Lager began operation with an available working gas volume of around 500 million m^3. The patron of the opening ceremony was the then Prime Minister of Lower Saxony, Gerhard Schröder, who went on to become Federal Chancellor. Since the early days, STORAG ETZEL Service GmbH as it is today has been managing operations at the Etzel Gas-Lager.

When operations started, the originally purely Norwegian consortium opened up to admit the German supply partner Ruhrgas AG, today Uniper Energy Storage GmbH.

The extension

The capacity of the complex was expanded as of 2006. The use of the latest technology, especially regarding to the additional compressor, and the increase in storage and working gas capacities were core objectives during the three-year construction period from 2009 to 2011. Since the expansion, the Etzel Gas-Lager utilises 19 caverns in total. The working gas capacity has been increased to over 1.2 billion m³. This corresponds roughly to the annual consumption of more than half a million detached houses.

Construction of a new gas adsorption plant

Changes in the gas markets led to higher quality requirements for the natural gas stored in the Etzel Gas-Lager. An adsorption plant was built. The plant went into operation in December 2014 after just two years of planning and construction. With six vessels standing over 13 metres high, the adsorption plant is quite literally a prominent part of the Etzel Gas-Lager.

Operation

As a general rule, natural gas is put into storage as summer approaches and taken out of storage again in winter. But the Etzel Gas-Lager can also cover spikes in demand at short notice or absorb short-term supply shortages at any time, e.g. due to unscheduled maintenance of natural gas fields in the North Sea, cold spells or gas trading activities. Users communicate their intention to use the storage facility, sending nomination requests electronically for hours or whole days. The systems can be taken from zero to full power within one hour. Safe plant operation around the clock, 365 days a year, is guaranteed by the STORAG ETZEL Service GmbH team.

Inward transfer, storage and outward transfer

The natural gas is compressed on arrival and routed to the caverns through the ring-shaped field pipeline system. The caverns can be controlled individually or in interconnected groups. Therefore, the Etzel Gas-Lager can be filled completely within three months.

When the gas is taken back out of storage, it is routed from the caverns and transported through the field pipeline system to the Etzel Gas-Lager. It is cleaned and dried in the adsorption plant. After measurement, the gas is fed into the pipeline system. When pressure levels in the caverns are relatively low, the gas must be removed with the help of the compressors.

The facility provides enough capacity to supply over one million detached houses for up to forty cold winter days. The Etzel Gas Lager therefore plays a significant part in guaranteeing a secure and reliable supply of gas for Germany and the whole of Europe.

Facts & figures:

Owners of Etzel Gas-Lager

Uniper Energy Storage GmbH:	~ 75 %
Equinor Storage Deutschland GmbH:	~ 24 %
TOTAL Etzel Gaslager GmbH:	~ 1%

Facility

Compressors:	3
Pressure up to:	190 bar
Caverns:	19
Working gas volume:	1.2 billion m³
Field piping:	7.3 km

	Injection	Withdrawal
Flow rate	0.74 million m³/h	1.32 million m³/h
Equivalent	8.5 GW	15 GW

Withdrawal string and main pipe rack

EKB Storage: Innovative, reliable, transparent

Flexible storage services for a secure energy supply – for today and for the future.

The Etzel-Kavernenbetriebsgesellschaft (EKB Storage) operates one of the most efficient commercial storage facilities in Germany with its above-ground facility and nine caverns. It is an important intermediary between producers, transporters and customers.

The plant essentially consists of one gas injection (compression) and one gas withdrawal (decompression). Thus, EKB offers its customers transparent and flexible storage capacities and products as well as state-of-the-art and energy-efficient technology in order to be able to react quickly to current market conditions.

The task of EKB Storage is to provide its customers with storage volume and the associated injection and withdrawal capacity. With a total storage volume of 950 million m^3 per hour it is possible to inject approx. 450,000 m^3 and to withdraw approx. 800,000 m^3 of natural gas. The used technology also enables customers to react at very short notice to changes in the increasingly fast-moving market enviroment.

From the beginning of the project in 2009 EKB Storage has also been concerned to create and retain jobs in the region. At present, EKB Storage employs 13 staff members who are supported by highly qualified specialists from external companies. “A long-term and sustainable commitment in the region is very important to us," says Christian Rohde, Managing Director of EKB Storage.

Compressor unit with main pipe rack in the background

Gas cavern well head

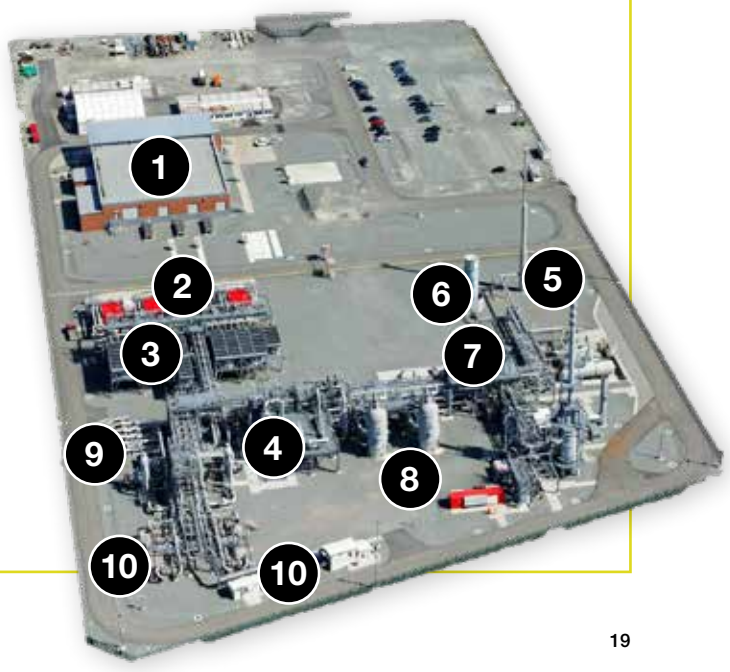
This also includes the protection of the environment and nature. “We are conscious of our responsibility and work with the highest possible safety standards,” he continues.

“Every year, our quality objectives for process optimization, occupational safety and customer satisfaction are reviewed and, if necessary, further improved. This also includes regular auditing which is recorded in the quality management system."

There are also many remarkable technological advances in the field of renewable energy sources. “We follow them with great interest and are open to our potential future involvement as a storage service provider,” adds Christian Rohde.

The above-ground facilty consists of the following buildings and technical equipment:

1. Operating building
2. Compressor
3. Gas cooler
4. Gas preheating unit
5. Ground flare
6. Cold blowdown system
7. Regeneration unit (gas drying)
8. Adsorber (gas drying)
9. Station entrance (pipeline connection)
10. Gas quantity and quality measurement



The gas coolers at the ESE-Erdgasspeicher Etzel natural gas storage facility

ESE-Erdgasspeicher Etzel

We **safeguard the future**

With a working gas volume of around two billion m³ and a total of 19 connected caverns, the ESE-Erdgasspeicher Etzel natural gas storage facility is one of the largest storage installations in Germany and makes a major contribution to the security of supply.

The storage facility is extremely powerful and natural gas can be injected and withdrawn very quickly and flexibly. In concrete terms, this means that up to three million standard cubic metres of natural gas can be moved within one hour. This makes it an important part of the gas industry infrastructure, allowing an immediate response to be taken to peaks in demand in particular (e.g. in the event of cold spells or temporary supply restrictions on gas from far-off production sources).

The storage facility is also ideally connected to the European natural gas system. On the one hand, through the North German Natural Gas Transversal (NETRA) long-distance gas pipeline, which supplies natural gas on the north-eastern axis, and through the Bunde-Etzel Pipeline (BEP) on the other hand, which integrates the storage volume of the Etzel site into the European gas network.

Storage of natural gas is also playing an increasingly important role in view of the energy transition because, in conjunction with highly efficient gas power stations, storage facilities form a perfect symbiosis with renewable sources of energy.

The ESE-Erdgasspeicher Etzel natural gas storage facility is owned by a consortium comprising Uniper Energy Storage, OMV Gas Storage Germany, VNG Gasspeicher and Gas-Union Storage and has been operated by Uniper Energy Storage since 2012 on behalf of the consortium.

Uniper Energy Storage GmbH

Uniper Energy Storage combines decades of experience with the full breadth of expertise accumulated in the storage of gas within the Uniper Group throughout Europe. The company operates natural gas storage facilities in Germany, Austria and Great Britain, thereby playing a key part in ensuring a secure and flexible gas supply. Storage capacity for around 8.2 billion m³ of working gas is at the disposal of the customers. This makes the company one of the biggest operators of storage facilities in Germany and Europe.

View of gas cooler, pressure reduction unit, drying unit and boiler house

As a participant in the process of shaping the future of power supply, Uniper Energy Storage is also developing energy storage solutions. With Power-to-Gas plants which produce green hydrogen and synthetic natural gas (SNG) using renewable electricity and feed it, inter alia, into the natural gas grid, Uniper is a pioneer in this technology.

OMV Aktiengesellschaft

Based in Vienna, OMV produces and markets oil and gas, innovative energy solutions and high-quality petrochemical products – in a responsible way. In its downstream operations, which are subdivided into downstream oil and downstream gas, OMV operates a gas pipeline network in Austria and has gas storage facilities with a capacity of 2.7 billion m³ (30 terawatt hours). The Central European Gas Hub (CEGH) has established itself as an important gas trading platform on the gas corridors from east to

west and also operates a gas exchange. The natural gas hub in Baumgarten (Austria) is the largest junction for gas from Russia in Central Europe.

VNG Gasspeicher GmbH

VNG Gasspeicher is a wholly-owned subsidiary of Leipzig-based VNG AG. As the third largest storage operator in Germany, the company provides a total capacity of around 2.4 billion m^3 in storage facilities at several locations, particulary in eastern Germany. The geographical location and grid connection of the underground gas storage facilities provide access to major European trading markets. VNG Gasspeicher stands for innovative products and individual product combinations which are consistently oriented to the market with flexibility and reliability.

Gas-Union Storage

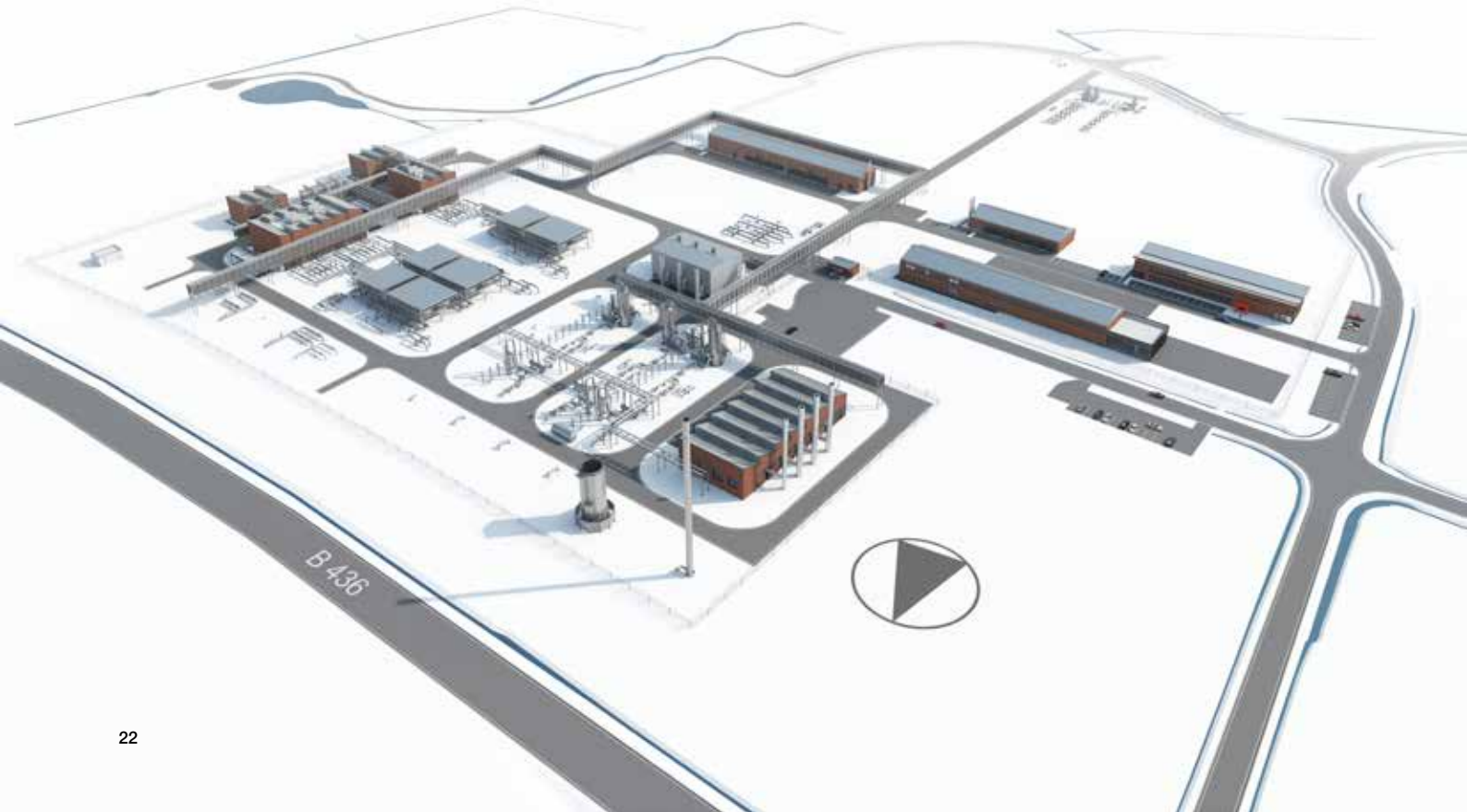
Gas-Union Storage was founded in 2012 as a wholly-owned subsidiary of Gas-Union. It manages the natural gas storage facility in Reckrod (Hessen) and the co-ownership shares of Gas-Union in the ESE-Erdgasspeicher Etzel natural gas storage facility. The company has storage capacities with a working gas volume of around three terawatt hours in total. This amount of natural gas can heat around 300,000 homes for one year. Gas-Union Storage therefore makes an important to a secure and flexible natural gas supply in Germany.

Public relations

We feel very strongly about good community relations and we actively seek open dialogue with you. We have a voice on the Cavern Advisory Council, for example, in order to foster communications between citizens, politicians, interest groups, storage facility operators and cavern operators. We are also committed to a socially-minded approach in the region.

If you are interested or have any questions, please do not hesitate to contact us directly at our email address:
ust.info@uniper.energy

Further information can be found here on the Internet:
http://www.uniper.energy/storage
http://www.omv.com
http://www.vng-gasspeicher.de
https://www.gas-union-storage.de



ESE-Erdgasspeicher Etzel

"As a control room operator, I am responsible for the control and monitoring of the entire system. We want to provide a high level of availability for our customers and we also aim for safe, green and energy-saving operation of the storage facility. In order to achieve these goals, we need to work in close cooperation with our colleagues from the trades and disciplines. We also work with local companies which have known our plant for many years and provide us with valuable support in pipeline construction and underground engineering, for example, or in measurement and control technology. I like working at the ESE-Erdgasspeicher Etzel natural gas storage facility. We are a completely new and young team and have already been closely involved in the construction phase. It is exciting and fascinating to see the development of such a complex plant, to work together to sort out teething troubles, and to make sure everything runs perfectly and safely. It helps people to forge bonds and pull together like a family."

Matthias Grimminger,
Control room operator, Uniper Energy Storage GmbH

Over 600,000 detached houses could be supplied by the ESE-Erdgasspeicher Etzel natural gas storage facility for one year.

Environmental protection and noise control

- Use of especially quiet cooling technology with low speeds
- Emissions minimized by state-of-the-art installation engineering and noise reduction measures
- Use of the best available technology for heat generation in the gas preheating unit
- Considerable reduction of local emissions through the use of electric drives for the storage compressors

“Crystal”: Modern, efficient and flexible

Friedeburger Speicherbetriebsgesellschaft mbH “Crystal” is a storage company belonging to EnBW Energie Baden-Württemberg AG and Eléctricité de France S.A. It is named “Crystal” after the (salt) crystals which surround the storage caverns.

Crystal operates an aboveground facility at the Etzel site which is connected to four caverns on the one side and to the European gas network on the other. The four caverns are used to store natural gas and release it to the gas network as and when required. We have up to 400 million standard cubic metres of natural gas in storage for our customers. This is enough to supply around 280,000 households with natural gas for one year. If there is a bottleneck in the market, we can provide our customers with natural gas within 30 minutes. We can transfer a maximum of 700,000 standard cubic metres per hour from our caverns to the gas network for several days. This quantity can supply around one million households at the same time. The safe operation of the facility around the clock on 365 days a year is guaranteed by a team of 15 experts.

Efficient energy consumption and plant operation in harmony with the environment are important to us and are therefore enshrined in our company objectives. This is why we are certified as conforming to DIN ISO 14001 for environmental management and DIN ISO 50001 for energy management.

Natural gas, a strong energy source

Natural gas is a mixture of gas that mainly consists of methane as well nitrogen, a small proportion of other hydrocarbons and traces of helium. The natural gas which is used today originated deep below the surface of the earth many millions of years ago.

Natural gas is very rich in energy and hence is a very efficient source of energy that is gaining prominence in the German energy mix from year to year. Domestic gas production accounts for just a small percentage of the annual consumption of the Federal Republic of Germany. Therefore, currently more than 90% of the natural gas is being imported from countries like Russia, Norway and the Netherlands. Demand is expected to remain at a high level in the long term. In Germany, natural gas is primarily used for heating and power generation. Hereby, consumption can vary greatly depending on the outside temperature. Natural gas storage facilities are needed to even out these fluctuations in demand which are mainly seasonal in nature. Sufficient storage capacity is furthermore essential for security of supply. In the liberalized and increasingly liquid natural gas markets, storage facilities are also a prerequisite for effective competition where the focus is on the short-term use of storage capacities for trading activities of gas traders and utility companies.

The aim of the storage operators is to provide the German population with a stable and secure supply of energy. In those months when demand is lower, the volumes of natural gas that are not required are stored. When demand increases – in the winter months, for example – gas storages can release these reserves again to avoid bottlenecks. The storage operators therefore contribute to long-term security of supply for Germany.

Burner flame on a gas stove

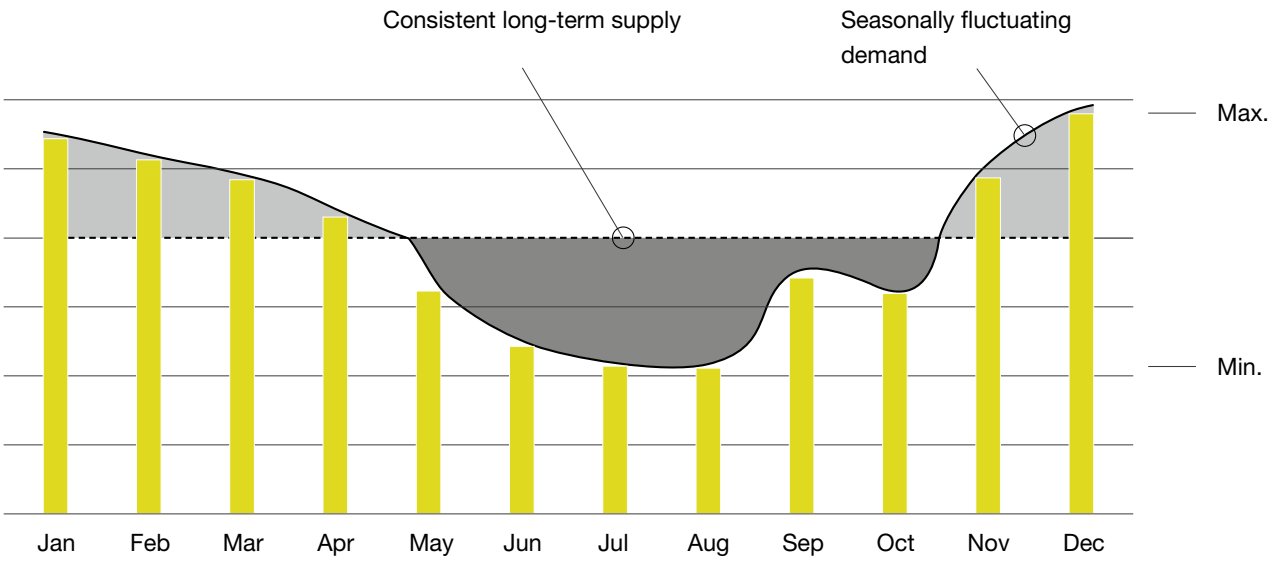
Natural gas is the cleanest of the fossil fuels. The ease of availability of natural gas is another factor which is allowing gas to expand on its key position in an energy market which is increasingly low carbon intensive. With the use of modern, efficient technologies based on natural gas, most of the German CO2 reduction targets can be achieved quickly in ways which are cost-effective and socially acceptable.

Natural gas is also playing an important role in the process of the German energy transition. On days when the renewable generation like wind or solar is not available, gas power plants can quickly be put into operation as the perfect complement to wind power and solar energy. Natural gas therefore facilitates the integration of renewable sources of energy into our energy system. Today, natural gas and natural gas storage facilities are already playing a major part in the economical and secure supply process but they will also make a significant contribution to a sustainable energy industry in the foreseeable future.

Natural gas heating

Refueling of a natural gas vehicle

Natural gas storage strengthens supply security



Use of stored natural gas for energy supply

Storage of surplus capacities

Gas sales

Bars: sale / consumption of natural gas

Dotted line: supply / purchase of natural gas

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Zukunft ERDGAS e.V.

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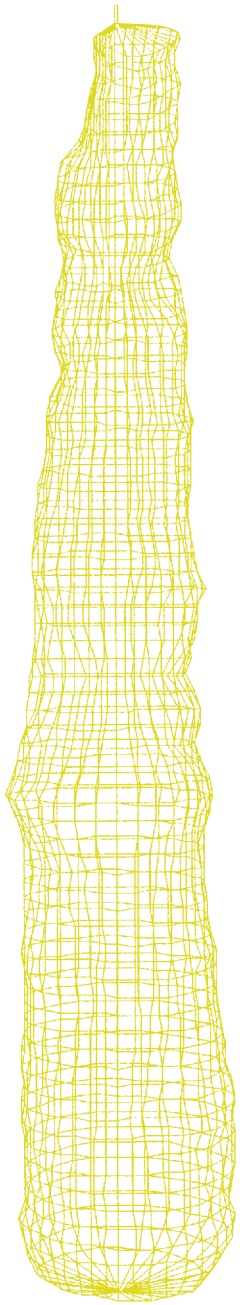

For further information please visit:
www.kavernenspeicher-etzel.de

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