Operation Squirrel

Even in times of emergency, countries must be able to ensure energy supplies for a specified period of time. In northern Germany, **OIL AND GAS** are stored in man-made salt caverns created deep underground.

According to the Roman historian Tacitus, Frisians don't sing – *Frisia non cantat*. Whatever truth there may be in his words, the black-and-white cows here definitely moo. Just beneath the lush pasture where some of them are peacefully grazing are a few layers of peat, followed by around 700 meters of the best halite – or rock salt, as it's commonly known. Hans Joachim Schweinsberg picks up an inch-thick section of a drill core. Ten centimeters in diameter, it weighs 406 grams. "This salt was precipitated from the sea that covered what is now the North German Plain about 240 million years ago," he explains. Schweinsberg – a geologist by profession – works for IVG Caverns where he is director of the Etzel Cavern Information Center. Drill cores like this show whether the rock is suitable for the company's purposes, which is to create large caverns for storing oil and natural gas.

PHOTOGRAPHY: NILS SCHIFFHAUER

Oil and gas are stored beneath the lush green pastureland of East Frisia.

Caverns – prize pieces of real estate

Here in the municipality of Friedeburg, the nearest big town is Wilhelmshaven where the new JadeWeserPort – Germany's only deepwater container harbor that doesn't depend on the tide – will soon be helping to offset a period of industrial decline and cutbacks in the German navy. IVG Caverns is already making a big contribution to this process of economic regeneration. In fact, around half of the company's annual investment of 100 million euros remains within a radius of 70 kilometers. At peak times this generates more than 1,000 limited contract jobs in the area and according to Manfred Wohlers, Managing Director of the Etzel cavern facility, at least 200 will become permanent if there is further expansion.

As Wohlers explains, the cavern facility is a prize asset in the portfolio of IVG Immobilien AG. One of Europe's major real estate companies, IVG Immobilien manages assets valued at over 22 billion euros, including several office properties with a total market value of 4.3 billion euros. The system of caverns extends beneath the fields of Etzel. Each is best compared to a carrot suspended vertically at a depth starting at 1,000 meters and ending at somewhere between 1,400 and 1,700 meters. This unusual piece of real estate provides up to 650,000 cubic meters of space for storing oil or natural gas, the latter pressurized at up to 200 bars. Deposited in the 52 caverns – up to 144 are planned in all – is a large share of Germany's energy reserves. These were first accumulated in the mid-1960s. In 1950 coal and lignite from domestic production still met around 88 percent of Germany's energy needs. By 1966, oil already accounted for almost 46 percent of the country's energy supplies, following economic growth and a rapid expansion of motorized transport. Only 10 percent of this was produced at home with almost 70 percent coming from OPEC. Back then the world was in the grip of the Cold War and memo-

Safety first: Bernhard Hamphoff from Dräger measures a pipe flange to ensure there are no gas leaks.

ries of the Berlin Blockade of 1948-1949 were still painfully fresh. While the city was kept supplied with food and fuel for almost a year during the blockade, thanks to an airlift involving 200,000 flights, that would have been impossible for the whole country. The outbreak of the Korean War in 1950 showed how vulnerable the global flow of financial resources and raw materials were to the geopolitical forces. By 1964 the Americans had entered Vietnam.

For the German government, which at the time had already launched "Operation Squirrel" in 1961, urging households to stock emergency supplies was a clear indication of the necessity to build up the country's strategic petroleum reserves (SPR). Mandatory stockpiling was implemented in 1966, a measure that prompted discussion throughout >

The leases for these unusual pieces of real estate run for at least 30 years

> Europe. As the degree of oil dependency increased, so too has the length of time that national reserves must be able to last. In Germany this has risen from 45 days to 90 days, but in actual practice the time period is now the equivalent of 145 days. South Korea holds the world's largest SPR, enough to cover 185 days.

Safely stored deep underground

Such crucial reserves require safe storage. Above-ground facilities, in addition to being vulnerable to attack, also occupy a large area and are comparatively expensive. In 1970 the German government commissioned the Bonn-based company Industrieverwaltungsgesellschaft (IVG), which then was still state-owned, to provide storage for 10 million barrels of petroleum at a single location. Etzel was selected for its combination of favorable conditions. It sits above a salt dome ideally suited for creating caverns and it is close to not only the deepwater harbor of Wilhelmshaven where oil tankers dock but also to the North Sea which provides the seawater required to flush out the caverns from the rock salt.

When test drilling is completed, the main borehole is sunk through cap rock and at least 200 meters of salt. Two concentric pipes, one inside the other, are sunk into this hole: The so-called production string, 9 5/8 inches in diameter, pumps in seawater and a 7-inch pipe inserted inside is used to discharge the brine. A process known as Solution Mining is used to form the cavern. Water from the North Sea, with a salt content of around 30 grams per liter, is flushed into the hole at a pressure of between 30 and 60 bars where it dissolves up to 300 grams of rock salt per liter. Sixteen pumps at the main pumping station supply as many as 6,000 cubic meters of seawater an hour for this purpose. The resulting brine is then cleaned and pumped back along a 1.1-meter diameter pipeline to Wilhelmshaven, 25 kilometers away, where it discharges into the North Sea from the Niedersachsenbrücke pier.

To flush out a cavern, around eight times its volume in seawater is needed. "And around three and a half years, plus capital expenditure of between 15 and 20 million euros," adds Wohlers. Drilling only begins when the company has a customer for a new cavern. Leases with the energy companies run for 30 years and can be extended. The utilities are responsible for construction and operation of the above-ground gas compression plant, while the caverns are the responsibility of IVG Caverns, in line with German mining law. To create the caverns, a number of directional drillings are undertaken from a central location. For reasons of stability, salt caverns must be separated by a distance of around 300 meters.

Prepared for future shifts in energy policy

The salt dome beneath Etzel is ideal for a range of uses. Salt caverns provide hermetically sealed storage for not only oil but also gas, which is stored in the same type of cavern at a pressure of up to 200 bars. Maintenance and repair needs are monitored by means of sophisticated measuring systems (see the box) – to prevent a potentially catastrophic buildup of explosive gases. The gas caverns are operated at a pressure of at least 60 to 80 bars. This, as Schweinsberg explains, "prevents the caverns from slowly closing up – what we call convergence."

The caverns are subject to enormous geomechanical forces and even at a depth of 1,500 meters the temperature is already 55 °C. Under these conditions salt becomes plastic and starts to flow, although very slowly. Does this convergence have any effects at the surface? "In principle, yes," says Schweinsberg, "and we monitor it very closely." In practice, the ground at the imaginary center of the cavern system has sunk by all of 26 centi-

Gas safety from day one

From the earliest days of IVG Caverns, mobile and stationary gas detection systems from Dräger have protected employees and the surrounding area. Today's mobile systems largely feature devices from the x-am 3000, 5000, and 7000 series, whereas the stationary gas detection systems – e.g., for gas venting – employ, for example, open-path systems and Polytron measuring heads.

meters over the last 35 years. At the edges however, this is just a couple of centimeters or even millimeters which is well short of what would become noticeable on buildings or lead to the subsidence familiar to people who live in areas where there is or has been coal mining. And are there other consequences? "We communicate very openly with the general public," says Press Officer Armin Garbe, as he prepares to meet a group of women from the area who have cycled over to the information center. No questions are off limits. According to Garbe, all the restrictions on noise and light emissions are adhered to and the seawater pumped back into the North Sea has substantially less than the maximum allowed concentration of pollutants.

What's more, the operation creates jobs with a future. What began as a storage site for the nation's petroleum reserves – almost one third of Germany's SPR is still held here – is now getting a further boost from the gas industry. "And we're not worried about the future," says Wohlers, because energy policy shifts won't make the caverns obsolete. As he explains, potential uses include energy storage in the form of pressurized air. Even more tempting for Wohlers is the prospect of synthesizing methane from hydrogen and CO_2. "The whole infrastructure, right up to the consumer, could then more or less stay as it is." **Nils Schiffhauer**

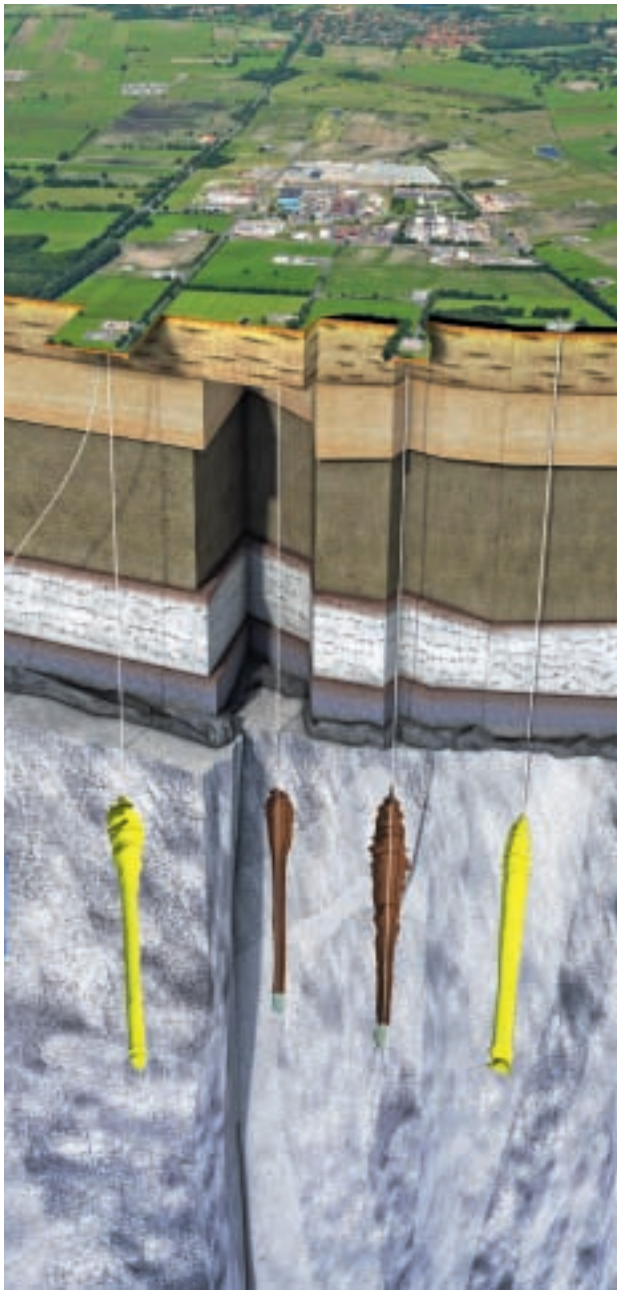
Further information online, including:
Product information
www.draeger.com/103/gas

Piping is the only sign of the cavern many meters underground.

Pipes, valves, and pressure gauges hold the gas in check.

The caverns are created using drill strings of pipes bolted together.

PHOTOGRAPHY: NILS SCHIFFHAUER (2), IVG CAVERNS (2)



A look down below: A cross-section image depicting oil and gas caverns in Etzel, East Frisia, Germany.