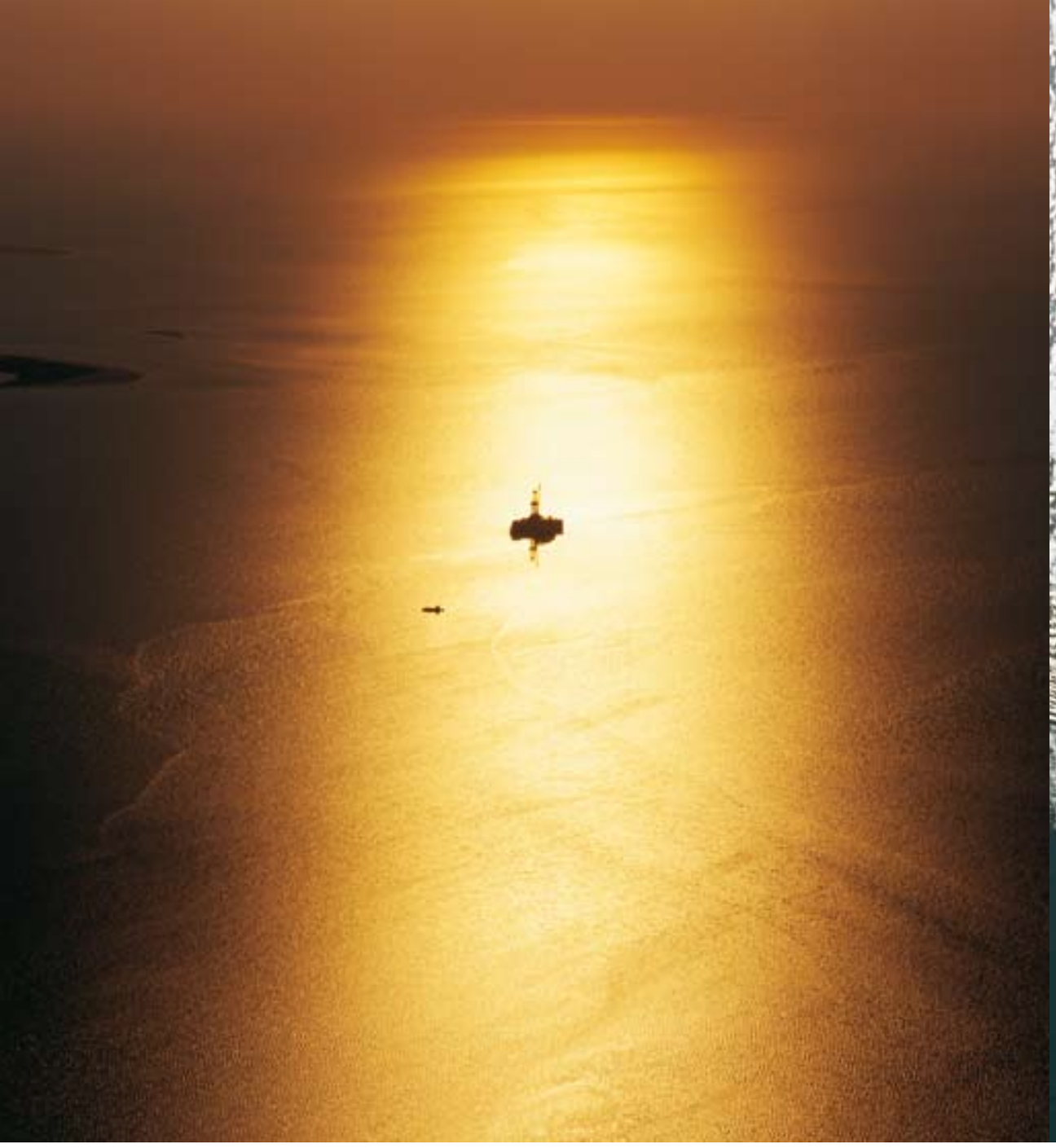

RWE

Operator: RWE Dea AG (50 %)

wintershall
BASF Group

Partner: Wintershall Holding AG (50 %)

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## Efficient and environmentally compatible

# Oil production in the Wattenmeer tidelands

Crude oil production
Mittelplate

# Over 21 years' incident-free crude oil production from Germany's richest oil field

*Top: Aerial view of the Mittelplate oil production facilities. In the foreground, the Dieksand Land Station with the crude oil treatment plant. The Mittelplate Drilling and Production Island sits seven kilometres off the coast of Friedrichskoog Spitze.*

*Right: The satellite image shows the production area as seen from a height of 850 kilometres.*

Leading-edge technology in the exploration and production of oil, expertise ranked with the best in the world, and the work of experienced, responsible specialists are the prerequisites for the environmentally-compatible, safe production of crude oil from the Mittelplate reservoir located off the west coast of the German state of Schleswig-Holstein.

By early 2009, RWE Dea AG as operator and its partner Wintershall Holding AG – each with a 50-per cent stake – had produced around 22 million tons of crude from the oil deposit. The reservoir holds a further 30 million tons of crude in technically and commercially recoverable reserves. There may be potential for additional resources to be developed in other parts of the oil field.

As the remaining oil deposits in Germany are now largely depleted, the Mittelplate field has not only become Germany's most productive oil field, but with just under 65 per cent of the national crude oil reserves, it is one of the few proven deposits with a viable future.

The rapid development of geophysical methods and drilling technology in recent years has opened up new horizons for efficient drilling and production technologies, making it possible for oil production to be continually optimised.

Crude oil production is carried out using a combination of offshore and onshore installations – that is, crude is extracted both from the sea surface and from the mainland.

While the western sections of the deposit have been developed from the Mittelplate Drilling and Production Island located seven kilometres offshore since production started in 1987, the land-based production, under way since mid-2000, is by means of high-tech, extreme extended-reach production wells. These wells, some of which extend over more than nine kilometres, extract crude from the eastern section of the field. All activities have been carried out without incident in the 21 years since production started. The drilling, production and transportation concept, which is constantly adapted to incorporate numerous innovations, has proven itself time and again. A major proportion of capital spending to date – some 700 million euros – has gone towards implementing safety measures of an extremely high standard.


## Oil production in the National Park

Mittelplate Island is located in a protected area designated as the Wattenmeer Tidelands National Park, in the southern part of the Wattenmeer tidal flats in the German state of Schleswig–Holstein. The facility is inside the Protection Zone 2, where certain types of uses of the tidelands are permitted. The extraction of oil is permitted under the National Park legislation.

The legislation specifies the types of measures and uses that are allowed, and it also provides for exceptional permits and exemptions. These include the drilling for, and extraction of oil, but these measures are restricted to the approved Mittelplate Drilling and Production Island and must be coordinated with the National Park Authority.

# Safe drilling and production technology facilitates exploitation of domestic resources


*Top: The Drilling and Production Island, viewed from the west.*

*Bottom: The T-150, which cost about 50 million euros, is one of the most modern drilling rigs in Europe. An area of about 900 m² accommodates some 2,200 tons of steel construction and equipment. The height of the installation is approx. 70 metres.*

Entrepreneurial courage and determination marked the beginning of the Mittelplate oil production project: in November 1979, the second oil shock hits consumers. Oil and gas companies raised their level of investment in the exploration and production of domestic energy supplies. The Mittelplate 1 exploration well struck oil in August 1980. The oil deposits are located at a depth of 2,000 to 3,000 metres in porous Dogger sandstone formations. Additional wells soon confirm considerable oil potential off the west coast of the state of Schleswig-Holstein. Working from an artificial drilling and production island constructed on top of the tidal flats, test production from the deposit commences with six wells under a government-approved pilot program in October 1987.

The safety and protection of the tidelands were assured right from the start as the entire facility is fully sealed off from the surrounding tidal flats. The island covering an area of 70 x 95 metres was constructed on the sandy tidelands in the form of a compact, leak-proof steel-and-concrete basin and is surrounded by high sheet pile walls facing the open sea. Nothing can escape to the outside unchecked, and even rain and spray water is collected and treated on the island. A comprehensive closed waste disposal system guarantees that the North Sea and the Wattenmeer tidelands are not exposed to contamination. Sophisticated monitoring and control systems provide multiple levels of safeguards for all drilling and production operations.

The pilot phase was successfully concluded in 1991. Since then, RWE Dea and Wintershall have continually upgraded and improved the drilling and production operation on Mittelplate Island by incorporating new technologies and innovative concepts.

Using a minimum of space, 22 wells had been drilled from the artificial island by early 2009. The island has slots for a total of 44 wells. The wells reach depths of up to 3,000 metres, where the oilbearing sandstone layers are located.

Since the end of 2005 the offshore field development, which requires evermore sophisticated technologies, has been proceeding by means of a new and powerful, electrically operated high-tech drilling rig. The rig features special equipment that allows it to operate in an environmentally compatible manner in the ecologically sensitive tidelands.


## Striking oil the high-tech way

To allow access to more distant sections of the deposit, the facilities on Mittelplate Island were upgraded to meet the new requirements during the period from 2003 to 2005.

New living quarters, a new portal crane and the new T-150 drilling rig were installed on the island, at a total cost of 90 million euros.

# Intelligent solutions optimise oil production on Mittelplate

*Top: Experienced crews ensure safe drilling operations.*

*Bottom: The state-of-the-art T-150 drilling rig in operation: the electrically-powered rig can drill wells over a distance of up to 8,000 metres to reach the oil reservoir. This method allowed the Mittelplate oil field to be developed gradually from the island.*

The Mittelplate oil production project enjoys an outstanding reputation in the global oil industry. The most demanding engineering standards developed to guarantee the safe exploration and production of oil in an ecologically sensitive environment are considered exemplary for similar projects worldwide. The technologies deployed in the environmentally compatible development of the oil field in particular have been setting new benchmarks worldwide.

The drilling and production concept is also a commercial success: by means of the production wells drilled from this facility – the only one of its kind – some 12.8 million tons of crude had been extracted by the end of December 2008. The total volume of crude produced from the seven high-tech, extended-reach wells drilled from the mainland amounts to 9.5 million tons.

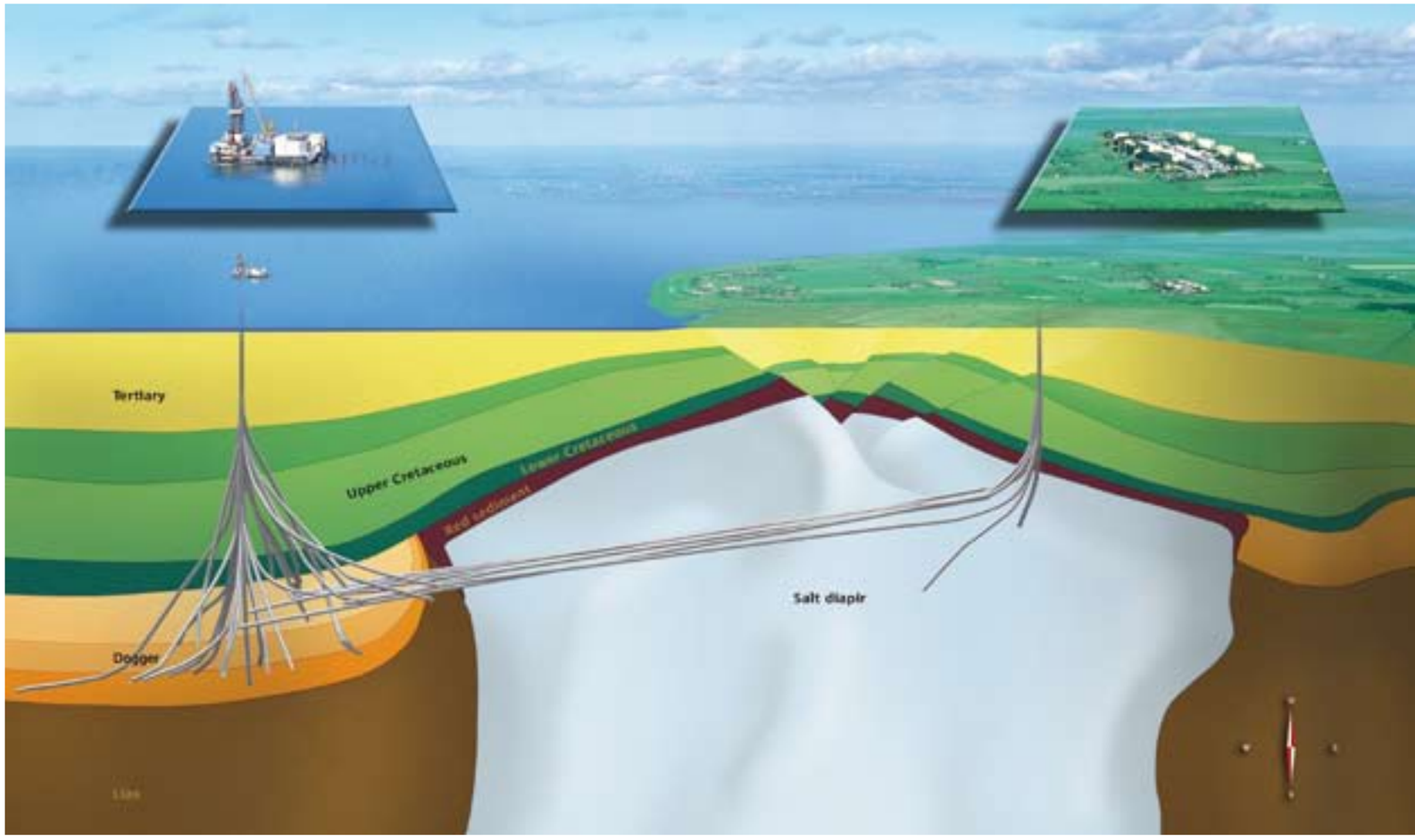
The combined annual production from both offshore and onshore wells makes a substantial contribution to the domestic supply, almost equalling imports from Saudi Arabia or Syria. The annual volume of crude produced from Mittelplate is processed into 700 million litres of heating oil, enough to heat about 320,000 single family homes every year, and 240 million litres of petrol, enough to power 230,000 cars for a year.

Using advanced drilling technology, additional oil has also been produced from the eastern sections of the Mittelplate reservoir directly from the mainland since mid-2000.

The volume of crude from these seven production wells is up to 1 million tons each year. Specialist crews supervise the production by means of process control systems.

The breakthrough that allowed the complementary onshore development of the oil deposit to become a reality was facilitated by advances in extended-reach drilling technology, which makes it possible to drill boreholes with extreme deviations and so reach across vast horizontal distances.

7,727, 8,284, 8,367, 8,995, 9,275, 8,450 and 8,672 metres – these are the impressive lengths of the extended-reach wells drilled from the land-based drilling site at Dieksand.

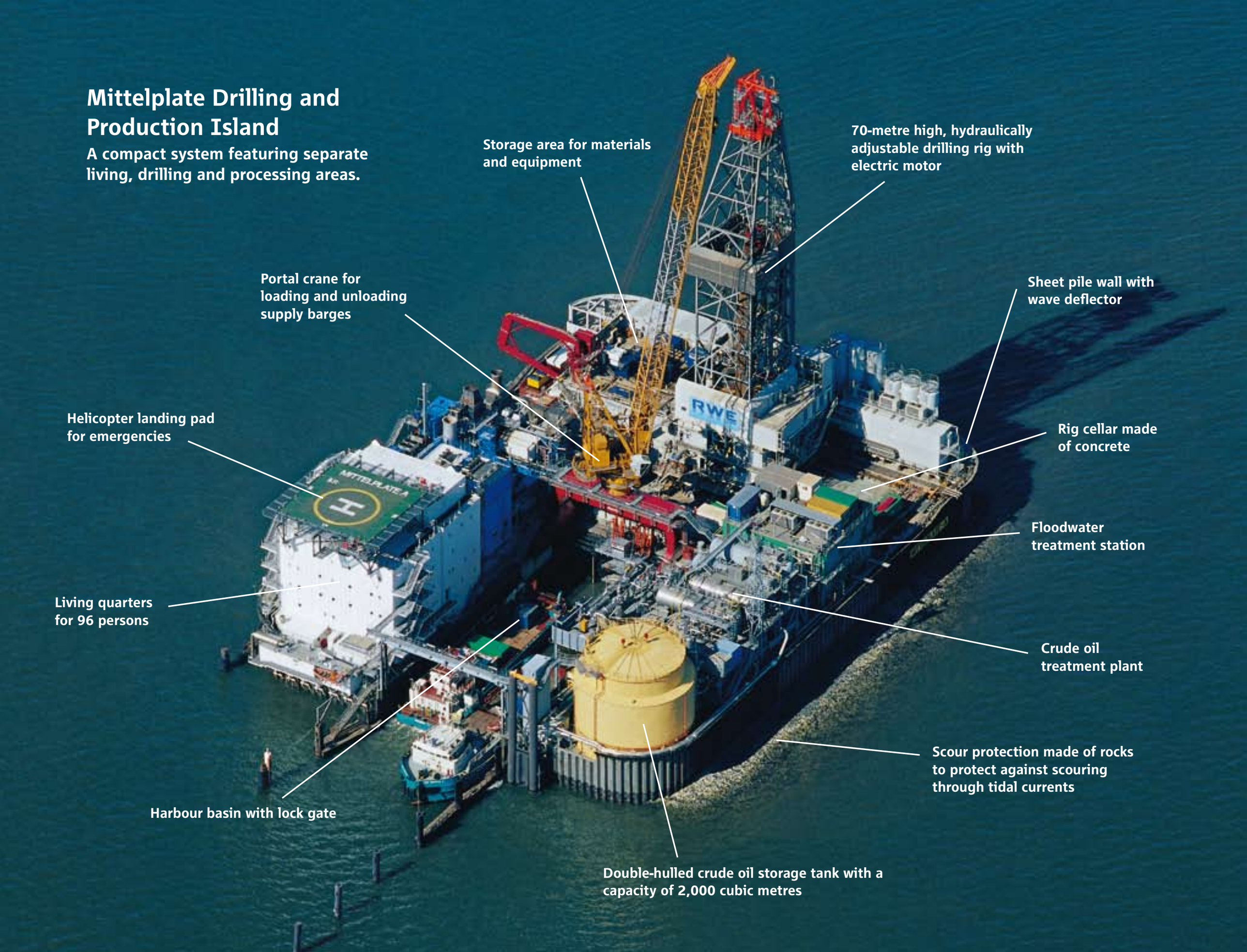



## Extended-reach wells

The illustration shows the paths of the wells sunk to date. The drilling operations presented a major technical challenge to both geologists and drilling engineers. The wells needed to be deviated and then extended over distances ranging from 8,000 to more than 9,000 metres. The seven production wells sunk here set new standards and are among the most widely deviated extended-reach wells in the world.

# Mittelplate Drilling and Production Island

**A compact system featuring separate living, drilling and processing areas.**



# Mittelplate Drilling and Production Island: unique in the world, for environmentally compatible oil production

*Top: Sheet pile wall with wave deflector. On the sea side, the sheet pile wall extends to a height of 11 metres. Nothing can enter from the outside, apart from rain and spray. And nothing can escape to the outside, not even rain water.*

*Right: Sophisticated, state-of-the-art technology, multiple safeguards in all work procedures and the use of experienced and responsible skilled staff result in an optimum safety package for drilling operations.*

The facilities and equipment on Mittelplate Drilling and Production Island are designed to meet a set of safety and environmental protection standards that were specially developed for the oil production in the Wattenmeer tidelands. The basic principle is to establish reliable protection against the forces of nature on the outside, and equally reliable insulation of the plant towards the outside so as to protect the environment.

The island perimeter is fortified by means of a scour protection belt made of rocks and water-resistant mortar. Due to constant, naturally occurring movement in the tidal flats, this scour protection requires regular maintenance to adapt it to the changing conditions.

Designed on the basis of detailed and comprehensive hydrographical, fluid dynamics and meteorological studies, this type of construction provides maximum stability. Neither storm tides, shifting tideways or floating ice have in any way affected the island since the start of production.

The solid construction of the basin, which is designed to withstand extreme forces, offers yet another advantage: in the event of an accident, the impermeable surface of the island (which is sealed by means of a specially developed concrete compound and surrounded by the sheet pile walls) could contain far more crude than is stored on the island at any given time. Furthermore, the extensive systems of piping and cable ducts are of oil-tight construction, as are the rig cellars.

Waste water from the residential quarters and kitchens is purified in the island's own treatment plant, collected in tanks and then disposed of on the mainland along with the solid waste. Even rain and spray is collected and treated on the island.

During drilling operations, the so-called drilling mud propels rock cuttings to the surface. Here the cut-tings are separated out and then carried to the mainland in containers for processing. The drilling mud is recycled and re-used.

The comprehensive, closed waste disposal system – constantly monitored by public authorities – prevents any environmental impact on the North Sea and the Wattenmeer tidelands. Specialist personnel monitor and control both drilling and production operations on the island round the clock by means of instrumentation and control systems.


## Working responsibly in a sensitive environment

Over the years it has been shown that the responsible and proper consideration of all aspects of environmental protection will lead to the development of suitable protective measures, and the technological means for implementing these measures. For example, in the event that any system parameters deviate in the production area, the crude oil pumps are automatically shut off. The production wells are fitted with quick-action stop valves at a depth of about 90 metres. If pressure drops, the valves shut off automatically. Additional shut-off valves fitted at the wellhead provide an additional level of safety.

*Left: The health and safety of the workers has top priority on Mittelplate. Work clothing conforms to international recognised safety standards.*

*Right: The double-walled oil storage tank for intermediate storage of the extracted crude has a capacity of 2,000 cubic metres. In the event of damage to the inner wall, the outer hull would safely contain the entire volume of oil.*

*Bottom centre: View of the drilling rig's substructure, with the shut-off valves that guarantee safety at all times.*

*Bottom right: The island has an integrated harbour basin that can accommodate supply ships and transport barges. During loading and unloading operations, the basin is sealed and secured with a lock gate.*

*Top: View of the island during construction.*

*Centre: Crew making adjustments at the wellhead of a production well.*

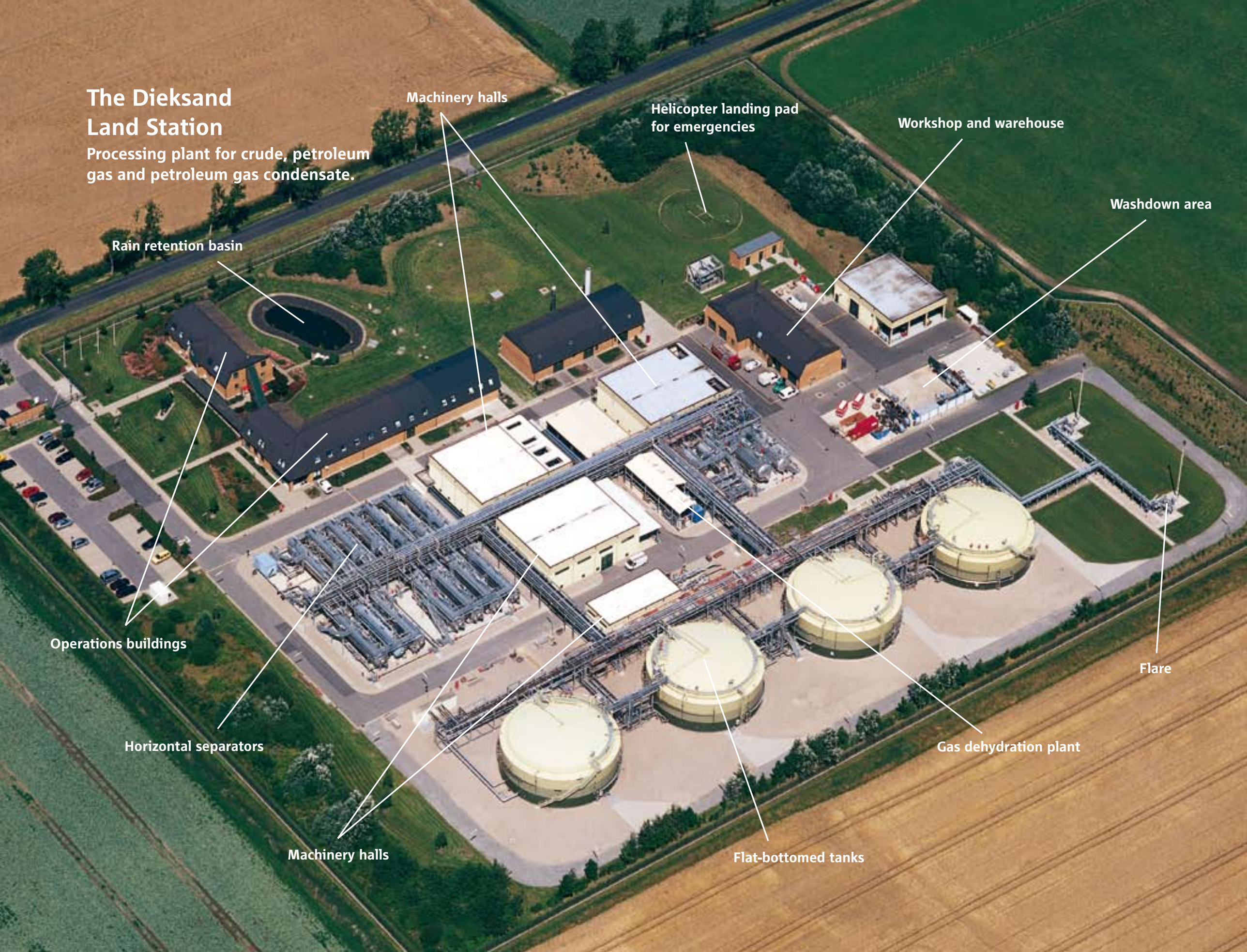
*Bottom: The process tanks for the treatment of the crude are linked in a closed system fitted with vapour recovery pipes, which effectively prevents emissions.*

*By the end of 2005, much of the equipment and facilities on Mittelplate Island had been upgraded, optimised or replaced. This also includes a new, high-performance portal crane with a slewing range that is adequate to meet all lifting requirements on the entire island.*

*The living quarters capable of housing up to 96 persons were built and fitted out at a cost of around 20 million euros.*


# The Dieksand Land Station

**Processing plant for crude, petroleum gas and petroleum gas condensate.**



# The Dieksand Land Station: Central control station for onshore oil production, processing and transport

*Top: The entire operations of the Land Station are constantly monitored by specialist personnel from the control station.*

*Centre: The Dieksand production wells were drilled using one of the heaviest deep-hole drilling rigs in Europe.*

*Bottom: The processing plant represents the heart of the Land Station.*

Production wells extract the Mittelplate crude from the oil-bearing sandstone formations located at depths of 2,000 to 3,000 metres 24 hours a day. The oil produced both on Mittelplate Island and through the horizontal extended-reach wells on the mainland reaches the processing plant at the Dieksand Land Station via pipeline. Here, the valuable commodity is processed to make it suitable for refining.

The facilities for processing the crude are needed to separate the mixture produced from the wells into pure oil, petroleum gas and condensate. Water extracted along with the oil is separated out and then pumped back into the oil-bearing rock formations in order to maintain pressure inside the reservoir. The crude is then treated further in four flat-bottomed tanks with a capacity of 2,500 $m^3$ each. It then goes via pipeline to Brunsbüttel and Heide to the customers, the refineries. The petroleum gas is fed into compressors and then undergoes a dehydration process, before entering the pipeline to Brunsbüttel as well. The condensate separated out from the crude is subjected to the same treatment.

The construction concept for the Dieksand Land Station, which covers an area of 55,000 $m^2$, is designed specifically to minimise the impact of operations on the environment. All container vessels without double walls are placed inside impermeable collector basins made of concrete. To control noise emissions, compressors and pumps are housed inside process buildings.

The entire plant conforms to all the relevant statutory water protection regulations, preventing any contamination of groundwater.

A process control system monitors onshore oil production as well as all the crude oil treatment processes and automatically shuts down the entire treatment plant in the event of any incident. The safety technology is designed with multiple levels of redundancy. The operations buildings also contain offices, sanitary facilities, a fire-fighting station and central heating unit as well as workshops, laboratory and storage facilities.

The throughput capacity of the processing systems was more than doubled from its previous figure of 1.2 million to 2.5 million tons annually. The plant can process up to 7,000 tons of crude every day.

*The flat-bottom tanks at the Land Station are fitted with a double bottom. After secondary purification, the crude is pumped into the pipeline to Brunsbüttel.*

## Oil processing and transportation

The Land Station is the central control station for the crude oil processing and the entire transport network. From here, the pipeline carrying the crude produced on the island to the processing plant at the Land Station as well as the pipelines from the Land Station to Brunsbüttel are monitored and controlled.

With the construction of the pipeline linking the island to the mainland in 2005, a substantial expansion of the treatment plant was needed to provide the capacity to process the offshore production from the Mittelplate oil field at the Land Station as well. Around 42 million euros was invested in the modifications and expansion of the processing facilities.

# Pipeline link improves ecological balance and oil transportation

*Top: The piping runs were joined by welding, and a protective coating made of glass-reinforced plastic applied to cover the welded joints. The joints were then x-rayed and subjected to pressure testing.*

*Bottom: The short-term intervention necessitated by the construction of the pipeline has not had a lasting impact on the ecology of the tidal flats. This was confirmed by studies carried out by independent experts throughout the construction.*

For 18 years, the crude produced on Mittelplate Island had been shipped to the Port of Brunsbüttel by specially designed double-hulled barges. Loading and transportation of around 15 million tons of crude was performed without any incident. Due to tidal and meteorological factors restricting transport capacity, the island's annual production capacity reached its limit at a level of approx. 900,000 tons of crude.

Revised higher estimates of remaining reserves and further improvements in drilling and production technologies led to a search for solutions to remove this bottleneck and allow these potentials to be exploited more quickly and more efficiently. The outcome was the planning for a pipeline linking Mittelplate Island to the Dieksand Land Station. A pipeline link would boost the potential production capacity on Mittelplate Island to a level of up to 1.6 million tons of crude per year.

The implementation of the technically demanding pipeline construction concept developed by geologists, engineers and environmental experts was completed on schedule and was in full compliance with the strict environmental requirements imposed on the project teams engaged in this project in the Schleswig-Holstein Wattenmeer National Park. The total investment in the pipeline link and the modifications to the processing plant at the Land Station amounted to about 100 million euros.

On the sea side, two 7.5-kilometre stainless-steel pipelines were laid from the dike line at Friedrichskoog-Spitze through the tidal flats off the coast and on to Mittelplate Island.

Behind the dike, the pipelines were extended over a distance of 2.8 kilometres to the Dieksand Land Station. One pipeline with a diameter of 25 cm is provided for transporting the crude from the island, and the second pipeline, with a diameter of 15 cm, serves as a return line for the reservoir water extracted in the water separators at the Land Station. On the island, this returned reservoir water is reinjected below ground in order to maintain reservoir pressure.

The pre-fabricated sections of submarine pipelines were drawn into two parallel horizontal boreholes drilled beforehand, with the entire offshore distance being divided into six sections. The pipeline was buried at depths of up to 20 meters. These depths are sufficient to allow the pipelines to pass safely underneath the tideways as well as the dike. Inside the six construction pits along the pipeline route, the piping runs were welded together at a depth of five meters.

## Environmentally compatible pipeline link

The overall ecological benefits of the pipeline construction project are considerable. Transportation by pipeline eliminates the need for around 2,000 journeys by the double-hulled barges each year. Instead, just under 3,000 tons of crude can now be transported through the pipeline each day, regardless of weather and tidal conditions.

The technical concept for laying the pipelines by means of directional horizontal drilling technologies and the efficient, on-time completion of the construction project confined the impact of construction on the tidal flats to a minimum. The pipeline went into operation at the end of October 2005.

# Responsible oil production in the sensitive Wattenmeer tidelands

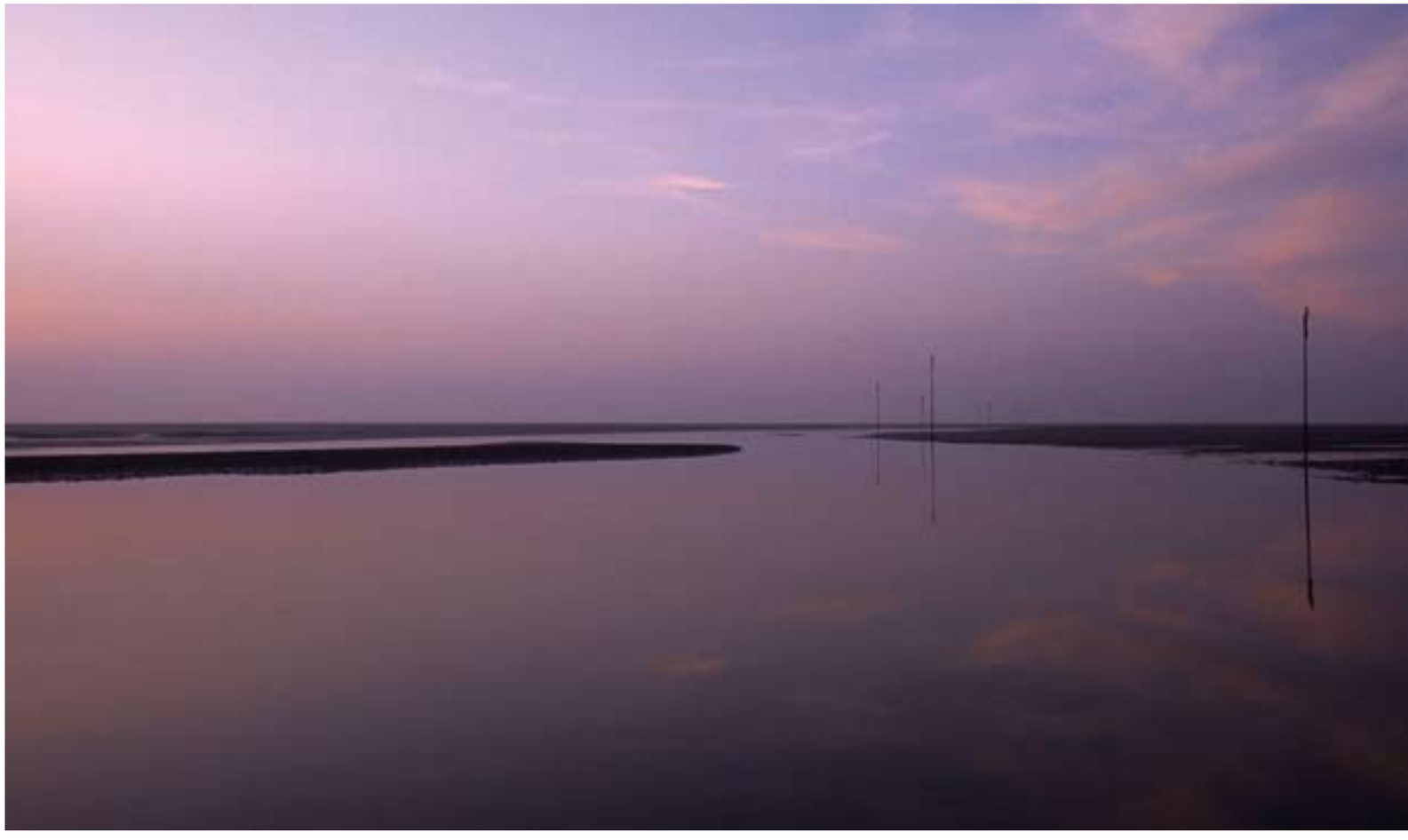
*The findings of the studies carried out so far and which will be continuing into the future indicate that, with the exception of the structure of the island itself, there have been no lasting deviations from the natural changes occurring in the tidal flats. No negative effects from the oil production on the environment, and especially on the tidal flats and its inhabitants, have been recorded to date.*

The oil production activities associated with the Mittelplate oil field have repeatedly been met with sceptisicm, accusations and criticism. These concerns were taken into consideration throughout all planning activities and in the formulation of regulatory requirements and approvals for the Mittelplate project, both in the initial stages and for any subsequent developments.

The issue is whether valuable resources can be extracted without endangering or destroying the natural environment. This is a fundamental issue – and the answer to the questions is equally basic in nature. Commercial activities without any impact on the environment whatsoever will always be an exception. Nevertheless, today and from here on, it must be an absolute requirement that the elimination of any such effects to the extent possible must be pursued with a high level of responsibility, and through the application of state-of-the-art technologies. Given the outstanding importance of environmental protection, the choice of technologies employed in the exploration and production of oil must be based on the principle of ensuring minimal intervention in ecological systems.

RWE Dea as operator and its partner Wintershall are aware of their immense responsibility for the Wattenmeer tidal flats, a unique natural habitat. For this reason, the last 21 years of incident-free oil production on Mittelplate saw the implementation of extensive measures designed to protect the environment. Throughout the continual development of the oil field, independent research institutes and engineering consultants conducted long-term studies to investigate and assess the effects of oil production on the sensitive environment. This included biological surveys focusing on microorganisms, fish and birdlife, as well as marine geomorphological and sedimentological studies in certain areas.

Mittelplate represents impressive evidence of the fact that the interests of the Wattenmeer tidal flats are compatible with production of crude oil, a vital commodity.



## Protecting the unique natural environment of the Wattenmeer tidelands

The protection of the Wattenmeer tidelands and its inhabitants has top priority. This is why RWE Dea supports the listing of the Wattenmeer region as a World Heritage Site. In consultation with the state governments of Schleswig–Holstein and Lower Saxony, the company made a commitment not to erect any additional structures for the production of oil or gas in the Wattenmeer Tidelands National Park. This means that in future, additional potential oil deposits will be exploited only using the existing facilities on Mittelplate Island or by means of extreme extended-reach wells drilled from outside the national park.

# Leading-edge technology ensures incident-free production at a high level

The short supply routes and the good infrastructure in the state of Schleswig-Holstein can be used to good effect. Companies operating at the ChemCoast Park Brunsbüttel process the crude to produce a vast range of products. Over 1,000 jobs depend directly on this domestic source of oil. At the Heide refinery alone, 490 employees are involved in the processing of the Mittelplate crude.

An additional benefit to the national economy is derived from tax revenues and royalties from the production operation. The royalties levied on the oil produced here represent a dependable source of income for the state of Schleswig-Holstein.

**Key figures about crude oil production on Mittelplate:**

**Investments since the start of the project:** More than 700 million euros

**Volume of crude produced without incident:** 22,352,000 tons

**Length of wells drilled successfully:** 148,000 metres

**Current reserve potential:**
30 million tons of crude = about 180 million barrels (not including additional potential resources)

**Potential reserves in Germany:**
At around 65 per cent, Mittelplate is Germany's biggest and highest-yielding oil field

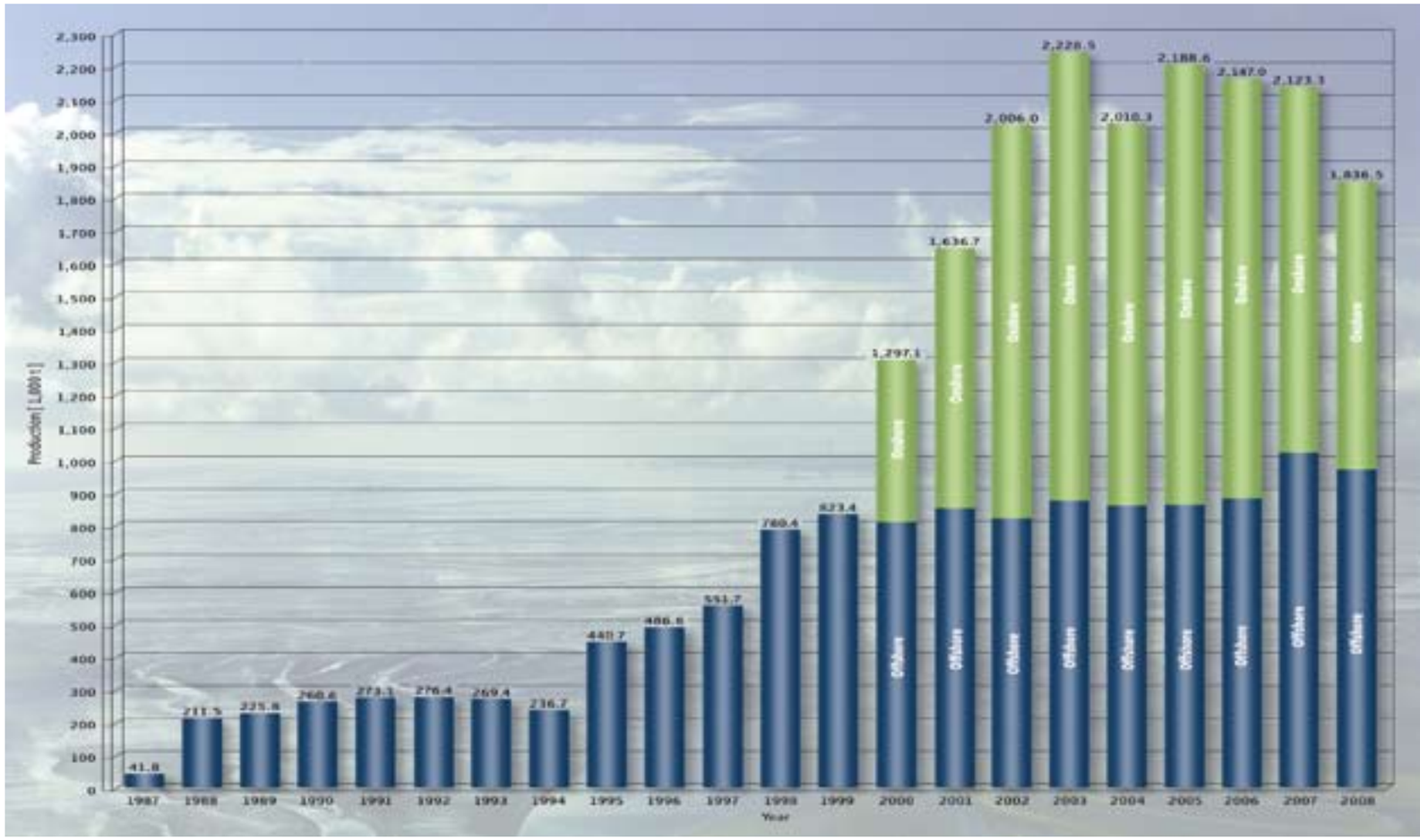
**Benefit:**
Oil production from the Mittelplate field reduces the degree of dependency on oil imports from abroad; it benefits the national economy and contributes to the security of energy supplies.

**Status:**
31. December 2008

After years of incident-free drilling, production and transport operations, it is clear that oil production from the Mittelplate deposit is technically feasible, commercially viable, and able to be carried out without compromising environmental protection in any way.

Thanks to the experience gained in this operation on the North Sea coast, RWE Dea and Wintershall now have at their disposal the expertise and the state-of-the-art technologies needed for environmentally compatible oil production. This kind of expertise is gaining in importance worldwide, and it represents a distinct advantage in the competition for exploration and production licences.

The Mittelplate oil deposit is valued at several billion euros. Its significance for the economy and in terms of its contribution to domestic value added is high. Each ton of oil produced from domestic sources reduces Germany's dependence on imports. The flow-on effects for the economy are enormous: investments and ongoing operations have been, and will be, lending momentum to the local job market and to regional suppliers for years, thus contributing to an economic revitalisation in general terms.




## Production from the Mittelplate field

Estimates of the reserve potential at Mittelplate have been adjusted upwards continually. In addition to the 22 million tons of crude produced already, current estimates are for some 30 million tons of commercially recoverable reserves.
As a result of the continual optimisation of the drilling and production concept, it has been possible to maintain the annual production rates at a high level. After many years of production from the Mittelplate oil field, a natural reduction in production volumes has been occurring in recent years. To help maintain the so-called plateau production at a high level for as long as possible, additional production wells will need to be drilled in order to tap previously undeveloped sections of the deposit.