Energistyrelsen
Miljø- og Energiministeriet

Oil and Gas Production in Denmark 1996

Preface

The Danish Energy Agency takes pleasure in publishing its annual report on developments in exploration and production of oil and natural gas in Denmark.

Once again, Danish oil and gas production has exceeded the production figures of previous years, making 1996 another successful year with increasing production.

Expected production figures have been written up compared to the five-year production forecast in the 1995 report. The expectations for future production from the new fields, South Arne and Siri, are the main reason for the marked upward adjustment of the production forecast for the period from 1999 to 2001. Thus, the expected production figure for 1999 has been written up by more than 40%.

The increase in oil and gas production and the reorganization of Danish energy supplies to provide consumers with more choices have made Denmark self-sufficient in oil and natural gas since 1991.

Based on the new production forecast, the Danish Energy Agency expects Denmark to become self-sufficient in energy as from 1997. Moreover, the oil and gas production is anticipated to exceed total energy consumption by 1998.

The main objective of future exploration for oil and gas is to discover as much oil and gas as possible in the Danish subsoil. This will make it possible to prolong the period during which Denmark will be wholly or partly self-sufficient in oil and natural gas. At the same time, prolonged use of existing facilities and pipelines is ensured.

Therefore, this year's report includes a special section on the new exploration opportunities currently available in Denmark, both as a result of the *open-door procedure,* which has already been initiated, and the planned *fifth licensing round,* which is expected to be opened in mid-1997.

Copenhagen, May 1997

Ib Larsen

Director

Conversion Factors

In the oil industry, two different systems of units are frequently used: SI units (also called metric units) and the so-called oil field units, which originated in the American oil industry. The metric units are based on international definitions, whereas the use of oil field units may vary from one country to another, being defined by tradition.

The abbreviations used for oil field units are those recommended by the Society of Petroleum Engineers (SPE).

Quantities of oil and natural gas may be indicated by volume or energy content. As gas, and, to some extent, oil are compressible, the volume of a specific amount varies according to pressure and temperature. Therefore, measurements of volume are only unambiguous if the pressure and temperature are indicated.

In addition, the composition, and thus the calorific value per volumetric unit, of crude oil and natural gas vary from field to field. The composition of Danish crude oil varies slightly with time, and therefore the conversion factors for t and GJ are dependent on time. The table below shows the average for 1996. For crude oil, the lower calorific value is indicated, whereas the upper calorific value is indicated for natural gas.

The SI prefixes k (kilo), M (mega), G (giga), T (tera) and P (peta) stand for 10^3, 10^6, 10^9, 10^{12} and 10^{15}, respectively.

A somewhat special prefix is used for oil field units: M (roman numeral 1,000). Thus, the abbreviated form of one million stock tank barrels is 1 MMstb, and the abbreviation used for one billion standard cubic feet is 1 MMMscf or 1 Bscf.

In certain contexts, the unit t.o.e. (tonnes oil equivalent) is used. The international definition of 1 t.o.e. is 10 Gcal.

	From	To	Multiply by
Crude Oil	m^3 (st)	stb	6.292955*
	m^3 (st)	GJ	36.3
	m^3 (st)	t	0.851[i]
	t	GJ	42.62[i]
Natural Gas	Nm^3	scf	37.2396
	Nm^3	GJ	0.0393
	Nm^3	kmol	0.0446158
	m^3 (st)	scf	35.3014
	m^3 (st)	GJ	0.0373
	m^3 (st)	kmol	0.0422932
Units of Volume			
	m^3	bbl	6.28981
	m^3	ft^3	35.1467
	gallon	in^3	231*
	bbl	gallon	42*
Energy	t.o.e.	GJ	41.868*
	GJ	Btu	947817

Reference pressure and temperature for the above-mentioned units:

		Temp.	Pressure
Crude Oil	m^3 (st)	15°C	101.325 kPa
	stb	60°F	14.73 psia[ii]
Natural Gas	m^3 (st)	15°C	101.325 kPa
	Nm^3	0°C	101.325 kPa
	scf	60°F	14.73 psia[ii]

*) Exact value
[i]) 1996 value
[ii]) The reference pressure used in Denmark and in U.S. Federal Leases and in a few states in the USA is 14.73 psia.

Contents

1. New Exploration Opportunities 5
Fifth Licensing Round 5
Open-Door Procedure 5

2. Exploration 7
Exploratory Surveys 7
Drilling Activities 8
New DUC Work Programmes 9
Extended Licence Terms 9
Transfer of Licence Shares 10
Relinquishments 10
Released Well Data 10

3. New Field Developments 11
Harald 11
Siri 12
South Arne 12

4. Production 13
Production Continues to Rise 13
1996 Developments in General 14
Successful Water-Injection Projects 14
Increasing Water Production 15
Production Wells 16
Producing Fields 18
The Dan Centre 18
The Gorm Centre 19
The Tyra Centre 20
Natural Gas Storage Facilities 22

5. Reserves 23
Assessment of Reserves 23
Production Forecasts 26
Methods and Definitions 28

6. Economy 29
Crude Oil Prices and Dollar Exchange Rate in 1996 29
Economic Assumptions 29
Sales Value of Danish Oil and Gas Production 29
Denmark's Energy Balance 30
Impact of Oil and Gas Production on the Danish Economy 31
The Finances of the Licensees 34

7. Health and Safety 37
Expansion of Fixed Offshore Installations 37
Projected Fixed Offshore Installations 37
New Gas Transit Pipelines 38
Supervision of Operations by the Danish Energy Agency 38
New Regulations 39
Notification of Industrial Injuries 39
International Cooperation 41

8. Environment 43
CO_2 Emissions 43
Assesment of Effects on the Environment 46

9. Research 47
Energy Research Programme 1997 47
International Cooperation 47

Appendices
A Licences in Denmark 49
B Exploration and Appraisal Wells, 1986-1996 51
C Exploratory Surveys 1996 52
D New Field Developments 53
E Danish Oil and Gas Production, and Gas and Water Injection, 1972-1996 55
F Producing Fields 57
G1 Energy Consumption and Supply 1975-1996 66
G2 Financial Key Figures 67
H Organization 68

1. New Exploration Opportunities

The main objective of future exploration for oil and gas is to discover as many oil and gas accumulations as possible in the Danish subsoil. This will make it possible to prolong the period during which Denmark will be wholly or partly self-sufficient in oil and natural gas. At the same time, prolonged use of existing installations and pipelines is ensured.

The prospects of meeting this objective seem to be good, as the interest shown in the fourth licensing round in Denmark was greater than expected. This interest in continued exploration in the Danish sector of the North Sea has been further intensified by the oil discovery that the Statoil group made when drilling the Siri-1 well in December 1995. Therefore, in general, there seems to be a good chance of kindling the oil companies' interest in exploration activity in Denmark for many years to come.

Thus, for the Central Graben with adjoining areas, the Danish Energy Agency will attempt to continue encouraging exploration activity at the present level, as experience from recent years seems to indicate that some potential discoveries consist of small deposits that will only be profitable if exploited in conjunction with the existing processing and pipeline facilities. Based on the information available, this area is still assumed to hold out such attractive potential that competition must be expected for new licences. Therefore, the licensing round procedure will be upheld for this area.

As regards the rest of Denmark, *Eastern Denmark*, efforts were made in the first, second and third licensing rounds (1984-90) to promote greater exploration activity in the above-mentioned areas through a so-called *linkage procedure*. Applicants were informed that applications which included offers for exploration in the less attractive areas in Eastern Denmark would be given priority in the selection of successful applicants.

Against this backdrop, a number of licences were awarded, leading to fairly extensive exploration activity and the drilling of a number of onshore wells. However, this activity did not yield any profitable results. Since then, the oil companies have shown limited interest in these areas.

There is still some potential for exploration activity in these areas, and the interest in exploration will be put to the test by facilitating the oil companies' access to licences through a so-called *open-door procedure*. This procedure is more flexible, as licences may be awarded in step with the interest shown in certain areas, without awaiting new licensing rounds, which are held at several-year intervals.

Fifth Licensing Round

The work programmes drawn up under the licences awarded in the fourth licensing round will ensure the continuation of stable exploration activity for the next year or so. All obligatory work commitments are expected to be met by the end of 1997. As mentioned above, the oil discovery made by the Statoil group in drilling the Siri-1 well has heightened the interest in the areas bordering on the Central Graben. Therefore, the prospects of holding a new licensing round for these areas are good, and a fifth licensing round is expected to be held in mid-1997.

Open-Door Procedure

Before initiating a fifth licensing round, an open-door procedure was established for the remaining Danish area. The 1995 amendments to the Danish Subsoil Act opened up the possibility of using this procedure, which is suitable for those areas for which the interest in exploration is so limited that not many applications are expected and no competition is expected to arise between oil companies. In addition, the procedure may be suitable for motivating small oil companies with innovative ideas to apply for licences and to allocate resources for exploring the Danish area without having to fear competition from more "established" companies. The flexibility of the open-door procedure allows licences to be awarded without holding an actual licensing round. In practice, this means that the Danish Energy Agency makes an announcement to the effect that new licences may be awarded on an ongoing basis in step with the interest shown in certain areas.

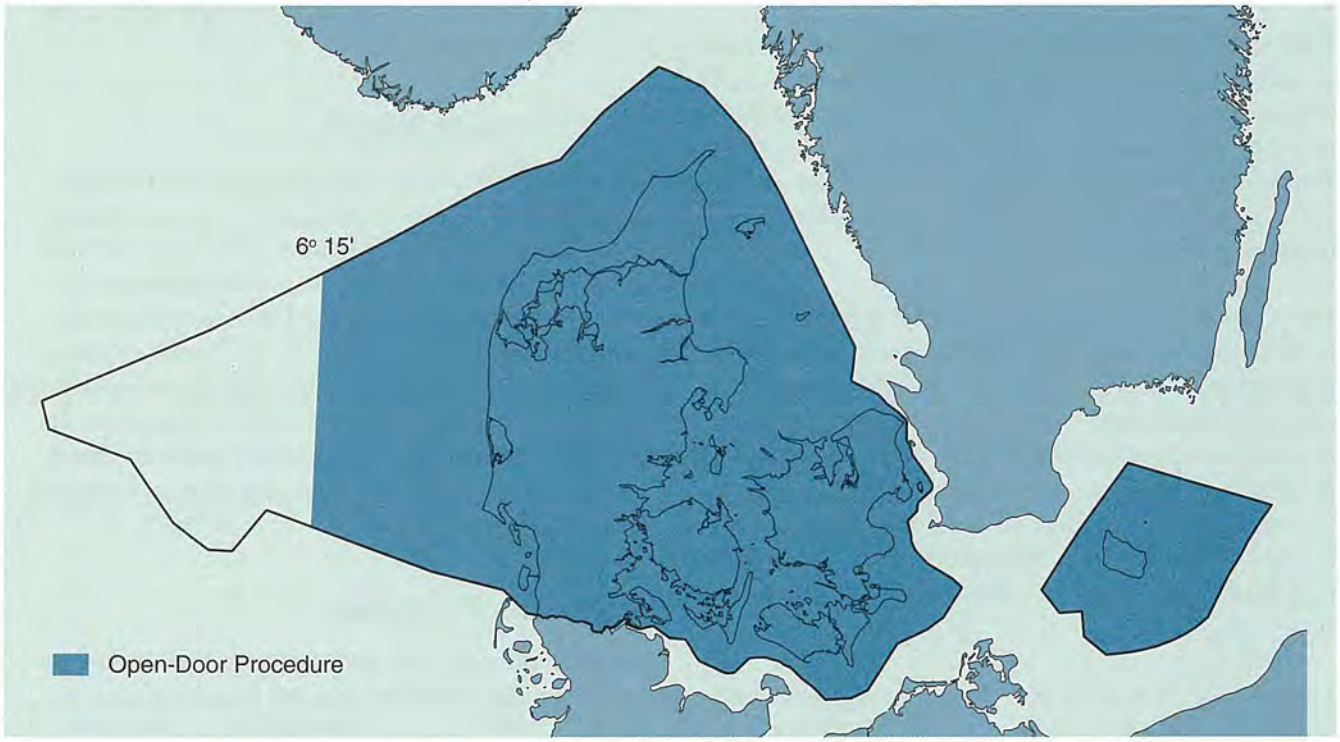
This procedure will be applied for the entire area east of 6° 15' East longitude, see Fig. 1.1 on the next page.

Conditions Applicable to the Open-Door Procedure

Applications will be considered and licences awarded in the order they are received. In 1997, applications may be submitted until 30 September, and subsequently from 2 January - 30 September every year. The procedure may be discontinued subject to three months' notice, and this will enable the Danish Energy Agency to consider, prior to the next application period, whether the procedure is to be discontinued or adjusted by selecting some of the areas for a new licensing round or changing the terms applicable to the procedure.

New Exploration Opportunities

Fig. 1.1 Open-Door Area



Those parts of Eastern Denmark for which applications were not invited in the fourth licensing round will therefore be available for licensing. The terms used in the fourth licensing round will also apply to the open-door procedure. One consequence is that the state-owned company, DOPAS, will have to pay its proportionate share (20%) of the licence and will not be granted a carried interest.

The requirements laid down in the Subsoil Act as to the applicants' expertise and financial background will remain unchanged, and the awarding of licences will also be subject to the condition that work programmes are carried out. However, the requirements as to the scope of the work programme can scarcely be upheld at the previous level due to the exploration risk attached to these areas.

The size of the area granted under the licence and the licence period will depend on the work programme offered for the relevant area. The intention is thus to prevent a large area from being licensed for a prolonged period of time without active exploration being carried on in the entire area.

The work programmes drawn up under the licences will be based on six-year licence terms. The obligatory part of the work is to be performed within the first two years. It is therefore a condition for retaining the area beyond this two-year period that the oil companies carry out such additional seismic surveys as to allow the selection of a well site. Subsequently, it is a condition for retaining the licence beyond the first four-year period that the oil companies commit themselves to drilling one or more wells.

The areas to be offered for licensing include areas to which special interests are attached, such as environmental, preservation, hunting management, raw materials extraction, fishing and shipping interests.

If applications for such areas are received, licences will only be granted subject to conditions that safeguard these interests. This may prevent the granting of licences for particularly sensitive areas.

2. Exploration

Exploration in Danish territory in 1996 was characterized by a high activity level, partly as a result of the exploratory commitments stemming from the licences awarded in the Fourth Licensing Round, and partly due to the renewed interest sparked by the Statoil group's Siri discovery in December 1995. Thus, in 1996, the scope of 3D seismic surveys was the greatest ever in Danish territory.

An outline of the companies that hold licences for exploration and production in Danish territory is shown in Appendix A. The map of licence areas at the back of the report shows the geographic coverage of licences awarded.

Exploratory Surveys

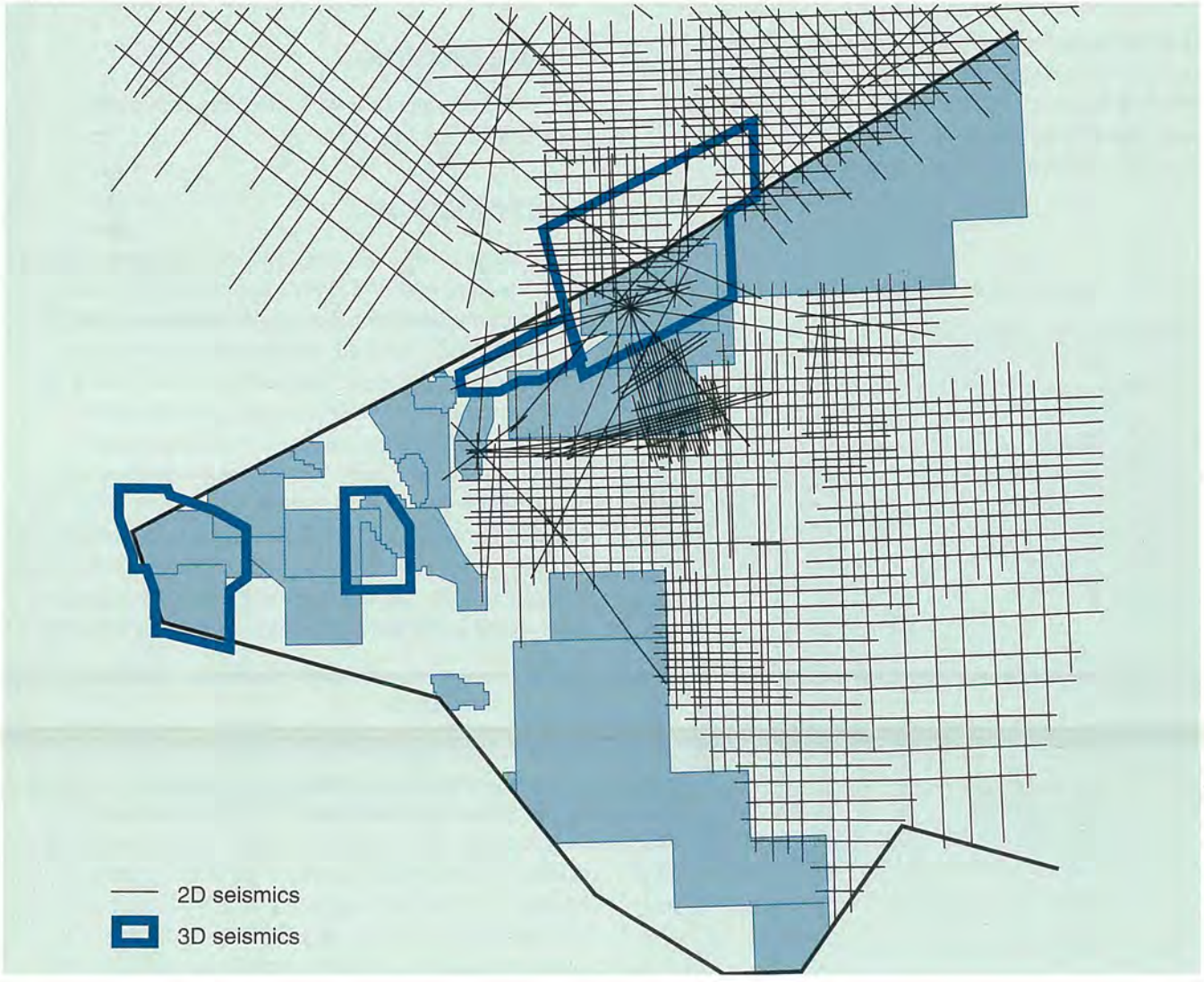
The areas covered by the seismic surveys conducted in 1996 clearly indicate that the Siri discovery made by the Statoil group at end-1995 revived the interest in exploration, particularly in the areas immediately to the east of the Central Graben, see Fig. 2.1.

One of the surveys made was a 3D seismic survey of the open area due west of the Siri discovery. In this area, the Elna-1 well drilled by Dansk Undergrunds Consortium (DUC) encountered gas and condensate in Palaeozoic sandstone in 1985.

In the remainder of the open areas east of the Central Graben, an extensive grid of 2D seismic lines was collected in 1996. These new seismic lines have significantly augmented existing data, as large parts of this area have previously been investigated on a limited scale only.

The above-mentioned surveys have been made by seismic surveying companies alone or in cooperation with oil companies, and the data collected are sold to interested parties.

Fig. 2.1 Seismic Surveys in 1996



In addition, both 2D and 3D seismic surveying data were collected in connection with exploration and appraisal activities under existing licences. In the western part of the Central Graben, the Amerada Hess and Phillips groups completed a 3D survey which was initiated in 1995. Further, Dansk Operatørselskab, Danop, supervised the implementation of the second phase of a major 3D programme in the Central Graben. The first phase of the programme was carried out in 1995. Based on the Siri discovery, the Statoil group carried out a major 3D seismic survey in cooperation with Geco-Prakla, a seismic surveying company.

Finally, the Geological Survey of Norway conducted a Norwegian/Danish aeromagnetic survey in the Skagerrak and the northeastern part of the North Sea.

Combined, 3D seismic surveying activity reached an unprecedented level in 1996, and the scope of 2D seismic programmes was the greatest since 1986, see Fig. 2.2.

Appendix C contains an outline of the exploratory surveys.

In addition to the new seismic surveys, seismic surveying data previously acquired have been reprocessed, i.e. thoroughly reviewed and updated. Both seismic data from the Central Graben and the areas east of the Central Graben have been reprocessed.

Fig. 2.2 Annual Seismic Surveying Activities

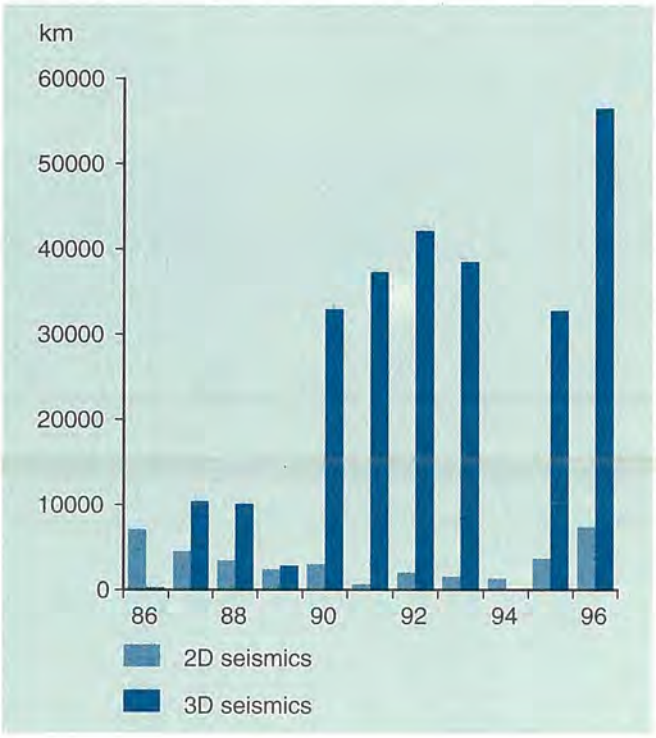
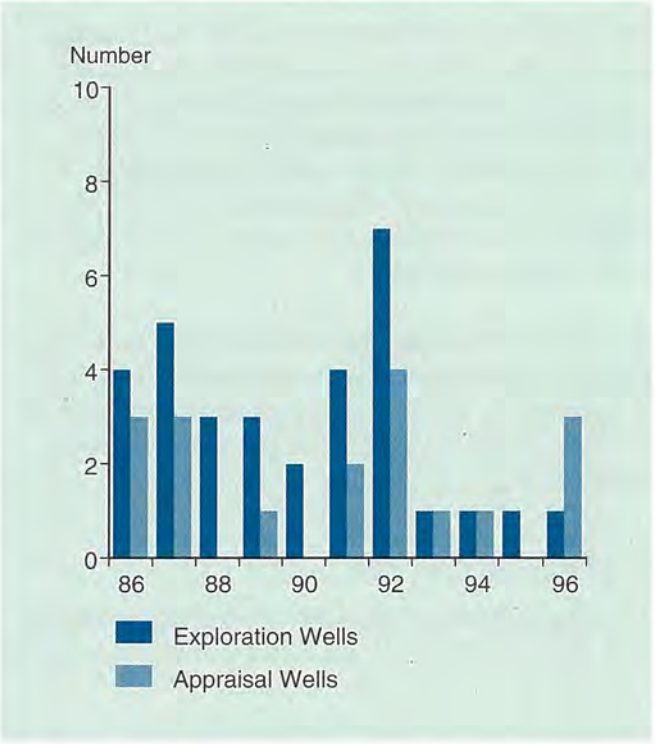


Fig. 2.3 Exploration and Appraisal Wells



Drilling Activities

In 1996, three appraisal wells and one exploration well were drilled, see Fig. 2.3.

Rigs-2 (5604/29-5)

Under licence 7/89, the Amerada Hess group drilled the Rigs-2 well as part of a further appraisal of the South Arne accumulation, for which a development plan has now been filed. The well, which was drilled in the northeastern flank of the structure, demonstrated good reservoir properties, both in a vertical well section penetrating the chalk reservoir and in two subsequent deviated well sections drilled further out on the flank. In a production test, oil was produced at a rate of about 850 m^3/day. The production rate was curbed for technical reasons, and therefore does not reflect the maximum capacity of the well. The South Arne Field is described in more detail in the section on *New Field Developments.*

Siri-2 (5604/20-2)

The Siri-2 appraisal well was drilled in the western part of the Siri structure to delineate the oil discovery made by the Statoil group at end-1995 under licence 6/95. Before drilling this well, the Statoil group carried out an extensive 3D seismic survey of the area. Against this background, the Statoil group has completed its appraisal of the Siri discovery, declared it commercial and submitted plans for development of the field. More in-

formation on the Siri discovery is given in the section on *New Field Developments.*

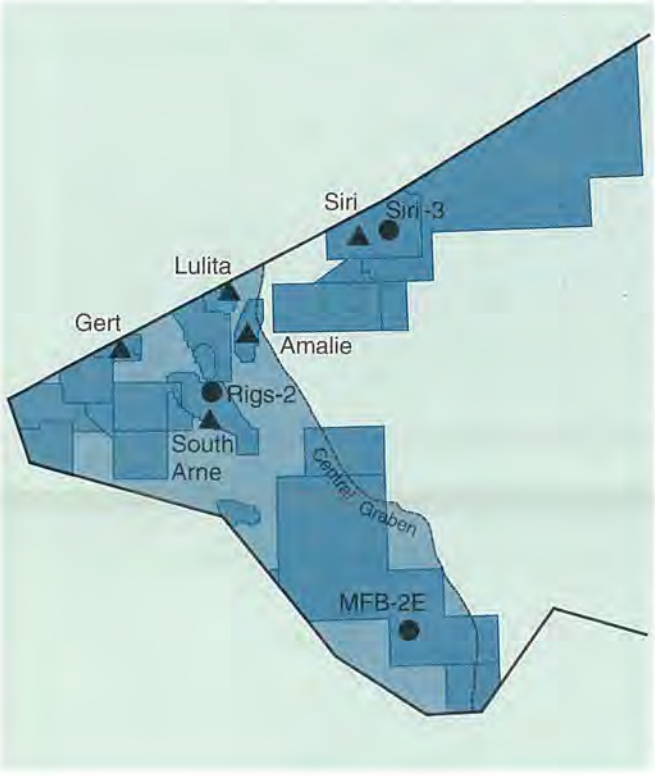
MFB-2E (5505/17-12)

In order to appraise the western flank of the Dan oil accumulation, Mærsk Olie og Gas AS drilled the MFB-2E horizontal well, which set a *North Sea record* for horizontal drilling. The MFB-2E well, which is also to be used as a production well in the ongoing development of the Dan Field, was extended to a horizontal length of about 3.5 km to delineate the oil-bearing high-porous chalk. At the beginning of 1997, Mærsk Olie og Gas AS spudded another delineation well in the western flank of the field.

Siri-3 (5605/13-1)

The Siri-3 well, situated about 8 km east of the Siri discovery, is the second exploration well drilled under the Statoil group's licence 6/95. Like the previous Siri wells, this well encountered oil in Tertiary sandstone. To provide further information about the discovery, a deviated well section was drilled, from which oil was produced at satisfactory production rates. The Statoil group will now subject the oil discovery to a further appraisal in order to ascertain whether there is a basis for exploiting it commercially.

Fig. 2.4 Location Map



New DUC Work Programmes

According to the 1981 agreement between the Danish state and A.P. Møller, six-year work programmes are to be revised every three years for each of the nine blocks in the Contiguous Area. Mærsk Olie og Gas AS, the operator for the DUC group, has now submitted proposed work programmes for the period from 1997 to 2002. However, a gradual relinquishment of the approx. 2000 km^2 concession area is to be commenced already from the year 2000, at which time 25% of the area is to be relinquished, followed by another 25% in the year 2005. A.P. Møller was granted its licence, the so-called Sole Concession, in 1962 for a 50-year term.

Extended Licence Terms

At the end of 1994, the Statoil group declared the Lulita discovery commercial. With a view to subsequent exploitation of this accumulation, the group was granted a 30-year production licence on 8 March 1996. At the same time, the Statoil group delineated the accumulation, which comprises parts of the Statoil group's licences 7/86 and 1/90.

On 14 August 1996, the Danish Energy Agency also granted the Statoil group a 30-year extension of the licence comprising the Amalie discovery, made in 1991 under licence 7/86. This gas accumulation was declared commercial by the Statoil group in 1996, and it was delineated in conjunction with the extension of the licence term.

Licences 7/86 and 1/90 have now been relinquished in respect of the areas not comprised by the above-mentioned field delineations.

The Amerada Hess group was granted a 30-year production permit for its South Arne deposit on 17 February 1997. Before that, the area covered by licence 7/89 had been extended slightly in order to include the part of the South Arne oil accumulation extending beyond the original licence area, and to give the licensee an opportunity to arrange for expedient exploration of the Middle Jurassic Nora structure. The 30-year extension encompasses the delineated South Arne accumulation.

The exploration term of the Mærsk group's licence 3/90 has been extended by two years to allow the Concessionaires to continue their appraisal of the concession area adjoining the Gert Field.

A two-year extension has also been granted for the Statoil group's licence 2/90. At the same time, the term of licence 3/95 has been adjusted so that it coincides

with the term of licence 2/90, as the exploration of these two licence areas has been coordinated.

Transfer of Licence Shares

With effect from 1 January 1996, Total Marine Danmark withdrew from the three Statoil licences, 7/86, 1/90 and 2/90. As a result, Denerco Oil A/S and LD Energi A/S increased their shares of these licences, while Amerada Hess Energi A/S increased its share of licence 2/90 and the part of licence 7/86 comprising the Amalie discovery.

Statoil Efterforskning og Produktion A/S has transferred a 6% share of licence 3/95 to Amerada Hess Energi A/S. The transfer was made with retroactive effect from 15 May 1995, the date on which the licence was issued.

Moreover, the holders of licences 2/95 and 8/89 have adjusted their shares so that each licensee holds identical percentage shares in the two Amerada Hess consortia. Prior to this adjustment, the two consortia coordinated the exploration of the two licence areas, which adjoin one another.

Relinquishments

As mentioned above, parts of the areas covered by licences 1/90 and 7/86 have been relinquished.

Released Well Data

Generally, data collected under licences granted in pursuance of the Danish Subsoil Act are protected by a five-year confidentiality clause. However, the confidentiality period is limited to two years for licences which expire or are relinquished.

In 1996, data regarding the following exploration wells were released:

Amalie-1	5604/26-2	Statoil
E-5	5504/12-4	Mærsk
Skjold Flank-1	5504/16-6	Mærsk
Baron-1	5604/30-2	Norsk Hydro
TWC-3P	5504/11-3	Mærsk

All information about released well data, seismic surveying data, etc. collected in connection with exploration and appraisal activities, is provided by the Geological Survey of Denmark and Greenland.

3. New Field Developments

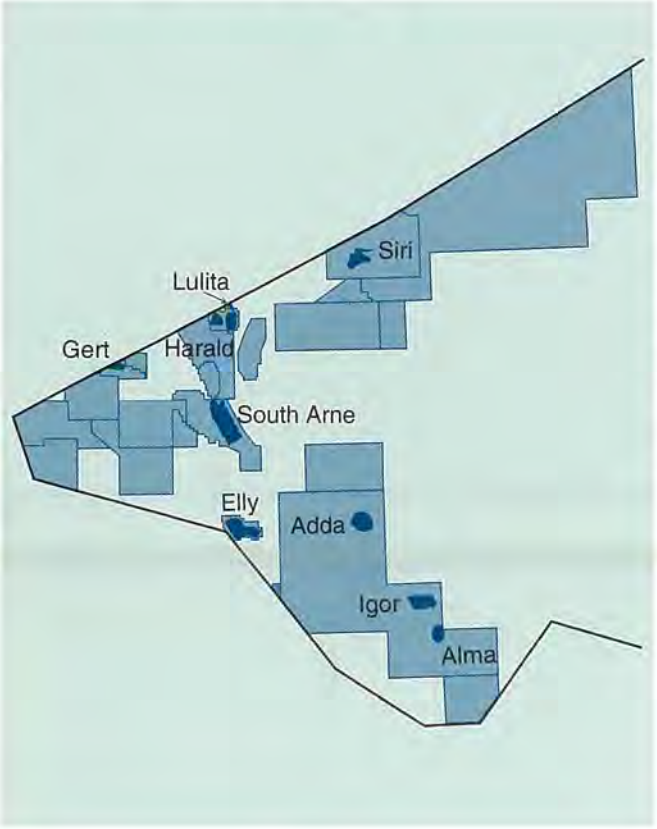
To date, Dansk Undergrunds Consortium (DUC) has been the only producer of oil and gas in the Danish sector of the North Sea. This is now about to be changed, as two other groups of licensees have made discoveries that are expected to be developed within the near future, viz. the Statoil group's Siri Field and the Amerada Hess group's South Arne Field.

Mærsk Olie og Gas AS is also planning to develop and initiate production from a number of new fields within the next few years, initially the Harald gas field, which is expected to be brought on stream in the first half of 1997.

Moreover, on behalf of DUC (the Sole Concession) and the Statoil group (licences 7/86 and 1/90), Mærsk Olie og Gas AS is expected to submit a development plan for the Lulita Field in spring 1997, with first oil expected late 1997.

Appendix D contains a complete outline with key figures on the fields for which development plans have been submitted. These fields include the Igor and Adda Fields, whose development was approved in 1990. The development plans for the Elly and Alma Fields were approved at the beginning of 1995. As yet, no decision has been made with regard to the Gert Field, for which a development plan was submitted in 1991. Negotiations are still ongoing between the licensees on each side of the Danish/Norwegian border regarding joint operation of the Gert/Mjølner Field.

Fig. 3.1 Future Field Developments



A description is given below of the most imminent new field developments: Harald, Siri and South Arne.

Fig. 3.1 shows the location of future field developments. Their location relative to existing fields is illustrated by Fig. 4.1 in the following section.

Harald

Harald consists of two gas accumulations 80 km north of the Tyra Field, just south of the border between the Norwegian and Danish sectors. The Harald Field comprises the following accumulations: Lulu discovered in 1980 and West Lulu discovered in 1983. The Lulu reservoir consists of Danian and Maastrichtian chalk, whereas the West Lulu reservoir consists of Middle Jurassic sandstone. Thus, the Harald Field will be the first field in Danish territory to produce from a sandstone formation.

In March 1996, a revised development concept for the Harald Field was approved. The revision implies that both gas accumulations will be developed from a single platform complex, consisting of two platforms situated at Harald East. This platform location has been chosen so that the Lulita Field can be produced from the Harald facilities.

The two platforms were installed in the Harald Field during 1996. Initially, production will take place from three wells in the West Lulu reservoir and two wells in the Lulu reservoir. Drilling operations were commenced at West Lulu in March 1996, while the Lulu drilling operations were initiated at the end of 1996. The first natural gas from the Harald Field is expected to be supplied in the first half of 1997.

The gas produced in the Harald Field will be transported through a gas pipeline (owned by Dansk Naturgas A/S) via Tyra East to shore, while the condensate produced will be conveyed through an oil and condensate pipeline to Tyra East for processing and transportation to shore. This pipeline also carries the Svend production to the Tyra Field.

New Field Developments

Siri

The Siri Field is an oil accumulation in Tertiary sandstone. The Siri Field is situated approx. 25 km east of the Central Graben, where all previous commercial oil and gas discoveries have been made. Statoil Efterforskning og Produktion A/S is operator for the field, with Danop as co-operator.

The Siri deposit was discovered in 1995 under licence 6/95. The field was declared commercial in March 1997, at the time an application for a development project was filed with the Danish Energy Agency.

The Siri oil accumulation has a fairly low gas content. The gas produced is proposed to be reinjected or used as fuel on the platform.

The proposed development concept is based on a jack-up platform, housing integrated accommodation, production and support facilities. The platform will be connected to an oil storage tank on the sea bed. The oil is to be transported via loading buoy facilities and tanker transport. According to the development concept, the field will be developed by means of six horizontal oil wells and three combined water/gas-injection wells. Production start-up is scheduled for October 1998 according to the development plan.

South Arne

The South Arne Field is an oil accumulation, with a fairly high gas content, in Danian and Maastrichtian chalk. The field is situated in the northern part of the Danish area of the Central Graben, approx. 250 km west of the west coast of Jutland and approx. 15 km south of the Svend Field. Amerada Hess is operator for the field.

The South Arne discovery was made in 1969, but was not declared commercial until 1996 under licence 7/89. In August 1996, the Amerada Hess group filed a development and production plan for the field, supplemented by further material submitted in February 1997.

According to the proposed development plan, the field is expected to be brought on stream in mid-1999. The development project is divided into three phases. Phase I provides for the drilling of up to 12 horizontal wells, of which five will be predrilled. Production in phase I will be based on primary recovery, using the reservoir pressure. The injection of water is being contemplated for phase II. Phase III is based on a possible further development of the field, with more wells being drilled and production being initiated from structures and formations not comprised by phase I.

According to the present development concept for the field, a combined wellhead/processing and accommodation platform is to be installed, with sufficient capacity for any subsequent installation of water-injection equipment. Further, the establishment of a storage facility for the oil produced is proposed, as the development concept provides for buoy loading and tanker transport.

4. Production

In 1996, Danish oil and gas production came from eleven fields, the oil fields Dan, Gorm, Skjold, Rolf, Kraka, Dagmar, Regnar, Valdemar and Svend, as well as the Tyra and Roar gas fields. Apart from the Svend Field, all the fields are situated in the southern region of the Central Graben.

Dansk Undergrunds Consortium, DUC, is in charge of recovery from all these fields. The operator is Mærsk Olie og Gas AS.

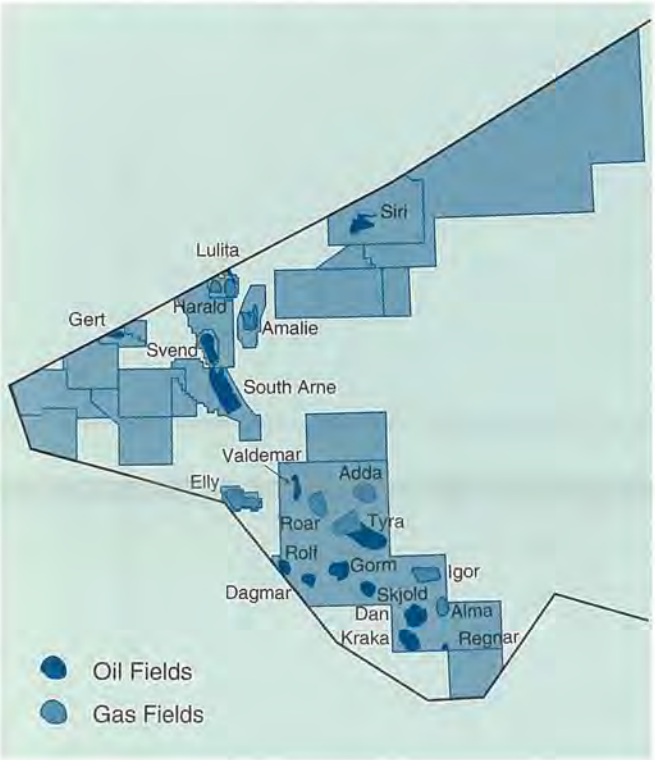
Fig. 4.1 is a map showing the location of the Danish producing fields and new field developments, see the section on *New Field Developments.*

Production Continues to Rise

Once again, Danish oil and gas production exceeded the production figures recorded in previous years, and thus, 1996 was another successful year with increasing production.

Over the past ten years, Danish oil production has been steadily mounting, and it is worth noting that this increase can largely be attributed to the rise in production from the Dan, Gorm and Skjold Fields. Oil production from these three fields has more than doubled in the past decade, and the increase in production accounts for as much as 70% of the total increase in Danish oil production. That the same fields have continued to augment production for so many years is exceptional, also in an international context.

Fig. 4.1 Danish Fields in the North Sea



A major reason for the successful development of Danish oil production is the drilling of horizontal wells and the injection of water into tight chalk formations.

The increase in the production of gas referred to above heralded a new gas sales contract between DUC and Dansk Naturgas A/S for natural gas supplies of up to 7.5 billion Nm^3 annually, as from 1997.

Total oil and condensate production in 1996 amounted to 12.09 million m^3, equal to 10.29 million tonnes. This means that the 1996 production of oil and condensate was 12% higher than in 1995.

Gross gas production amounted to 7.5 billion Nm^3 in 1996, of which 1.25 billion Nm^3 was reinjected into the Gorm and Tyra Fields. Thus, net gas production amounted to 6.25 billion Nm^3. Of the total amount of gas reinjected, 98% was reinjected to enhance the recovery of liquid hydrocarbons from the Tyra Field. Net gas production in 1996 was 21% higher than the previous year.

Gas production from the Tyra and Roar Fields accounted for 2.62 and 1.33 billion Nm^3, respectively, of total net gas production, while the balance constituted associated gas produced in conjunction with oil in the other fields.

Natural gas supplies to Dansk Naturgas A/S amounted to 5.71 billion Nm^3 (approx. 91% of net gas production). Of the remaining net gas produced, 0.37 billion Nm^3 (approx. 6%) was used for energy supplies to the platforms, while an amount of 0.17 billion Nm^3 (approx. 3%) had to be flared without being utilized. The gas is flared chiefly for safety and technical reasons. Of the gas flared, 2 million Nm^3 was poisonous gas (containing hydrogen sulphide) from the Dagmar Field.

Fig. 4.2 shows the development of Danish oil and gas production in the period from 1986 to 1996. Gas production comprises gas supplied to Dansk Naturgas A/S and gas used for energy supplies to the platforms.

Further information about annual oil and gas production, as well as water and gas injection, for the period from 1972 to 1996 is given in Appendix E.

Fig. 4.2 Production of Oil and Natural Gas

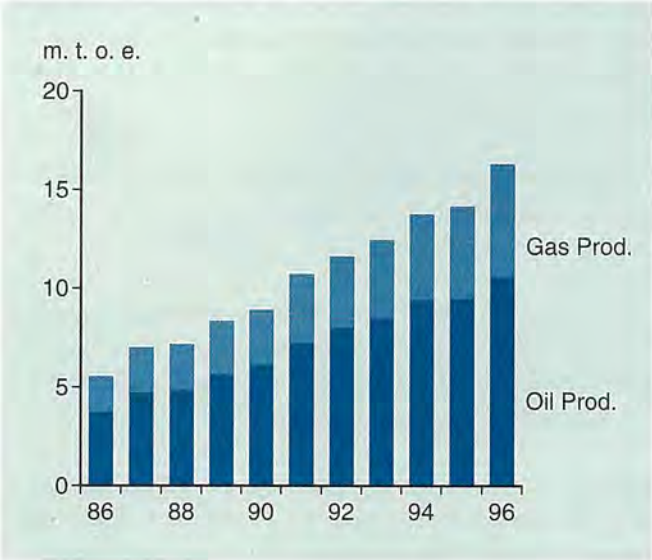


Fig. 4.3 shows the development in gas supplies to Dansk Naturgas A/S in the period 1986 to 1996, broken down into the Tyra Field, the Roar Field, and a combined figure for associated gas produced from the Danish oil fields.

1996 Developments in General

Activities in 1996 were mainly characterized by the further expansion of oil production in the Dan Field and the start-up of production from the Roar Field on 7 January and the Svend Field on 2 May. In addition, 1996 saw the installation of major new facilities and the conversion of existing facilities for the purpose of performing the gas sales contract concluded between DUC and Dansk Naturgas A/S.

The further development of the Dan Field provides for a large expansion of the Dan Centre production facilities. Thus, in August 1996, the jacket for the new Dan FF wellhead and processing platform was installed. The increase in production from the Dan Field is based on drilling new production wells and extending water injection to the whole field. Accordingly, nine wells were drilled in the course of 1996.

The gas sales contract providing for increased gas supplies has necessitated development of the Roar and Harald gas fields, including establishing the necessary infrastructure by way of installing pipelines to transport production from the so-called Northern Area to the Tyra Field. New compression and reception facilities at the Tyra Centre also had to be established. Two platforms have been installed in the Harald Field in the northern region of the Danish part of the Central Graben. The first natural gas is expected to be supplied from the Harald Field in the first half of 1997.

To improve the utilization of lift gas and enhance recovery from the Gorm, Skjold and Rolf Fields, an extra deck on Gorm F, housing wellhead compression facilities, was installed at the Gorm Centre in August 1996.

In June 1995, the Danish Energy Agency approved a minor development plan for the Valdemar Field, providing for the drilling of up to two further wells, of which the first was drilled in 1996.

Finally, in October 1996, a plan for the further development of the Kraka Field was filed with the Danish Energy Agency.

Successful Water-Injection Projects

The injection of water has led to greatly enhanced recovery of oil from some of the major Danish oil fields. In total, 22 million m^3 of water was injected into the Dan, Gorm and Skjold Fields in 1996, a 41% increase as compared to 1995, which is largely attributable to increased water injection in the Dan and Gorm Fields.

The best conditions for recovering oil are obtained if the reservoir pressure during production is stabilized above

Fig. 4.3 Natural Gas Supplies Broken down by Field

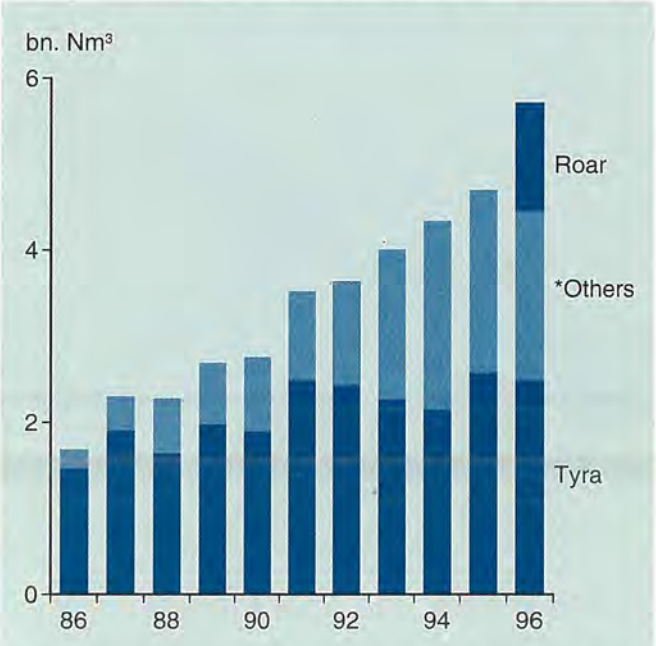
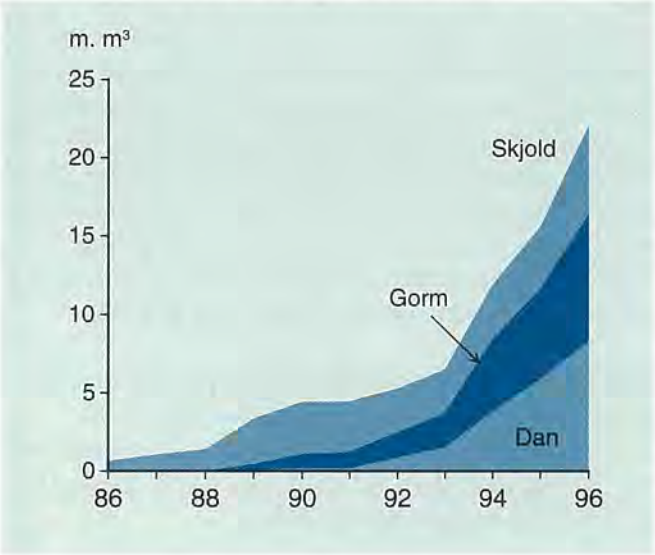


Fig. 4.4 Water Injected into Danish Fields



the bubble point of the oil. This is achieved when the natural influx of water from the water zone counterbalances the amounts extracted from the reservoir due to the production of oil, gas and water, without the reservoir pressure dropping below the bubble point. In other situations, it is necessary to inject water in order to stabilize the reservoir pressure at the desired level.

For the Rolf and Regnar Fields, the natural influx of water from the water zone has so far sufficed to achieve the desired stabilization of the reservoir pressure. In the Dan, Gorm and Skjold Fields, water has been injected to generate similar reservoir conditions. It is uncertain whether the production of oil can be increased from the Dagmar, Kraka, Valdemar and Svend Fields as a result of water injection.

Water injection was initiated on a minor scale in the Skjold Field in 1986, and in the Dan and Gorm Fields in 1989. As from 1993, the amounts of water injected have increased sharply. Fig. 4.4 shows the amounts of water injected during the period from 1986 to 1996.

The plans for the future operation of the Dan, Gorm and Skjold Fields are virtually to flood the reservoirs in water and thus to displace the oil from the reservoir rock. Within the next few years, the combined amount of injected water is expected to climb to 35 million m^3 a year, an increase of about 60% in relation to the level in 1996.

Based on the successful implementation of water-injection projects, oil production estimates have been written up considerably in recent years. The recovery factor for the Dan, Gorm and Skjold Fields is expected to increase by at least 20 percentage points as a result of water injection into the reservoirs.

Increasing Water Production

In 1996, Danish fields produced 9.9 million m^3 of water, thus producing almost as much water as oil. Until 1991, water production was moderate and only amounted to 1.5 million m^3. However, water production has gone up by 8.4 million m^3 within the past few years, and has therefore more than quintupled since 1991. Fig. 4.5 shows the development in water production for the Danish fields in the North Sea, broken down by processing centre, while Fig. 4.6 shows the share of water production relative to the total production of liquids. In 1996, water accounted for about 45% of all liquids produced.

The mounting water production can be attributed to several factors. In general, an increase in water production is to be expected over the life span of a field. The chalk reservoirs from which oil is produced contain both oil and water. In most cases, the oil flows much more readily through the reservoir towards the production wells. Therefore, oil exclusively is usually produced during the first few years, while no or very little water is extracted along with the oil. As more and more of the oil is produced, water begins to flow with the oil. At this point, an increasing content of water is observed in the production flow at the wellhead.

Moreover, oil reservoirs are frequently surrounded by water-filled formations, the so-called water zones, and in time, there will be a natural influx of water to the production wells from the water zone.

Fig. 4.5 Development in Water Production Broken down by Processing Centre

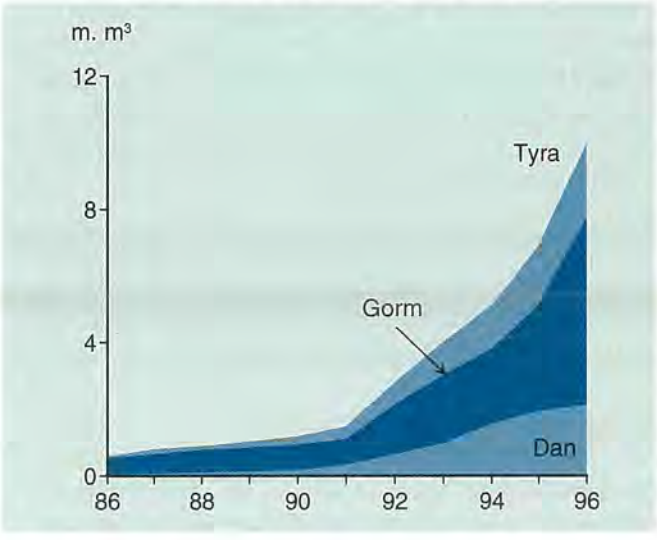
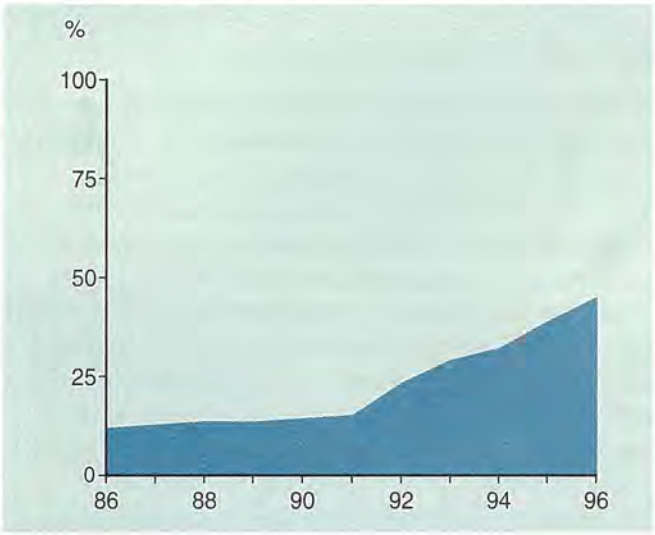


Fig. 4.6 Share of Water Produced Relative to Total Liquids Produced



Water injection engenders an increase in the water produced, as the water injected breaks through into the production wells.

Until the 1990s, the share of water produced constituted only 15% of the total liquids produced. The injection of water was initiated in the Skjold Field in 1986, and in the Dan and Gorm Fields in 1989, and the amounts of water produced have increased sharply in the course of the 1990s. For the Dan, Gorm and Skjold Fields, the shares of water production increased to about 30, 40 and 60%, respectively, in 1996. The Skjold Field is therefore one of the fields which produces more water than oil.

In future, the share of water produced, relative to total liquids produced from the fields, will continue rising, ultimately reaching nearly 100%. Already now, the shares of water production in the Regnar and Dagmar Fields have reached 88 and 96%, respectively, thus constituting the highest water production rates in Danish fields. However, the oil produced from the Regnar and Dagmar Fields constitutes less than 1% of total oil production, while the water produced constitutes almost 10% of total water production.

The water produced undergoes a thorough purification process before it is discharged into the sea. In order to limit the impact on the environment, attempts are currently being made to inject the water produced.

Henceforth, the challenge will be to prevent water from being produced for as long as possible. The operation of the fields will be based on the goal of improving the distribution of water injected and displacing the oil from the reservoir rock.

Production Wells

In 1996, 18 new horizontal or highly deviated production and injection wells were drilled in connection with developing the Danish fields in the North Sea. Nine of these are existing wells that have been redrilled. The number of wells drilled is slightly higher than the year before, when 16 wells were completed. In particular, the development of the Dan Field involved the drilling of several new wells. The total number of new wells is expected to be slightly higher in 1997 than in 1996.

At the turn of the year 1996/1997, the number of wells in operation in the Danish area totalled 217. In the course of 1996, the number of horizontal wells in operation was brought up to a total of 106, viz. 83 production wells and 23 water-injection wells.

The breakdown of the 18 new production wells drilled in 1996 is as follows: nine wells in the Dan Field, three in the Harald Field (in progress), two in the Svend Field, and one well in each of the Skjold, Valdemar, Tyra and Roar Fields.

Fig. 4.7 Danish Oil and Gas Fields

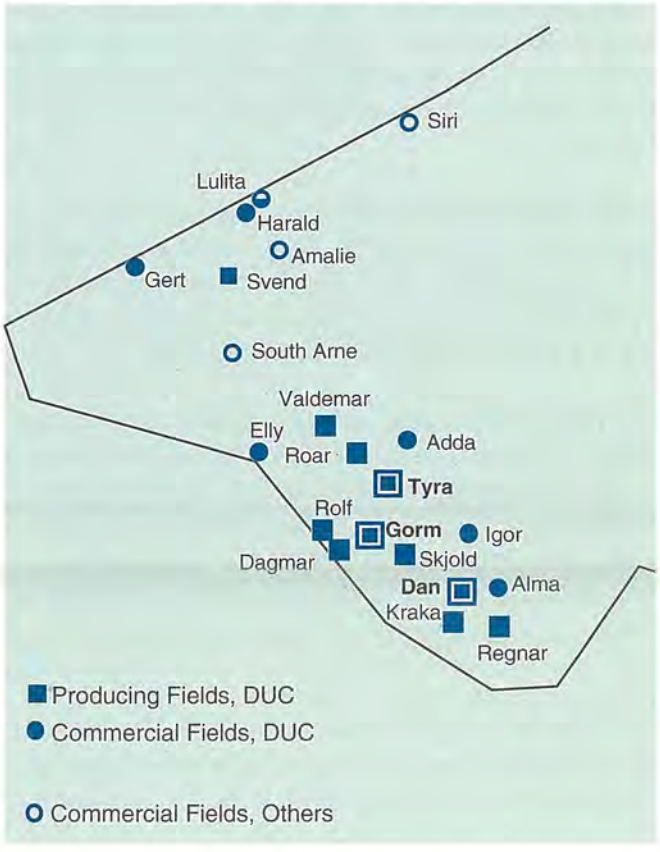
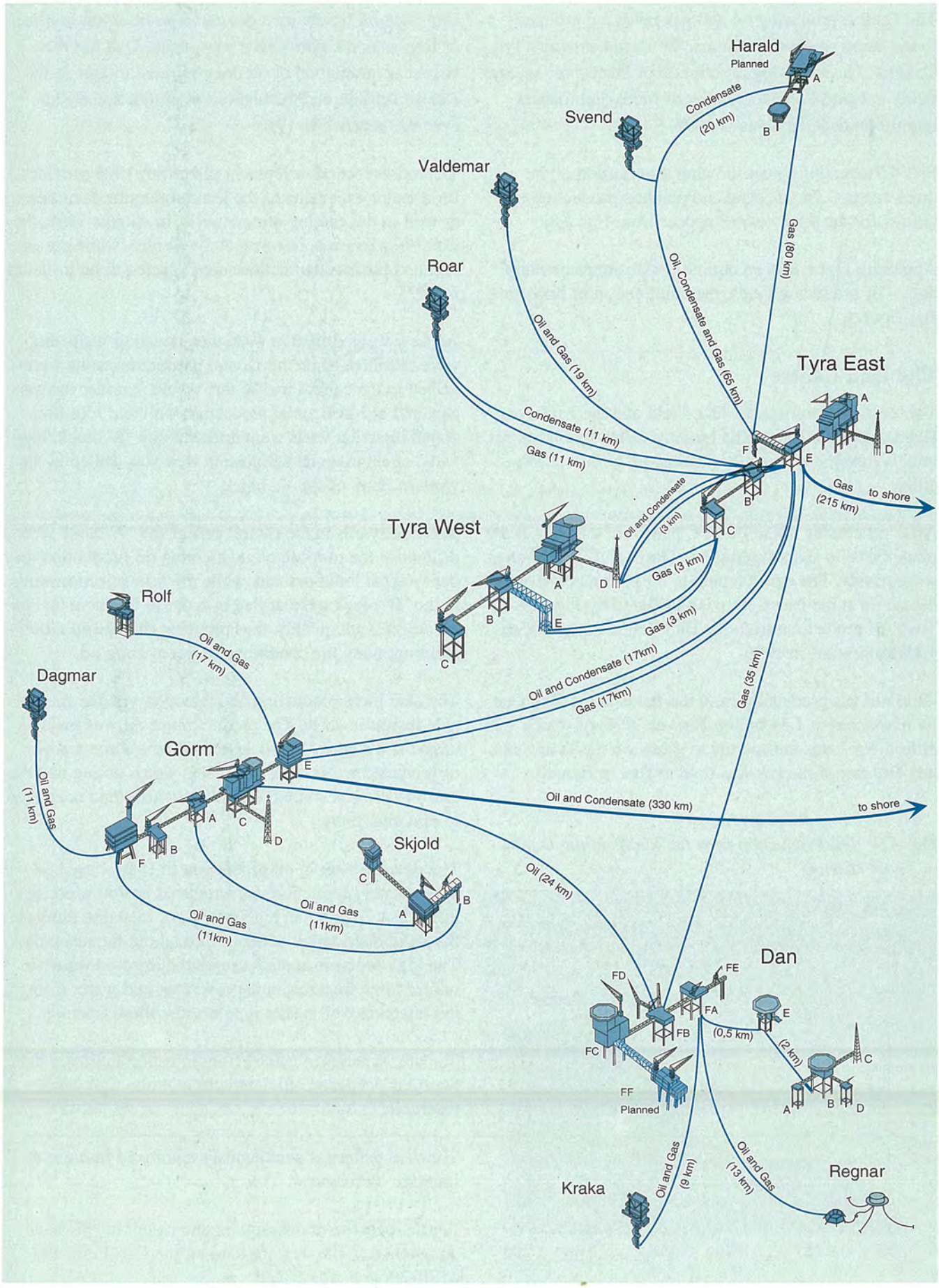


Fig. 4.8 Production Facilities in the North Sea, 1997



Producing Fields

The Danish producing oil and gas fields are grouped round three processing centres, the Dan, Gorm and Tyra Centres. The following description of Danish oil and gas fields is based on this grouping of fields and focuses mainly on developments in 1996.

Fig. 4.7 contains a map showing the location of the three centres. The existing and planned production facilities for the three centres appear from Fig. 4.8.

Appendix F provides an outline – with supplementary data – of producing fields, including the most important key figures.

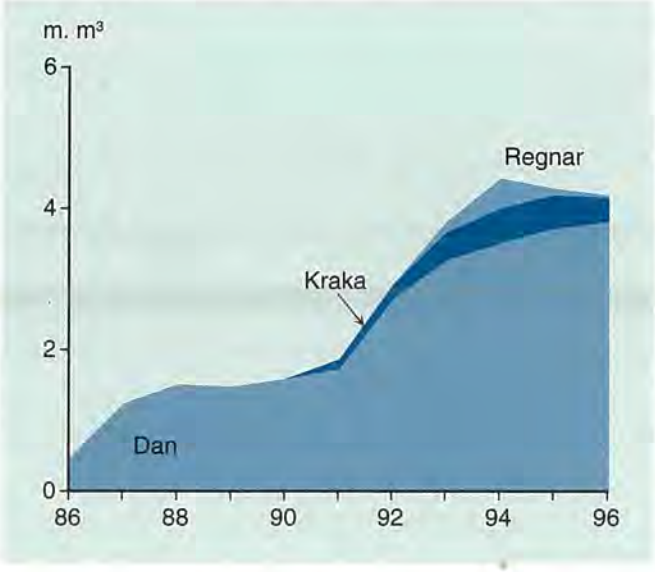
The Dan Centre

This centre comprises the Dan Field and the Kraka and Regnar satellite fields. The Igor and Alma Fields, as yet undeveloped, are also to be hooked up to Dan as satellites.

After processing at the Dan FC platform, oil and gas are transported to shore through the Gorm and Tyra Centres, respectively. The development in oil production from the fields at the Dan Centre is illustrated by Fig. 4.9. Total oil production from the Dan Centre amounted to 4.18 million m^3 in 1996.

Total net gas production from the fields at the Dan Centre amounted to 1.34 billion Nm^3 in 1996, of which 1.21 billion Nm^3 was transported to shore via the Tyra Centre. The rest of the gas was used as fuel or flared.

Fig. 4.9 Oil Production from the Fields at the Dan Centre



Dan

Dan is an oil field with a gas cap. The reservoir consists of Danian and Upper Cretaceous chalk. Dan has the largest accumulation of oil demonstrated to date in the Danish subsoil, and the highest oil production figure ever was reached in 1996.

The most recent development plan from 1995 provides for a major expansion of the Dan production facilities, as well as the drilling of new wells. In August 1996, the Dan FF jacket was installed at the Centre, while the associated processing facilities are expected to be installed in 1997.

All new wells drilled in 1996 were existing wells that were redrilled. Three horizontal production wells were drilled in the central part of the 'A' block under the gas cap, and one horizontal production well and four horizontal injection wells were drilled in the 'B' block. Finally, one horizontal delineation well was drilled in the western flank of the 'A' block.

The three wells in the central part of the 'A' block were drilled for the purpose of augmenting oil production under the Dan Field gas cap, while the four injection wells in the 'B' block were drilled in order to augment the reservoir pressure quickly, thus reducing the gas/oil ratio and improving the conditions for recovering oil.

The Dan Field production and injection yielded favourable results in 1996. The production of oil was maintained at a slightly higher level, with the same amount of produced water, as in 1995. It is worth noting that the gas/oil ratio has continued its downward trend compared to previous years.

The development in oil production in 1996, based on stable water production and a reduced gas/oil ratio, signifies that large-scale, high-rate water injection ensures the rapid distribution of water throughout the reservoir. The high pressure applied causes the injected water to induce large fractures in the reservoir, and water from the injection well rushes in to occupy these fractures.

To date, experience gained from injection indicates that the oil is displaced efficiently through the tight chalk reservoir.

The well pattern is continuously optimized in order to improve oil recovery.

For the purpose of determining the extent of the oil accumulation in the western flank of the Dan Field, the MFB-2E well was drilled.

In drilling this delineation well, good reservoir properties with high oil saturations were demonstrated, and the reservoir was found to extend further towards the west and to a greater depth than hitherto assumed.

Kraka

Kraka is a minor oil field with a gas cap, which is located approx. 7 km southwest of the Dan Field. The reservoir consists of Danian and Upper Cretaceous chalk. The field has been developed as a satellite to the Dan Field. Production from the field was initiated in 1991.

The first phase of the field development consisted of the completion of six horizontal wells, of which the last three commenced producing in 1993/94. Production experience from the field is encouraging, even though Kraka produced 28% less oil in 1996 than in 1995.

In October 1996, the Concessionaires submitted a plan for the second phase of the field development, of which the first stage consists of drilling another production well in the northern part of the field and utilizing lift gas in the wells. One objective of the well is to determine the production potential for this part of the field. This appraisal well is to be drilled at the beginning of 1997.

Regnar

The Regnar Field is a minor oil field situated approx. 13 km southeast of the Dan Field in the Contiguous Area. The reservoir consists of Danian, Upper Cretaceous and Zechstein carbonates. The field was brought on stream in 1993 from a subsea-completed well hooked up to the Dan Field.

The field consists of an accumulation of oil in a heavily fractured chalk reservoir, with characteristics similar to those of other Danish fields, such as Skjold, Rolf and Dagmar.

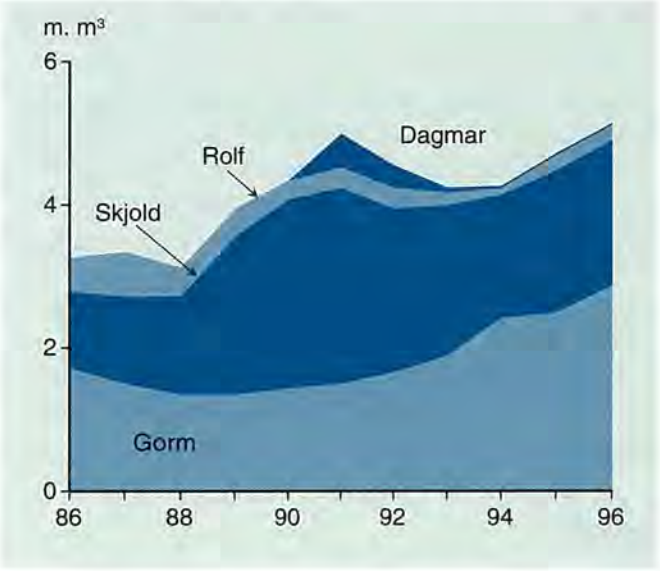
Since autumn 1996, production has been suspended due to technical problems.

The development in production in 1996 was better than anticipated, and it is assumed that the field can continue producing for a number of years. In 1996, oil production amounted to 0.04 million m^3.

The Gorm Centre

This Centre is composed of the Gorm Field and the satellite fields, Skjold, Rolf and Dagmar. The pipeline to shore emanates from the Gorm Centre, conveying oil and condensate from the Danish fields in the North Sea to the west coast of Jutland, and from there to the terminal facilities near Fredericia on the east coast.

Fig. 4.10 Oil Production from the Fields at the Gorm Centre



The development in oil production from the fields at the Gorm Centre is shown in Fig. 4.10. It appears from this figure that production, particularly from the Gorm and Skjold Fields, was substantial in 1996.

In 1996, oil production from the fields at the Gorm Centre totalled 5.14 m^3.

Total net gas production from the fields at the Gorm Centre amounted to 0.82 billion Nm^3 in 1996, of which 0.62 billion m^3 was transported to shore through the Tyra Centre.

Gorm

Gorm is a major oil field situated 27 km northwest of the Dan Field. The reservoir consists of Danian and Upper Cretaceous chalk. The field was brought on stream in 1981, and water injection was initiated in 1989.

Based on the approval of a revised plan in 1994, a new deck was installed on Gorm F in August 1996, and the new wellhead compression facilities were commissioned in January 1997. This is intended to improve the utilization of lift gas in the Gorm, Skjold and Rolf Fields.

The 1996 oil production figure was higher than the production figures recorded during the first years after the start-up of production in 1981. This is not a frequent occurrence in the oil industry. Usually, an oil field pro-

duces at a maximum rate for the first one to three years, after which production gradually declines over a number of years. However, the new horizontal production wells and the auspicious experience derived from using water injection have brought about this successful development for the Gorm Field. In 1996, the gas/oil ratio was reduced to a third of the ratio in 1989, when water injection was initiated. During the same period, the water content of total oil and water production only increased from about 30% to about 40% on average.

Gas injection has been nearly phased out in the Gorm Field, and in 1996 only 0.03 billion Nm^3 of gas was injected into the field. It should be noted that gas is only injected into the Gorm Field when the gas cannot be exported to the Tyra Centre.

Skjold

Skjold is a major oil field located 10 km southeast of the Gorm Field. The reservoir consists of Danian, Upper Cretaceous and Zechstein carbonates. Some parts of the reservoir are highly fractured. Production was initiated in 1982, and already in 1986, water injection in the reservoir commenced.

In 1996, oil production was 2% higher than in 1995, while the content of water relative to overall production jumped from about 40% to almost 60% during the same period. Nevertheless, the use of water injection is still viewed as producing favourable results. In recent years, new wells have penetrated long zones with high oil saturations, but also a few short zones with low oil saturations. The parts of the reservoir with high oil saturations indicate that large oil reserves still remain. In the water flooded parts of the reservoir, low residual oil saturations have been observed, indicating that the water has effectively displaced the oil. Therefore, the goal for future operation of the field is to ensure better distribution of water to greater parts of the reservoir.

In autumn 1996, a new production well was drilled in the southwestern part of the field. The well was drilled to appraise this area of the field, as well as to produce oil from the less developed, southwestern part of the field. The results indicate that there is potential for further developing the western part of the field.

Rolf

Rolf is a minor oil field situated 15 km west of the Gorm Field. The reservoir consists of Danian, Upper Cretaceous and Zechstein chalk. The reservoir is highly fractured. In 1986, the field, developed as a satellite field to Gorm, was brought on stream.

In recent years, the field has not undergone any further development. The production of oil, gas and water has stabilized at the 1995 level.

Dagmar

Dagmar is a minor oil field situated 10 km west of the Gorm Field. The reservoir consists of Danian, Upper Cretaceous and Zechstein carbonates. The reservoir is situated in the flank of a salt dome. The field, which has been developed as a satellite to Gorm, was brought on stream in 1991. Production takes place from two delineated wells.

Since its start-up in 1991, production from the Dagmar Field has plummeted, viz. from 0.47 million m^3 to 0.02 million m^3 of oil in 1996. However, in order to enhance recovery from the field, DUC is now planning to drill a new horizontal well. The new well is to appraise the structure in the southeastern flank of the salt dome, where a separate reservoir may exist. At the same time, the new well is to determine the lateral continuity of the Dagmar structure, both in terms of geology and reservoir pressure.

The Tyra Centre

In 1996, production from the Tyra Centre derived from the Tyra Field and the satellite fields, Valdemar, Roar and Svend. The Roar and Svend Fields were brought on stream in 1996. The Tyra Field is situated 15 km northwest of the Gorm Field. The Harald Field production is expected to be received at the Tyra Field in the first half of 1997, and subsequently the production from the small satellite installations, Adda, Elly and Tyra South East, is expected to be hooked up to Tyra East.

The gas produced is transported from Tyra East through the gas pipeline to the west coast of Jutland, while the oil and condensate produced will be transported to shore via Gorm.

Fig. 4.8 shows the location of the Tyra Centre complete with satellite fields and production facilities, as well as the associated infrastructure.

Fig. 4.11 shows oil production at the Tyra Centre in the period from 1986 to 1996.

Total oil and condensate production from the fields connected to the Tyra Centre constituted 2.77 m^3 in 1996. Total net gas production from the fields at the Tyra Centre amounted to 4.09 billion Nm^3 in 1996, of which 3.88 billion Nm^3 was transported to shore.

Tyra

Tyra comprises a large gas reservoir overlying a thin black oil zone. The oil zone is the second largest oil accumulation discovered in Danish territory. The reservoir rock consists of Danian and Upper Cretaceous chalk. Production commenced in 1984, and since 1987, part of the gas produced has been reinjected into the reservoir to increase the production of condensate. The oil zone is exploited from horizontal production wells.

As a result of the 1992 development plan, the extension of the Tyra Field installations continued in 1996. This extension was made primarily in consideration of the substantial increase in gas sales to Dansk Naturgas A/S as from 1997.

A number of the major new facilities in the Tyra Field, including the facilities for receiving production from the northern fields, Harald, Svend and Roar, as well as the compression facilities at both Tyra East and Tyra West were put into operation in 1996.

In addition, the deck on the TEB platform was extended, so that it can accommodate up to a total of 24 wells. A number of production wells will be converted into gas-injection wells. At the end of 1996, the first of another three horizontal gas wells at Tyra East was spudded.

In 1996, 2.62 billion Nm^3 of net gas was recovered from the Tyra Field, which is about 3% less than in 1995. Total oil and condensate production in 1996 was 11% less than the year before.

Valdemar

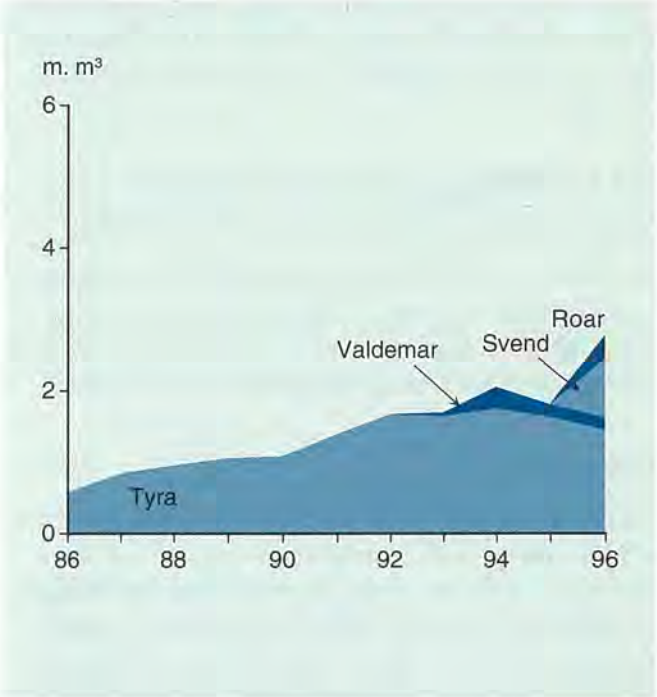
The Valdemar oil field is located approx. 20 km northwest of the Tyra Field, developed as a satellite to Tyra East. Since 1993, production has taken place from the North Jens area in the northern part of the Valdemar Field.

The main reservoir, from which production takes place, is situated much deeper than other Danish producing fields, and Valdemar thus consists of carbonates from earlier periods, viz. of Aptian/Barremian age.

Valdemar is a major oil accumulation by Danish standards. However, the reservoir consists of very tight chalk, which makes recovery very difficult.

In autumn 1996, a new production well was drilled in the North Jens area in order to enhance recovery. Despite the new well, the 1996 oil production figure for Valdemar did not exceed the figure recorded the year before. Moreover, the performance of the new well has led to a downward adjustment of the estimate of oil-in-place in the Valdemar Field. A further problem encountered in 1996 was that parts of the formation were extracted with the oil produced.

Fig. 4.11 Oil and Condensate Production at the Tyra Centre



Together with Mærsk Olie og Gas AS, the Danish Energy Agency has initiated a major research project aimed at enhancing the recovery of oil from Aptian/Barremian chalk. The further expansion of production at the Valdemar Field will be based on the results of this joint research project.

Svend

The Svend oil field is situated 60 km northwest of the Tyra Field. The reservoir rock consists of Danian and Upper Cretaceous chalk. The field has been developed as a satellite to the Tyra Field, and the production is conveyed to Tyra East through a pipeline section connected to the Harald-Tyra pipeline. Production was commenced in May 1996. The Svend Field consists of a northern reservoir called North Arne, discovered in 1975, and a southern reservoir called Otto, discovered in 1982.

Production is carried on from an unmanned STAR platform specially designed for greater water depths. Two horizontal wells have been drilled, one in the North Arne reservoir and one in the Otto reservoir.

The 1996 production figure for the Svend Field was much higher than expected. Thus, the daily production figure for the well in the North Arne reservoir reached 4,600 m^3 at end-1996, equal to about 29,000 barrels per day. So far, the oil produced is almost unaccompanied by water.

The heavy fracturing of the North Arne reservoir accounts for the oil production rate being so high for the North Arne well. However, it is uncertain for how long this high production rate can be sustained, as experience from the fractured fields in the southern region of the Central Graben shows that the length of such production periods may vary from a few months to several years.

Roar

Like the Tyra Field, Roar comprises a gas cap overlying a thin black oil zone. The reservoir consists of Danian and Late Cretaceous chalk. The Roar Field was brought on stream on 7 January 1996. The Roar Field is smaller than the Tyra Field, and is situated 10 km northwest of the Tyra Field in the Contiguous Area. The field has been developed as a satellite to Tyra East with an unmanned platform of the STAR type. In addition, the development of the field consisted of the drilling of two horizontal wells in the northern and the southern parts of the field, respectively. When separated, the production is conveyed to the reception facilities at Tyra East.

The production of gas from the two horizontal wells in 1996 was about 50% higher than the figure expected prior to the implementation of the development project. In 1996, this increased production from the Roar Field resulted in the stabilization of reservoir pressure in the Tyra Field, thereby improving the conditions for recovering liquid hydrocarbons.

Natural Gas Storage Facilities

Dansk Naturgas A/S has two natural gas storage facilities at its disposal, one at Lille Torup near Viborg in Jutland, and one at Stenlille on Zealand.

At the beginning of winter 1996/97, the total volume of gas injected into the Stenlille storage facility provided an extraction capacity of 230 million Nm^3.

To make a more exact assessment of the potential extraction capacity, Dansk Naturgas A/S plans to carry out further seismic surveys in 1997.

In 1996, a new drilling campaign was initiated comprising three additional wells.

At Lille Torup, six caverns have been established in a subterranean salt dome with a total extraction capacity of 300 million Nm^3 of natural gas. At present, this storage facility is being expanded by a seventh cavern that will bring total capacity up to 420 million Nm^3 of natural gas in mid-1997.

Before the winter of 1996/97, the storage facility had a capacity of about 400 million Nm^3. Dansk Naturgas A/S has carried out seismic surveys at Lille Torup which show that good opportunities exist for expanding the storage capacity to 7-800 million Nm^3.

5. Reserves

Assessment of Reserves

An assessment of Danish oil and gas reserves is made annually by the Danish Energy Agency.

The assessment made by the Danish Energy Agency at January 1, 1997 shows a decline in oil and gas reserves of 8% and 7%, respectively. Apart from the depletion caused by the production in 1996, the decline in reserves is attributable to a writedown of the production potential for the Valdemar and Siri Fields. Oil reserves are estimated to amount to 232 million m^3.

Compared to last year's assessment, total expected oil and condensate reserves have been written down by 8 million m^3. Production in 1996, which exceeded production in 1995 by 1.3 million m^3, amounted to almost 12.1 million m^3. Thus, the decline in oil reserves totals 20 million m^3.

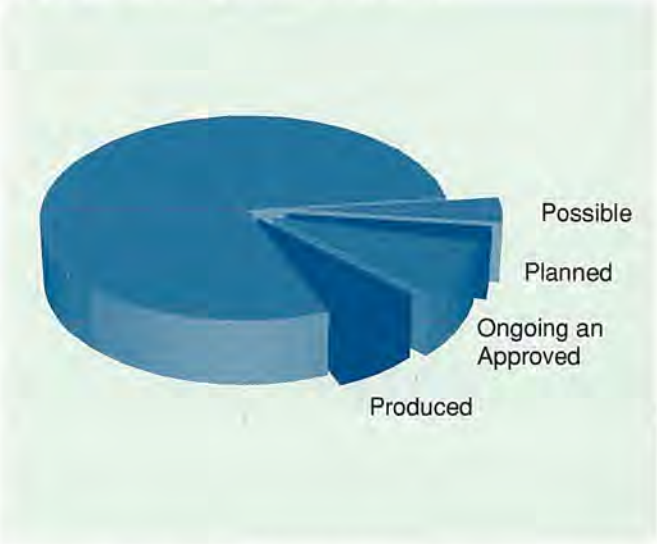
Oil reserves can be put into perspective by calculating the ratio of reserves to the previous year's production. Such a calculation results in a so-called *R(reserves)/P(production) ratio*, which is an indicator of the number of years for which oil production is estimated to be sustained. Based on the new assessment of reserves, the R/P ratio is 19, meaning that oil production is sustainable at the 1996 level for the next 19 years. In recent years, the R/P ratio has shown a declining trend, due mainly to the growth in production.

The reserves reflect the amounts of oil and gas that can be recovered by means of known technology under the prevailing economic conditions. The method used by the Danish Energy Agency in calculating the reserves and preparing the production forecasts is described at the end of this section.

The basis for the reserves assessment is illustrated by Fig. 5.1, where the size of the individual categories is related to the total amount of oil and condensate in place. Table 5.1 shows the Danish Energy Agency's assessment of oil, condensate and gas reserves, broken down by field and category.

A *low, expected* and *high estimate of reserves* is given for each individual field, in order to illustrate the uncertainty attached to the assessment. In assessing Denmark's total reserves, it is not realistic to assume that either a high or a low figure will prove accurate for all fields. Therefore, for a large number of fields, the total assessment of reserves should be based on the expected value.

Fig. 5.1 Oil and Condensate in Place



It appears from Fig. 5.2 that the expected amount of oil and condensate reserves ranges from 169 to 232 million m^3. The reserves assessed for planned and possible recovery, respectively, reflect the increasing uncertainty as to whether such reserves can be exploited commercially.

Likewise, Fig. 5.3 illustrates that the expected amount of gas reserves ranges from 125 to 158 billion Nm^3. Gas production figures represent the net production, i.e. produced gas less reinjected gas. It should be noted that the amounts of gas stated deviate from the amounts which can be marketed as natural gas, the difference (10-15%) representing the amounts flared or consumed on the platforms.

There have been several revisions of the Danish Energy Agency's assessment of reserves compared to the assessment made in January 1996. These revisions are attributable to new reservoir models resulting from improved knowledge of the fields and more production experience.

The areas where significant revisions have been made are described below.

Ongoing and Approved Recovery

The reserves of the Kraka, Gorm, Skjold and Svend Fields have been reassessed on the basis of production experience. The Dagmar Field reserves have been written up to reflect the drilling of an additional well in the field.

Planned Recovery

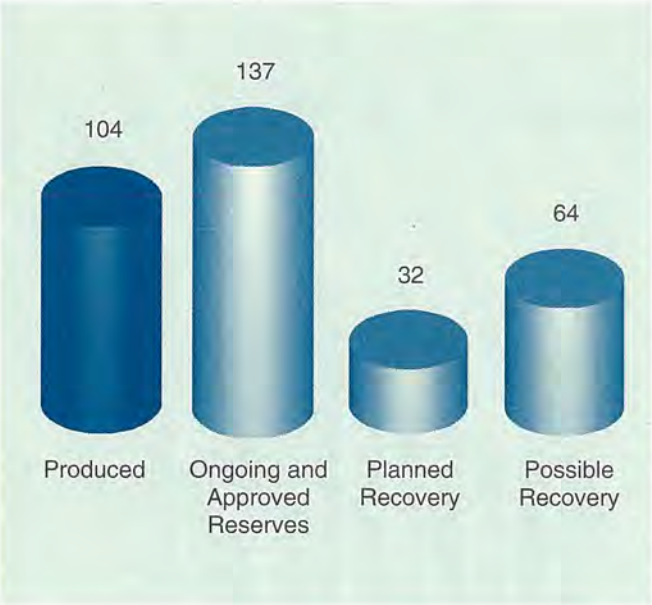
Planned recovery includes reserves in the Kraka Field recoverable as a consequence of a new development

Reserves

Table 5.1 Production and Reserves at 1 January 1997

Oil and Condensate, million m³					Gas, billion Nm³				
	Produced	Reserves				Produced, net	Reserves		
		Low	Exp.	High			Low	Exp.	High
Ongoing and Approved Recovery					**Ongoing and Approved Recovery**				
Dan	29	48	73	99	Dan	11	8	13	18
Kraka	2	1	2	4	Kraka	1	<1	1	1
Regnar	1	<1	<1	<1	Regnar	<1	<1	<1	<1
Igor	-	<1	<1	<1	Igor	-	1	2	3
Alma	-	<1	1	1	Alma	-	1	1	2
Gorm	28	8	20	32	Gorm	3	2	4	6
Skjold	23	6	14	24	Skjold	2	<1	1	2
Rolf	3	1	2	3	Rolf	<1	<1	<1	<1
Dagmar	1	<1	1	1	Dagmar	<1	<1	<1	<1
Tyra	14	4	7	11	Tyra	26	41	53	65
Valdemar	1	1	2	3	Valdemar	<1	1	1	1
Roar	<1	2	2	3	Roar	1	9	13	17
Svend	1	3	6	8	Svend	<1	<1	1	1
Adda	-	<1	1	1	Adda	-	<1	<1	1
Elly	-	<1	1	1	Elly	-	2	5	7
Harald	-	5	7	9	Harald	-	20	25	31
Subtotal	**104**		**137**		**Subtotal**	**45**		**114**	
Planned Recovery					**Planned Recovery**				
Kraka	-	1	2	3	Kraka	-	<1	1	1
Lulita	-	3	4	5	Lulita	-	1	2	2
Siri	-	5	8	12	Siri	-	-	-	-
South Arne	-	8	14	28	South Arne	-	3	6	11
Gert	-	1	2	3	Gert	-	<1	<1	<1
Amalie	-	1	2	3	Amalie	-	1	3	5
Subtotal			**32**		**Subtotal**			**11**	
Possible Recovery					**Possible Recovery**				
Prod. Fields	-	17	34	51	Prod. Fields	-	5	9	14
Other Fields	-	8	15	21	Other Fields	-	3	6	9
Discoveries	-	5	15	32	Discoveries	-	6	17	33
Subtotal			**64**		**Subtotal**			**32**	
Total	**104**		**232**		**Total**	**45**		**158**	
January 1996	92		252		January 1996	39		169	

Fig. 5.2 Oil Production and Reserves



plan providing for the drilling of an additional production well and the utilization of lift gas in the wells.

The reserves for the South Arne and Siri Fields have been included under *planned recovery,* as these fields were declared commercial in April 1996 and March 1997, respectively.

No gas reserves are indicated for the Siri Field, as the gas produced is to be used as fuel or to be reinjected according to the development plan. Additional reserves for the Siri Field have been included in the *possible recovery* category, as a further appraisal to be made as part of the development project will show whether the expectations for reserves in the northern part of the field can be confirmed.

Possible Recovery

The Danish Energy Agency has reviewed a number of options for enhancing recovery with the use of known technology, i.e. technology which is used today under conditions comparable to those prevailing in the North Sea.

Based on reservoir calculations and general estimates of investments, operating costs and oil price developments, it is assessed that the recoverable reserves can be augmented considerably by implementing additional water-injection projects in a number of fields.
The drilling of horizontal wells is considered to further increase the production potential of the oil zone in the Tyra Field as well as that of the tight chalk reservoirs in the Kraka and Adda Fields.

The estimated amounts of hydrocarbons in place in the Valdemar Field have been written down substantially as compared to previous years; therefore no production potential for this field has been included under *possible recovery.*

Finally, a number of discoveries that are under evaluation are included in this category. The category also includes discoveries that have been declared non-commercial, based on current technology and prices.

Further Production Potential

The total amount of oil and condensate that is recoverable with the use of known technology corresponds to only approx. 21% of the hydrocarbons in place in Danish territory.

In fields like Dan, Gorm and Skjold, where the production conditions are favourable, an average recovery factor of 35% of the hydrocarbons in place is expected, based on the assumption that known methods are used, including water and gas injection.

The total oil reserves recoverable also include contributions from the relatively large accumulations in the Tyra and Valdemar Fields. These contributions are quite low due to the very difficult production conditions.

Because of these fairly low recovery factors, there is an incentive for the oil companies and authorities to develop methods to improve the recovery of oil, so-called *IOR methods* (improved oil recovery).

Fig. 5.3 Gas Production and Reserves

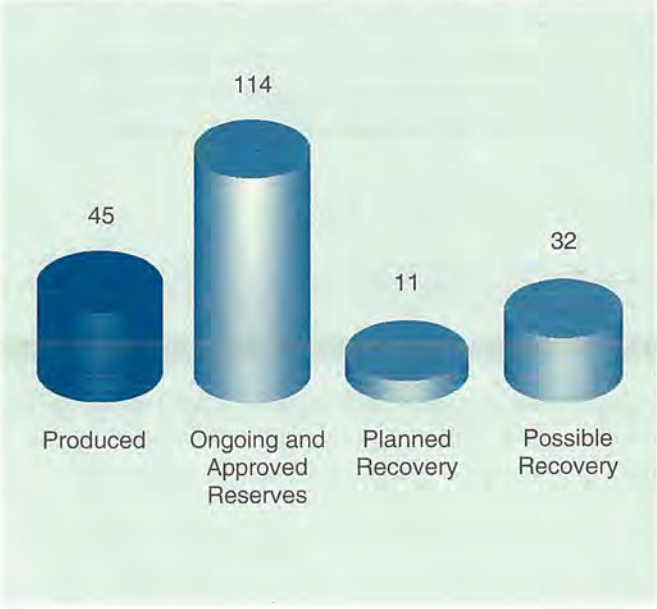


Table 5.2 Oil and Condensate Production Forecast, million m³

	1997	1998	1999	2000	2001
Ongoing and Approved					
Dan	3.9	4.6	5.2	5.3	5.3
Kraka	0.4	0.3	0.2	0.1	0.1
Regnar	0.0	0.0	0.0	0.0	0.0
Igor	-	-	0.0	0.0	0.0
Gorm	3.0	2.9	2.3	1.9	1.5
Skjold	2.2	1.8	1.6	1.3	1.0
Rolf	0.3	0.2	0.2	0.2	0.1
Dagmar	0.0	0.1	0.1	0.1	0.1
Tyra	1.3	1.1	0.9	0.7	0.7
Valdemar	0.2	0.2	0.2	0.2	0.2
Roar	0.5	0.4	0.3	0.2	0.2
Svend	1.4	0.9	0.7	0.5	0.3
Adda	-	-	0.5	0.1	0.0
Elly	-	-	0.2	0.1	0.1
Harald	0.9	1.4	1.2	0.9	0.7
Total	**13.8**	**14.1**	**13.5**	**11.6**	**10.3**
Planned	0.2	1.1	4.7	5.5	4.9
Expected	**14.1**	**15.2**	**18.2**	**17.1**	**15.3**

Production Forecasts

Based on the assessment of reserves, the Danish Energy Agency prepares production forecasts for the recovery of oil and natural gas in Denmark.

The present five-year forecast shows the Danish Energy Agency's expectations for production until the year 2001. In addition, the twenty-year forecast shows the Danish Energy Agency's assessment of the production potential for oil and natural gas in the longer term.

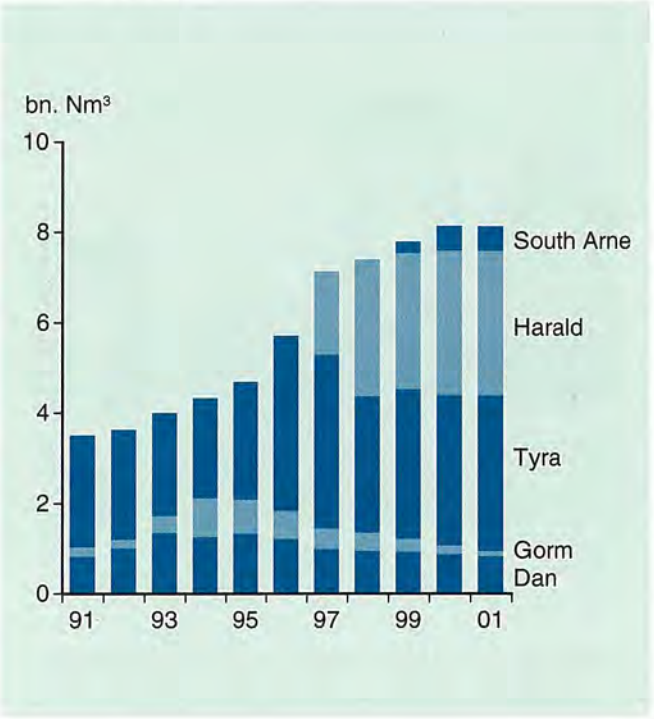
Five-Year Production Forecast

The five-year forecast uses the same categorization as the assessment of reserves, and includes only the categories *ongoing, approved,* and *planned recovery.*

Fields are incorporated into the production forecast from the time production startup is approved or from the earliest date on which production can be commenced.

As appears from Table 5.2, oil and condensate production is expected to reach approx. 14.1 million m³ in 1997, and is then anticipated to increase to 18.2 million m³ in 1999, equal to about 310,000 barrels/day. After that time, production is expected to decline.

Fig. 5.4 Natural Gas Sales Broken down by Processing Centre



It is assumed in the forecast that oil and condensate production will not be subject to any restrictions in terms of capacity or transportation. A production level of 18 million m³ exceeds the current capacity of DORAS' oil pipeline installations, so various possibilities of meeting this transportation requirement are being investigated. For instance, the development plans filed for the South Arne and Siri Fields provide for tanker loading of the oil produced.

In relation to the forecast in the Danish Energy Agency's Report on Oil and Gas Production in 1995, expected production figures have been written up.

Within the categories *ongoing* and *approved recovery,* the estimated production figures have been adjusted for the Dan and Gorm Fields, and written up for the Skjold and Svend Fields. The production forecast has been revised on the basis of recent production experience, which shows that the production properties of the Svend Field in particular are better than initially assumed.

The expectations for production from the remaining fields are largely unchanged in relation to last year's report. However, the Harald Field is expected to come on stream in April instead of October 1997, as previously assumed.

The *planned recovery* category comprises the further development of the Kraka Field and the future development of the Lulita, Siri, South Arne, Gert and Amalie Fields. The South Arne and Siri Fields have been included in the forecast, as these fields have been declared commercial, as mentioned above.

The expected production from the South Arne and Siri Fields is the main reason for the marked upward adjustment of the overall production forecast for the period from 1999 to 2001. Thus, the production forecast has been written up by more than 40% for 1999.

Expected production of natural gas is shown in Fig. 5.4, broken down by processing centre.

Twenty-Year Production Forecast

The twenty-year forecast has been prepared according to the same method as the five-year forecast, and thus uses the same categorization as the assessment of reserves. However, unlike the five-year forecast, the *possible recovery* category is also included.

In preparing the forecast up to the year 2016, it has been assumed that the course of production will be planned on the basis of the technical potential of the fields, without taking any possible legal and operational constraints into account.

Fig. 5.5 illustrates two oil and condensate production scenarios. The curve illustrating planned recovery is simply a continuation of the curve shown in Table 5.2, while the second curve also includes *possible recovery.*

Planned production will increase to about 18 million m^3 in 1999, after which production is expected to decline.

Within the category *possible recovery,* the production potential is based on the Danish Energy Agency's assessment of possibilities for initiating further production not based on development plans submitted. Thus, the Danish Energy Agency estimates that the increased use of water injection in certain fields represents further oil production potential, and moreover, that a potential for enhancing recovery from the oil zone in the Tyra Field as well as from the Kraka, Adda and Siri Fields exists.

It appears from Fig. 5.5 that production is expected to increase to about 20 million m^3 around the year 2000, which means that the production potential will increase by about 60% for a few years as compared to the current production level. After the year 2000, production is estimated to decline to about 6 million m^3 in 2010, bringing the production potential to about half the current level.

In fact, the above production forecast does not differ significantly from the forecast contained in the Danish Energy Agency's Report on Oil and Gas Production in 1995.

As mentioned above, the expectations for future oil production are based on the gratifying production results recorded in recent years. However, it should be emphasized that the assessment of possible recovery is subject to great uncertainty.

As opposed to the production of oil, which can always be sold at the current market price, the production of natural gas requires that long-term sales contracts have been concluded.

Since the start of gas sales in 1984, Danish natural gas has been supplied under two gas sales contracts from 1979 and 1990, respectively, providing for total supplies of 93 billion Nm^3.

In 1993, a supplementary agreement was concluded between DUC and Dansk Naturgas A/S for the sale of additional gas supplies. The new gas sales contract does not stipulate a fixed total volume, but rather a fixed annual volume that will be supplied for as long as DUC considers it technically and financially feasible to carry on production at this level.

The Danish Energy Agency's forecast for the planned course of production is based on the contracts with DUC providing for a maximum gas production plateau of 7.5 billion Nm^3 and total gas supplies of 130 billion Nm^3 until the year 2012.

The forecast for the possible course of production predicts total gas supplies of 151 billion Nm^3 during the period of the forecast.

Further Production Potential

The oil production scenario outlined above is not to be considered the upper limit of Danish production potential. Further production is possible if current efforts to develop enhanced recovery methods and improve equipment are continued and intensified. Moreover, the experience gained from the current development of the fields is expected to provide new opportunities for enhancing recovery.

Finally, the results of ongoing exploration activities are expected to lead to further production potential.

Methods and Definitions

As in previous years, the assessment only includes reserves in structures in Danish territory where the presence of hydrocarbons has been conclusively established through drilling and testing.

The method used by the Danish Energy Agency in calculating the reserves makes allowance for the uncertainty involved in all the parameters used in the calculation. For each oil and gas field, the reserves assessed are expressed by three values: *low, expected* and *high*, reflecting the margins of uncertainty tied to the oil and gas reserves in the relevant field.

Only a percentage of the oil and gas in place can be recovered. The amount of oil and gas that can be recovered throughout the life of the field is termed the ultimate recovery. Thus, the difference between ultimate recovery and the amounts of oil and gas produced at any given time constitutes the reserves.

Categories of Reserves

The projects which are ongoing or for which the operator has submitted plans are divided into three categories: *ongoing, approved* and *planned recovery*.

The Danish Energy Agency assesses the reserves recoverable under possible recovery projects for which the operator has not submitted specific plans to the authorities. The categories of reserves are defined as follows:

Ongoing Recovery
This category includes the reserves that are recoverable with the use of existing production facilities and wells. It is assumed that ordinary maintenance and workover operations are performed to ensure the continued functioning of the existing facilities.

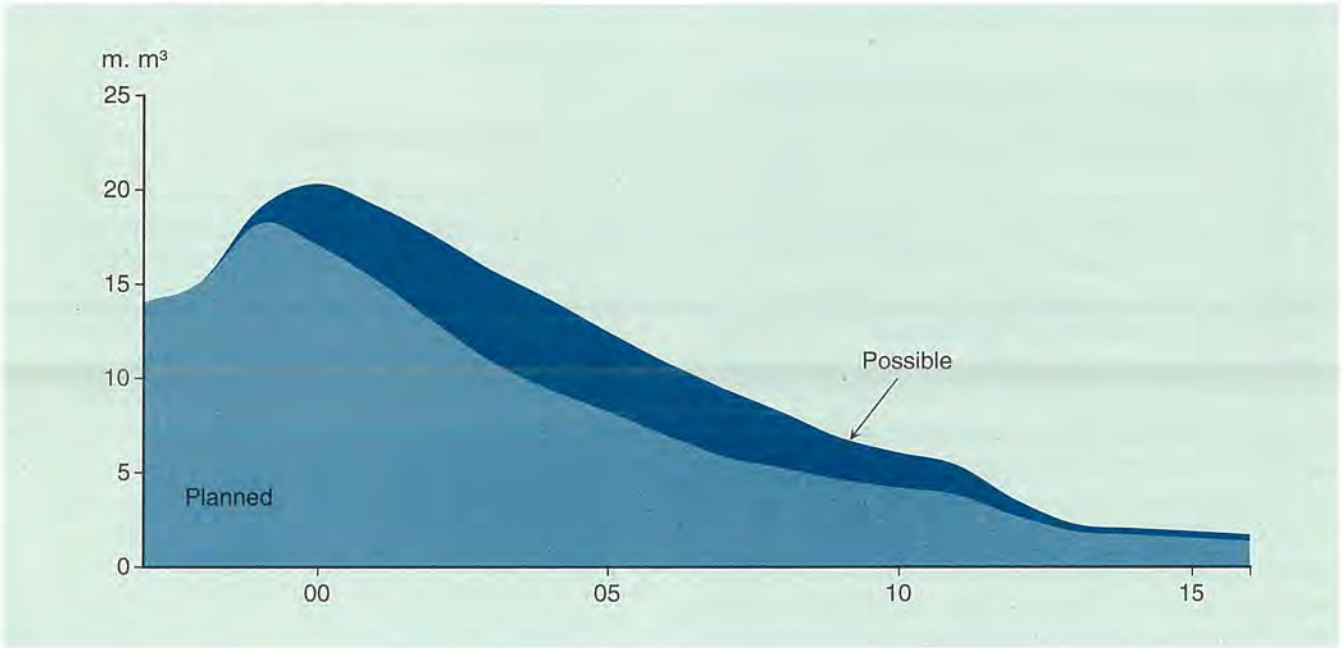
Approved Recovery
If a development plan has been approved, and production has not yet been initiated, the reserves assessed to be recoverable are categorized as approved recovery. This applies to the development of new fields as well as extensions and modifications of existing installations.

Planned Recovery
Planned recovery denotes projects described in a development plan that is being considered by the authorities. Likewise, the reserves attributable to discoveries for which a declaration of commerciality has been filed are termed planned recovery.

Possible Recovery
Possible recovery denotes reserves recoverable with the use of known technology, i.e. technology which is currently used in areas where the conditions are comparable to those prevailing in the North Sea. For instance, this includes water injection on a larger scale than before or wider application of horizontal wells.

For discoveries for which a declaration of commerciality has not yet been filed, the recoverable reserves are categorized as possible recovery. This category also includes recovery from discoveries considered to be non-commercial.

Fig. 5.5 Oil and Condensate Production



6. Economy

Growth in production and increasing crude oil prices characterized the financial development of the oil and gas sector in 1996. The total value of production climbed by about 37% compared to 1995, and the Danish state's revenue from production in 1996 is also expected to exceed last year's figure.

Oil and gas production in 1996 and the forecasts for future production are described in more detail in the sections on *Production* and *Reserves*. Developments in crude oil prices and the dollar exchange rate are reviewed below.

Crude Oil Prices and Dollar Exchange Rate in 1996

In 1996, crude oil prices were significantly higher than in preceding years, and the average oil price for the year is the highest since the Gulf crisis.

The average international crude oil price (as quoted for Brent oil) in 1996 was USD 20.66 per barrel as compared to USD 16.99 per barrel in 1995, equal to a 22% increase. On a monthly basis, the average crude oil price increased from USD 17.84 per barrel in January to USD 20.98 per barrel in April, after which it declined to USD 18.43 per barrel in June. The monthly average peaked in October at a price of USD 24.15 per barrel.

The rise in oil prices is attributable to a larger growth in demand than foreseen, as well as to diminished commercial stocks compared to previous years. The depletion of stocks was caused by the oil companies' changed inventory policy and the expectation that Iraq's return to the oil export market would deflate prices. For this reason, oil companies did not wish to have large amounts of oil in stock that might deteriorate in value. However, Iraq's reentry on the market, which was gradually postponed until the end of the year, only triggered a moderate price drop, as the demand had been boosted by the cold winters in North America and Europe.

For the year as a whole, the average USD exchange rate was DKK 5.80 per USD against DKK 5.61 per USD in 1995. Thus, overall, the USD exchange rate increased by 3%.

Economic Assumptions

The financial projections made in this section are based on two different crude oil price scenarios: one scenario assumes a constant price in real terms of USD 18 per barrel, and the other operates with a linear increase in oil prices from USD 20 per barrel in 1997 to USD 28 per barrel in 2005, after which the price is assumed to be constant in real terms. In both scenarios, the price of natural gas is assumed to parallel the development of the price of crude oil. Projections for prices of crude oil, natural gas and other energy products are described in the Danish Energy Agency's publication *Fuel Price Assumptions for Socio-Economic Calculations* from October 1995, (only available in Danish).

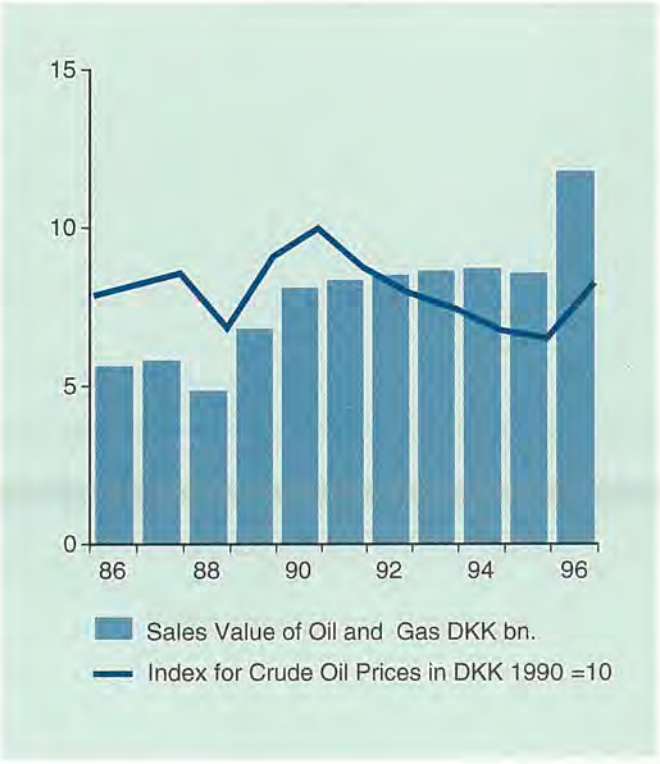
It should be noted that great uncertainty surrounds the price projections made, for which reason they must not be considered price forecasts. One example of the uncertainty attaching to price projections is the climb in the price of crude oil in 1996, which had not been foreseen.

For both price scenarios and for the whole period covered by the projection, the basis used is a dollar exchange rate of DKK 6.30 per USD in 1997 and DKK 6.00 per USD from 1998 and onwards.

Sales Value of Danish Oil and Gas Production

The total sales value of Danish oil and gas production increased from DKK 8.6 billion in 1995 to DKK 11.8 billion. This leap is due to the growth in oil and gas pro-

Fig. 6.1 Sales Value of Danish Oil and Gas and Crude Oil Price, Nominal Prices



duction and the above-mentioned rise in the price of crude oil. In 1995, the sales value constituted about 0.5% of the total value of Danish production *(Danmarks Statistik, Statistical Ten-Year Review 1996)*. The sales value of oil soared from DKK 6.5 billion in 1995 to DKK 9.2 billion in 1996, while the value of natural gas sold went up from DKK 2.1 billion to about DKK 2.6 billion.

The cumulative value of oil and gas production since the startup of production in 1972 amounts to about DKK 132 billion in 1996 prices. Fig. 6.1 shows the development in the value of the oil produced and the natural gas sold within the past ten years, in nominal prices.

As mentioned in the section on *Reserves,* the Danish Energy Agency expects a considerable increase in oil and natural gas production in the years to come. Accordingly, the forecast as at 1 January 1997 shows that oil production will increase from 12.1 million m^3 in 1996 to a maximum of 18.2 million m^3 in 1999. The marked upward adjustment, as compared to last year's forecast, is primarily attributable to the production expected from the new Siri and South Arne Fields.

Total gas production will also increase in the years to come. Against this background, the sales value of oil and gas is expected to rise over the next few years. However, this will depend on the trend in oil and natural gas prices.

Denmark's Energy Balance

The increase in oil and gas production and the reorganization of Danish energy supplies to provide consumers with more choices have made Denmark self-sufficient in oil and natural gas since 1991.

Based on the new production forecast, the Danish Energy Agency expects Denmark to become self-sufficient in all energy products as from 1997. Moreover, total oil and gas production is anticipated to exceed total energy consumption by 1998. However, these expectations are based on stagnating energy consumption.

Fig. 6.2, Table 6.1 and Appendix G1 show the historical and anticipated future development in three different degrees of self-sufficiency: The production of oil and gas is correlated to expected domestic oil and gas consumption (A) and to total domestic energy consumption (B), while total domestic energy production, including renewables, is correlated to total domestic energy consumption (C).

Compared to last year's projection, the degrees of self-sufficiency for the period 1997-2001 have been written

Fig. 6.2 Degrees of Self-Sufficiency

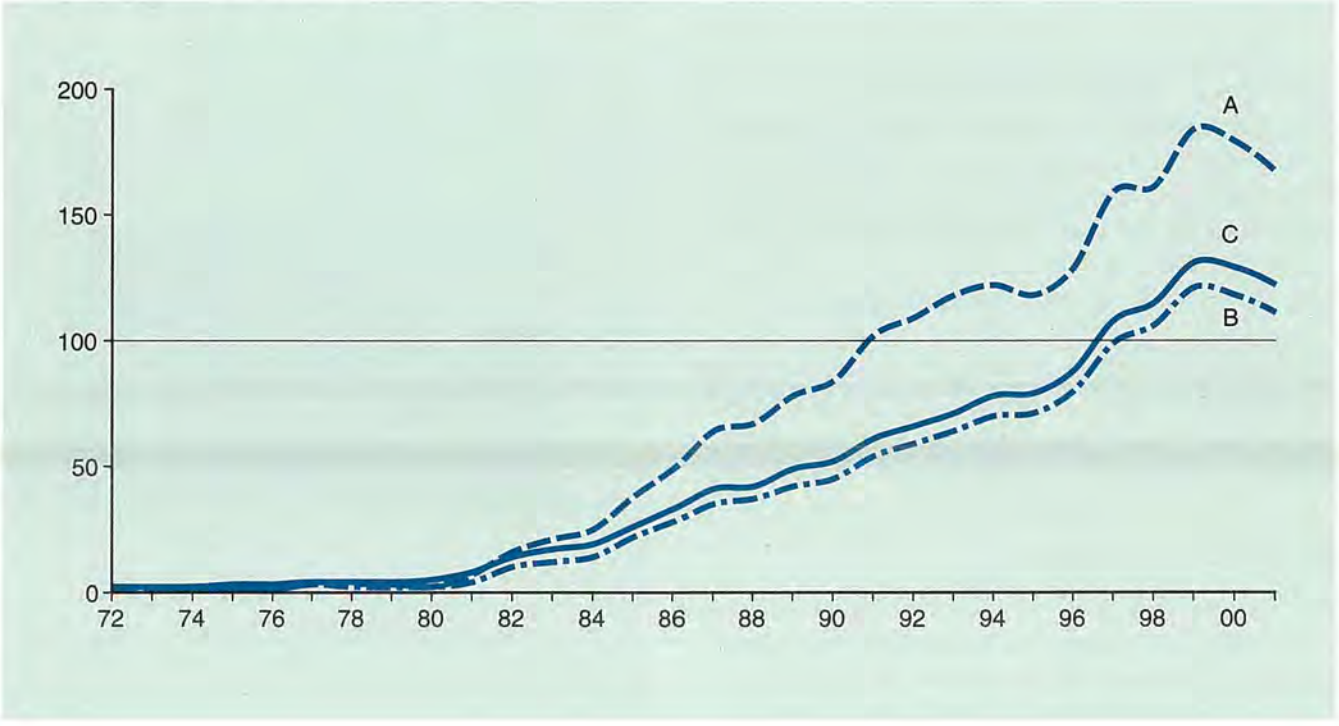


Table 6.1 Production and Consumption

	1997	1998	1999	2000	2001
Production					
Crude Oil					
PJ	512	552	663	622	556
m m^3	14.1	15.2	18.2	17.1	15.3
Gas					
PJ	301	318	337	350	355
m Nm^3	7.7	8.1	8.6	8.9	9.0
Of which sales gas	7.1	7.4	7.8	8.1	8.3
Consump. offshore	0.5	0.7	0.8	0.8	0.8
Renewable Energy					
PJ	71	77	79	87	89
Total Energy Consumption *)					
PJ	821	821	823	821	819
Degree of Self-Sufficiency %					
A)	159	161	184	179	167
B)	99	106	121	118	111
C)	108	115	131	129	122

*) Including fuel consumption offshore. The projection was made in spring 1996.
A) Oil and gas production vs domestic oil and gas consumption
B) Oil and gas production vs total domestic energy consumption
C) Total energy production vs total domestic energy consumption

up significantly, see Table 6.1. This is mainly due to the above-mentioned markup of the production forecast. The projection of consumption used corresponds to the estimated course of consumption set out in the Danish Government's energy action plan from 1996, *Energy 21*. Any change occurring in the estimated course of consumption within the next few years may affect the projected degrees of self-sufficiency.

Based on the production forecast, the degrees of self-sufficiency are expected to peak in 1999, coinciding with peak production. If no new discoveries are made in the Danish subsoil, the current propitious degrees of self-sufficiency of more than 100%, relative to total energy consumption, can only be expected to last into part of the next decade.

Impact of Oil and Gas Production on the Danish Economy

The oil and gas activities in the North Sea have an increasingly positive impact on the Danish economy. In the years to come, this trend is expected to become more pronounced as a result of the anticipated growth in production.

Net Foreign-Currency Value of Imported and Exported Energy Products

The net foreign-currency value of energy products is calculated by subtracting the cost of imports from the income from exports of energy products. This figure reflects the effect on energy product items in the balance of trade. The calculation does not take into account the cost of imports for field developments.

Before oil prices plummeted in 1985, the net foreign-currency expenditure on energy exceeded DKK 20 billion. It appears from Fig. 6.3 that there has been a marked decline in the net foreign-currency expenditure over the past ten years. This decline is primarily attributable to the growth in oil and gas production.

In 1996, the export value of energy products exceeded the import value for the first time. The main reason was the large-scale export of electricity to Norway and Sweden, but the increase in oil and gas production and climbing oil prices in 1996 also affected the relationship between the value of imported and exported energy products.

The Danish Energy Agency has estimated the net foreign-currency value for the period 1997-2001 on the basis of projections for oil and gas production and for product prices, see Fig. 6.3. Based on a constant price of USD 18 per barrel, the calculations indicate improved net earnings from trade in energy products until 1999. It should be noted that great uncertainty attaches to the

Fig. 6.3 Net Foreign-Currency Value of Imported and Exported Energy Products

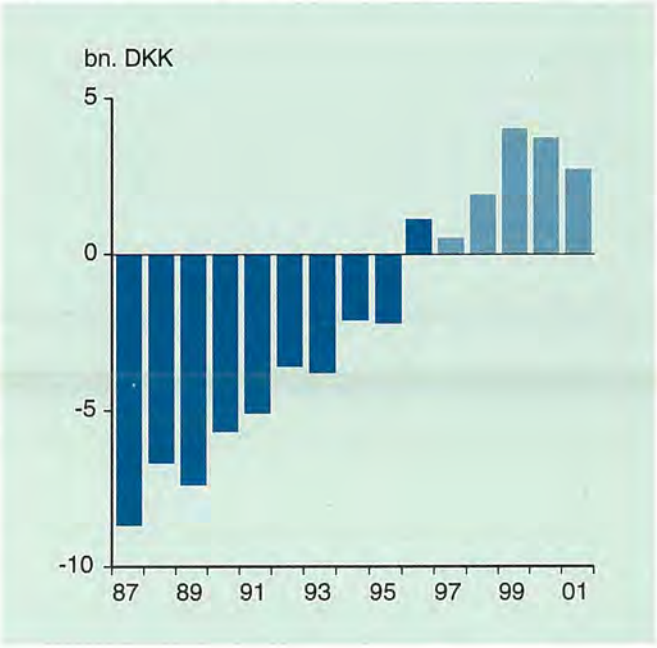


Table 6.2 Effect of Oil/Gas Activities on the Balance of Payments, DKK billion, 1996 Prices, Constant Prices

	1997	1998	1999	2000	2001
Socio-Economic Production Value	14.5	14.8	17.1	16.6	15.4
Import Share	3.8	3.7	3.2	2.5	1.6
Balance of Goods and Services	10.7	11.1	14.0	14.1	13.8
Transfer of Interest and Dividends	2.9	3.9	4.1	4.3	3.8
Balance of Payments Current Account	7.8	7.2	9.9	9.8	9.9
Increasing Real Oil Prices	8.9	8.9	12.5	12.7	13.5

projection for the net foreign-currency value of trade in energy products. Historical net foreign-currency expenditure is shown in Appendix G2.

Effect on the Balance of Payments

To supplement the calculations of the net foreign-currency value of energy products imported to and exported from Denmark, the future direct effect of Danish oil and gas production on the balance of payments has been estimated.

Denmark's production of oil and natural gas improves the balance of payments, due partly to the direct earnings derived from exporting part of the production, and partly to the foreign-currency expenditure saved, in that a share of production is used for domestic consumption, thus eliminating the need for energy imports otherwise required. Accordingly, the development in the socio-economic value of oil and gas production shown in Table 6.2 reflects the value of direct export revenue and the cost of imports saved.

When the import share of investments and operating costs is subtracted, the effect on the balance of goods and services results. In turn, the direct effect on the balance of payments on current account can be calculated when interest and dividends transferred abroad are deducted.

As a consequence of the developments in production and prices in 1996, the direct effect on the balance of payments on current account was more marked in 1996. The Danish Energy Agency estimates that this favourable effect represents a value of approx. DKK 6 billion. This trend is expected to become more pronounced in the years to come. The calculations based on a constant price scenario of USD 18 per barrel show that the direct net effect on the balance of payments will represent about DKK 10 billion in 1999. Based on the scenario with increasing real prices, the net effect will amount to about DKK 12.5 billion in 1999. Thus, the effect on the balance of payments is very sensitive to fluctuations in the price of crude oil.

State Revenue

The state revenue derived from oil and gas production consists of four elements: *corporate tax, hydrocarbon tax, royalty* and *the oil pipeline tariff* associated with the transportation of oil from the North Sea to the crude oil terminal at Frederica on the east coast of Jutland.

Corporate tax and hydrocarbon tax are collected by the Danish Ministry of Taxation, Central Customs and Tax Administration, while the collection of royalty and the oil pipeline tariff are handled by the Danish Energy Agency. Moreover, the Danish Energy Agency supervises the metering of the amounts of oil and natural gas produced on which the assessment of state revenue is based.

Total state revenue from oil and gas production activities has remained at a level of about DKK 2 billion in recent years, but is expected to increase in the years ahead. Based on a constant oil price scenario of USD 18 per barrel, total income is estimated to be about DKK 3 billion in the year 2001. Based on an increasing price scenario, the total income level will rise to about DKK 5 billion. However, great uncertainty attaches to the projection of state revenue, as the calculations have been made on the basis of a model. For instance, the calculated revenue deriving from corporate tax may vary considerably depending on the financing used in the model-based calculations.

Table 6.3 State Revenue from Oil/Gas Production, DKK million, Nominal Prices

	1992	1993	1994	1995	1996*)
Hydrocarbon Tax	0	0	0	0	0
Corporate Tax	1,000	866	1,106	1,043	1,035
Royalty	666	664	670	663	950
Profit Element	274	277	281	271	390
Total	**1,940**	**1,807**	**2,057**	**2,076**	**2,375**

*) Estimate

*Tabel 6.4 Expected State Revenue from Oil and Gas Production, DKK billion, 1996 Prices *)*

	1997	1998	1999	2000	2001
Hydrocarbon Tax	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Corporate Tax	1.3 (1.7)	2.1 (2.7)	1.9 (2.8)	1.9 (3.0)	1.8 (3.4)
Royalty	1.0 (1.1)	1.0 (1.2)	1.0 (1.2)	1.0 (1.1)	0.9 (1.1)
Profit Element	0.4 (0.5)	0.4 (0.5)	0.5 (0.7)	0.5 (0.7)	0.5 (0.6)
Total	**2.7 (3.3)**	**3.5 (4.4)**	**3.5 (4.7)**	**3.4 (4.8)**	**3.2 (5.1)**

*) Assessed amounts
( ) Based on constant oil prices

State revenue for the period 1992-1996 is indicated in Table 6.3. Estimated, future revenue for the next five years is shown in Table 6.4, while the development in future revenue until the year 2012 is illustrated in Fig. 6.4. As from 1998, fields held by the Statoil group and the Amerada Hess group are also expected to generate revenue.

Corporate tax

The DUC companies did not become liable to pay corporate tax until the beginning of the 1980s. At end-1996, state revenue from corporate tax payments totalled about DKK 9.5 billion, corresponding to DKK 10.6 billion in 1996 prices. In recent years, the corporate tax paid has amounted to about DKK 1 billion a year. In future years, corporate tax assessments are estimated to increase.

Hydrocarbon tax

Hydrocarbon tax was introduced by a Parliamentary Act in 1982. The objective of the Act was to levy a tax on particularly high profits, e.g. attributable to high oil prices. Hydrocarbon tax only became payable for a few years at the beginning of the 1980s, with total hydrocarbon tax payments amounting to approx. DKK 0.6 billion, corresponding to DKK 0.8 billion in 1996 prices. In light of the investments expected and price scenarios used for the next few years, it must be considered unlikely that hydrocarbon tax can be levied. In the longer term, hydrocarbon tax may become payable in case of a high oil price scenario.

The oil pipeline tariff

The users of the oil pipeline, to date the DUC companies only, are obliged to pay the costs relating to its establishment and operation. In addition, the users are to pay a profit element of 5% of the value of the crude oil transported to the owner of the pipeline, the state-owned company Dansk Olierør A/S (DORAS). DORAS pays an annual tax to the state, below referred to as the oil pipeline tariff, since 1992 constituting 95% of the income from the 5% profit element. In 1996, pipeline tariff payments amounted to DKK 390 million, a 44% increase against 1995. Up to and including 1996, the pipeline tariff payable by DORAS yielded about DKK 3 billion in revenue for the Danish state, corresponding to DKK 3.4 billion in 1996 prices. The Danish Energy Agency expects the revenue from the profit element to continue growing until 1999, depending on the development in oil prices, however.

The Minister for Environment and Energy has tabled a proposal to amend the Oil Pipeline Act to the effect that an exemption from the obligation regarding connection to and transportation through the oil pipeline is subject to payment of a tax to the state, constituting 5% of the sales value of the crude oil produced. This Bill will allow the licensees to choose the most appropriate form of transportation, whether by pipeline or buoy loading, without this affecting the total revenue for the state and Dansk Olierør A/S.

Royalty

The royalty payable for production comprised by the Sole Concession of 8 July 1962 amounts to 8.5% of the value of oil and gas produced, after deducting the cost of transporting the oil (including the 5% profit element). The royalty payable for any one year is based on the preceding year's production. In addition, royalty is levied on the commercial discoveries made under licences granted in the second licensing round. No royalty is pay-

Fig. 6.4 Taxes and Duties, DKK billion, 1997-2012, 1996 Prices

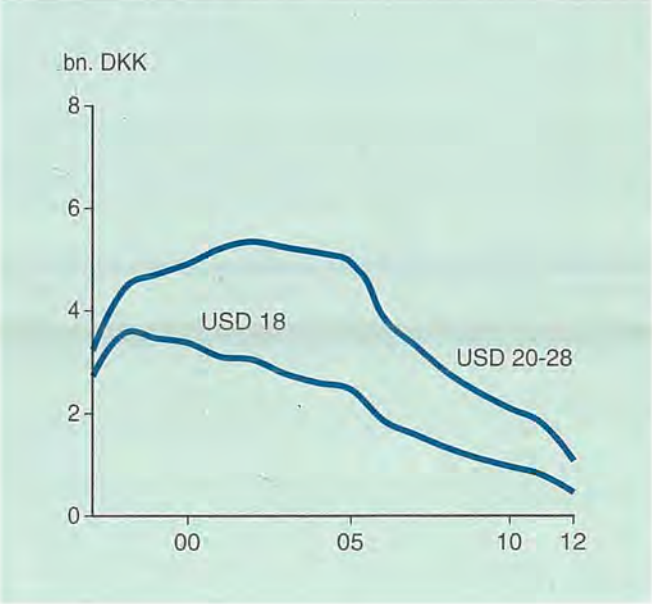
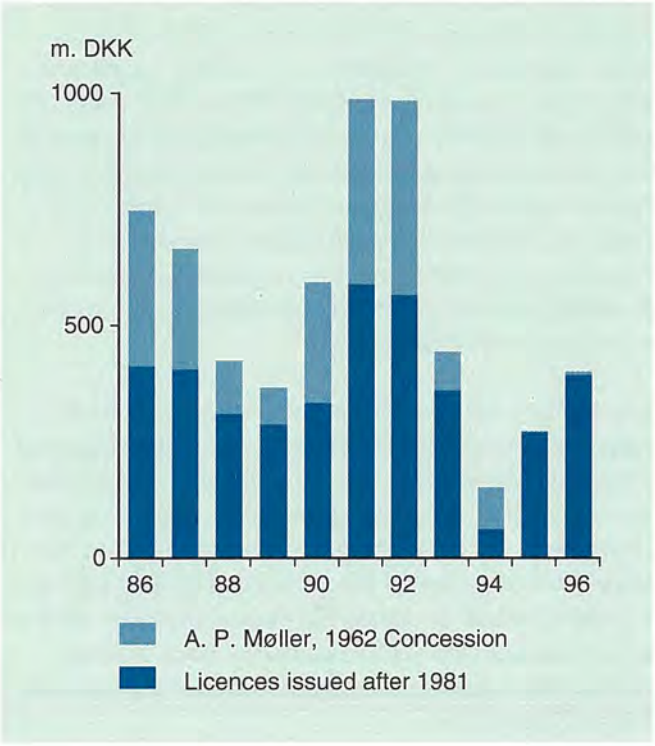


Fig. 6.5 Costs of Exploration, DKK million, Nominal Prices



able under licences awarded in the third and fourth licensing rounds.

In recent years, the amounts of royalty paid have exceeded DKK 0.5 billion a year. Royalty payments of about DKK 950 million are expected from 1996 production, an increase of 43% compared to the royalty levied on 1995 production. As is the case for the oil pipeline tariff, the Danish Energy Agency expects the revenue derived from royalty to grow in the years to come. Since 1972, total royalties of DKK 7.6 billion have been paid, corresponding to DKK 9 billion in 1996 prices.

The Finances of the Licensees

Major investments are required for oil and gas production activities, and the oil industry differs vastly from most other industries due to the high start-up costs and the long-term nature of the investments required, as well as the serious risk that the investments made will not be recouped and yield a return.

Costs of Exploration

The licensees' exploration costs increased by about 50% to approx. DKK 400 million in 1996 (preliminary calculation). Of this amount, wells accounted for about 50% of the licensees' exploration costs, and about 30% was attributable to general investigations, including seismic surveys. The remainder of exploration costs related to administration, interest expenses, etc. To the licensees' exploration costs must be added exploration costs that are not directly attributable to individual licences, and which need not be reported to the Danish Energy Agency.

In 1997, exploration costs are expected to rise to about DKK 0.5 billion, which is due to an anticipated increase

Table 6.5 Investments in Development Projects, DKK million, Nominal Prices

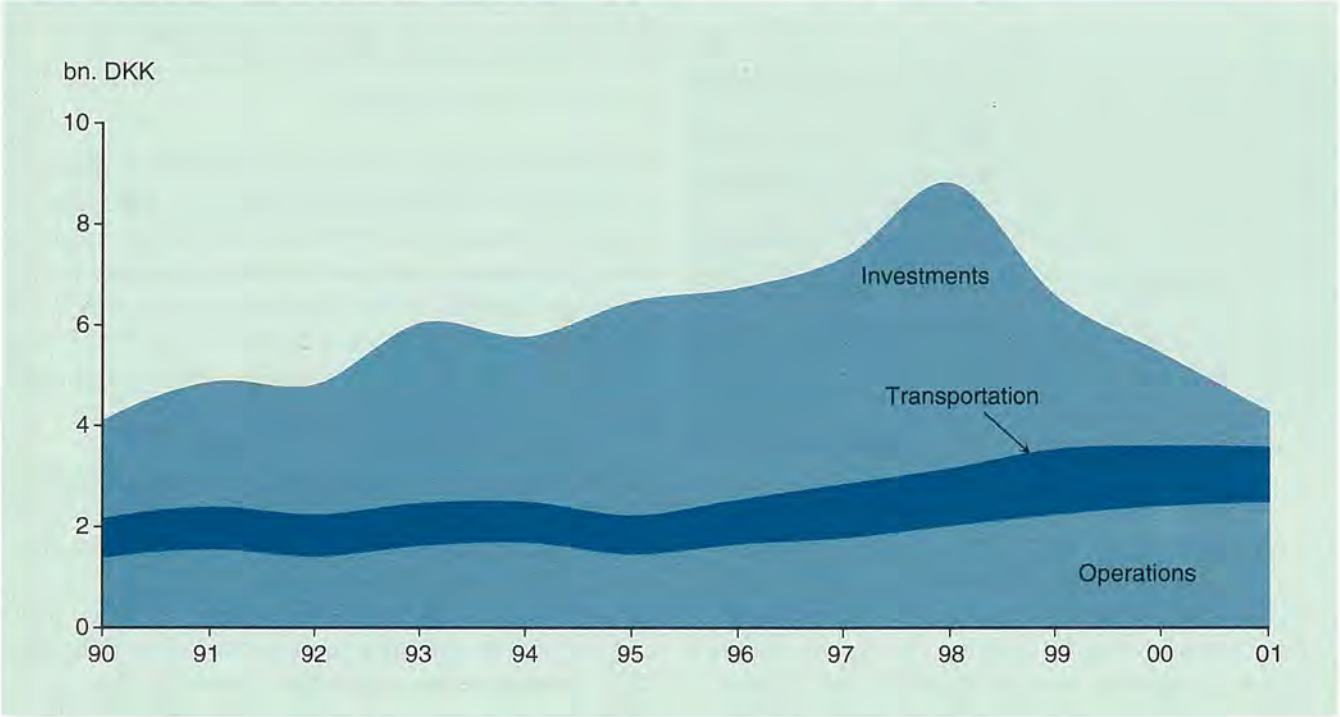
	1992	1993	1994	1995	1996*)
Dan	1,244	1,081	412	526	1,700
Kraka	97	79	175	3	1
Regnar	21	168	1	-	-
Gorm	411	722	516	632	350
Skjold	196	453	556	266	40
Dagmar	2	-	-	-	-
Tyra	372	380	1,158	1,450	725
Valdemar	27	375	106	1	80
Roar	1	2	25	289	75
Svend	-11	5	55	200	150
Harald	-4	6	149	810	1,075
Not allocated	46	88	-14	-10	3
Total	**2,402**	**3,358**	**3,140**	**4,167**	**4,199**

*) Estimate

Table 6.6 Investments in Development Projects, DKK billion, 1997 Prices

	1997	1998	1999	2000	2001
Ongoing and Approved					
Dan	1.5	0.9	0.6	-	-
Igor	-	-	0.3	-	-
Gorm	0.1	0.1	-	-	-
Dagmar	0.1	-	-	-	-
Tyra	0.4	0.2	0.3	1.0	0.2
Valdemar	-	0.1	-	-	-
Svend	-	0.1	-	-	-
Roar	-	0.1	-	-	-
Adda	0.1	0.1	-	-	-
Elly	-	0.3	0.3	-	-
Harald	0.5	0.1	-	-	-
Total	**2.7**	**1.9**	**1.5**	**1.0**	**0.2**
Planned	1.9	3.8	1.5	0.8	0.5
Expected	**4.5**	**5.7**	**3.0**	**1.8**	**0.7**

Fig. 6.6 Investments in Fields, Operations and Transportation, DKK billion, 1996 Prices



in the number of wells drilled, primarily as a consequence of the work programmes from the fourth licensing round.

Exploration activity from 1998 and onwards will depend on the oil companies' interest in the new opportunities for exploration made available by the introduction of the open-door procedure and the holding of a fifth licensing round.

Since 1963, the licensees have incurred aggregate exploration costs of about DKK 18.5 billion in 1996 prices, of which the DUC companies account for about DKK 13 billion. Fig. 6.6 shows the development in the licensees' exploration costs in the past decade.

Costs of Field Developments

In 1996, investments in field developments amounted to about DKK 4.2 billion, approximately corresponding to the 1995 investment level. Vast expenditure (about DKK 2.8 billion) was incurred in the development of the Dan and Harald Fields. Further, major expenses were involved in the development of the Tyra Field (approx. DKK 0.7 billion). The activities carried on in the individual fields in 1996 are described in more detail in the section on *Production.*

The 1996 investment level is expected to be maintained in the next few years. In the period 1997-2001, total investments in development projects are estimated to amount to DKK 16 billion in 1996 prices. The principal activity is expected to centre around the Dan, Tyra, South Arne and Siri Fields. In addition, investments are expected to be made in a new gas transportation system for transporting gas from the new Danish oil and gas fields and for transporting imported gas from Norway. As yet, no final decision has been made on this project, for which reason the associated future investments cannot be determined.

Moreover, the Danish Energy Agency envisages that there is additional potential for further developments of a number of fields, which will also affect the investment level in the years to come.

In total, the DUC companies have invested DKK 55 billion in 1996 prices in field developments. Historical investments in the past five years are shown by field in Table 6.5, while future expected investments are shown in Table 6.6.

Costs of Operations and Transportation

The costs of operating oil and gas production facilities have remained in the DKK 1.5 billion range in the past few years. In light of expected investments and the new operators in the area, total annual operating costs are estimated to climb in the years to come.

Table 6.7 Pretax Results of the DUC Companies, DKK million, Nominal Prices

	1991	1992	1993	1994	1995
Income	8,446	8,468	8,741	8,723	8,615
Operating Costs *)	2,070	2,023	2,299	2,209	1,988
Interest Exp.	336	267	297	314	337
Exc.-Rate Adj.	-182	-167	-408	632	472
Gross Income	5,859	6,011	5,737	6,833	6,762
Depreciation	2,373	2,126	2,386	2,716	2,554
Pretax Result	**3,485**	**3,885**	**3,351**	**4,117**	**4,208**

*) incl. transportation costs and exploration costs charged to expense

The costs of transporting the hydrocarbons produced to shore exclusively consist of payments towards covering the costs of the oil pipeline and the 5% profit element payable by users of the oil pipeline, see above. The producers do not pay any costs in connection with transporting gas to shore, as it is sold direct from the Tyra East platform to Dangas. In recent years, total oil transportation costs have amounted to about DKK 11 per barrel.

As a consequence of the anticipated growth in oil production, an investment in a minor expansion of the pipeline capacity will be made in 1997. This will increase the capital cost element forming part of the total payments to be made for use of the pipeline. By 1999, the final instalment on the loans financing the initial investment in the oil pipeline will have been paid, reducing the capital cost considerably. Conversely, the initiation of production from new fields, where the transportation of the oil produced will presumably be based on buoy loading, must be expected to push up the total costs of transporting hydrocarbons to shore.

The DUC companies have incurred total operating, administration and transportation costs (including payments of the 5% profit element) of about DKK 33 billion in 1996 prices since the startup of production in 1972.

Fig. 6.6 shows the historical development in annual investments, operating costs and oil transportation costs, as well as the costs projected for the future.

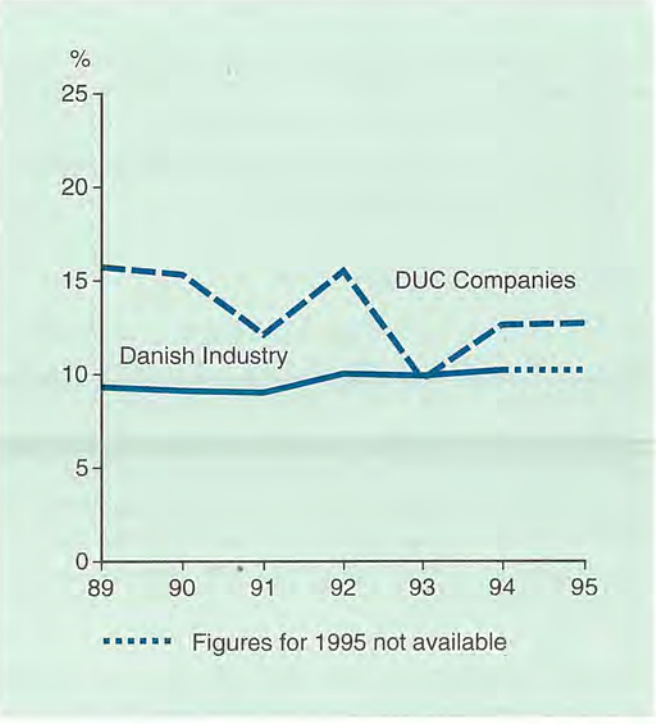
Financial Results of the DUC Companies

The financial results recorded by the DUC companies on oil and gas production activities are affected by many factors. The development in production in particular, which is largely determined by the investment level, as well as the trend of prices for oil and gas products and the dollar exchange rate, have a major impact. Below, only a few aspects of the DUC companies' financial results have been highlighted.

The DUC companies' pretax results have shown an upward trend in recent years, but stagnated in 1995, see Table 6.7. The result for 1995 was affected by smaller foreign-exchange gains than in 1994, higher interest expenses and a decline in the total value of production. It should be noted that the financial results recorded by the DUC companies for 1996 had not been published at the time this report went to press.

Fig. 6.7 shows that the DUC companies' rate of return (defined as the result after tax and duties less interest expenses, calculated as a percentage of total assets on the basis of the companies' financial statements) has been subject to greater fluctuations in the past few years as compared to Danish industry as a whole. Generally, the DUC companies' rate of return is higher than that of other industries, however. For the period 1989-94, the average rate of return recorded by the DUC companies was 13.5%, while the rate of return for other industries was 9.6% *(Danmarks Statistik, Statistical Ten-Year Review 1996)*. The higher rate of return may be considered a kind of risk premium for companies engaged in oil and gas production.

Fig. 6.7 Rates of Return (after Tax) for the DUC Companies and Other Danish Industries, 1989-1995



7. Health and Safety

The Danish Energy Agency supervises health, safety and environmental matters in connection with the exploration and production of oil and natural gas in the Danish part of the North Sea.

The Danish Maritime Authority handles certain aspects of safety supervision, especially such matters as concern the maritime equipment, design, strength, buoyancy and layout of mobile offshore installations, and matters concerning life-saving equipment, etc.

The National Agency of Environmental Protection handles the environmental aspects of the supervision relating to emergency preparedness in case of pollution of the sea from offshore operations, and also monitors discharges into the sea of substances and materials from offshore installations. Environmental matters are dealt with in a separate section of the report entitled *Environment.*

Expansion of Fixed Offshore Installations

The high activity level that in recent years has characterized the development of Dansk Undergrunds Consortium's (DUC's) oil and gas fields in the North Sea continued throughout 1996. Two new fields, Roar and Svend, were thus brought on stream, and major installations were hooked up and commissioned in the Tyra and Gorm Fields. In addition, two new platforms were installed in the Harald Field.

The ongoing development of the Dan Field has now progressed to the point where the four-legged jacket for the new wellhead and processing platform, Dan FF, has been installed. Drilling operations from the platform have also been initiated. The remaining platform facilities, including the processing and auxiliary equipment modules and the bridge to Dan FC, are expected to be installed in the summer of 1997. In addition, the extension of the deck on the Dan D platform has now been completed.

The vast expansion of fixed offshore facilities in 1996 was mainly carried out so that DUC can fulfil its contractual obligation from 1997 to increase natural gas supplies from its fields in the North Sea. This contractual obligation made it necessary to develop the Roar and Harald gas fields and to establish the necessary infrastructure by laying pipelines for transporting the production from these fields to the Tyra Field. Moreover, the Tyra Field installations were supplemented with new compression and reception facilities.

Furthermore, as a result of production technology developments, full-scale water injection has already been or will be implemented in the next few years in DUC's three largest oil fields in the North Sea: Dan, Gorm and Skjold.

In recent years, this has led to major extensions of the Skjold and Gorm installations. The last phase of this development project was completed in 1996 with the installation of a new deck on the Gorm F platform, which includes wellhead compression facilities. The new facilities in the Gorm Field were put into operation at the beginning of 1997.

The extension of the Dan Field installations was initiated in 1996, for the purpose of implementing the full-scale water-injection project. First of all, this project provides for the installation of the above-mentioned Dan FF platform, which is to accommodate a major extension of existing processing and water-injection facilities. In addition, the other platforms in the field will be subjected to major alterations and provided with new installations, in which connection the capacity of production and water-injection facilities will be considerably increased. The placing and location of the above-mentioned platforms and pipelines appear from Fig. 4.8 in the section on *Production,* which also includes a more detailed description.

In 1996, the Danish Energy Agency again considered and issued a good number of permits for construction of new installations, etc. in connection with the implementation of the above-mentioned projects. The Danish Energy Agency also issued a number of permits for offshore installation works and the subsequent commissioning of such new installations and pipelines.

Here, as in previous years, the Danish Energy Agency has focused in particular on the environmental and safety aspects of the individual installations, which are documented in the operator's safety assessments and safety management systems. The Danish Energy Agency has also continued its efforts to ensure a satisfactory working environment on the installations in the North Sea, placing particular emphasis on reducing noise levels on the new installations.

Projected Fixed Offshore Installations

As mentioned earlier in this report, plans to develop the South Arne and Siri oil fields are in the offing. The two groups of companies in charge of these development plans, headed by Amerada Hess and Statoil, are planning a prompt start-up of production from these fields.

In connection with the initial design work on the new production facilities, with pertinent oil and gas transportation systems, the environmental and safety aspects of the projected installations have been discussed with the companies. The considerations regarding potential transportation systems include the possibility of laying new pipelines and establishing loading buoy facilities directly in the fields.

New Gas Transit Pipelines

In connection with plans to augment Norway's gas supplies to the European continent, the Danish Energy Agency has approved the establishment by Statoil of a 42" pipeline, the *Norfra pipeline.* A 22 km section of this pipeline will traverse the Danish continental shelf, east of the existing *Zeepipe.*

In addition, Statoil has applied for permission from the Danish Energy Agency to establish another 42" gas pipeline, *Europipe II.* According to plans, 180 km of this pipeline will traverse the Danish continental shelf.

Supervision of Operations by the Danish Energy Agency

In 1996, the Danish Energy Agency paid inspection visits to all producing centres, Dan, Gorm and Tyra, as part of its supervision of the health and safety conditions on the installations. The inspections also included audits of the operator's safety management system.

Mobile Offshore Installations

In cooperation with the Danish Maritime Authority, the Danish Energy Agency supervises health and safety conditions on the mobile offshore installations used in the Danish sector of the North Sea. This supervision involves evaluating the physical and organizational layout of the installations before permitting them to be used in the area. Moreover, it is checked that Danish regulations are complied with during the performance of the pertinent installation works and drilling operations in the Danish sector.

In some cases, quite considerable problems may be associated with granting permission for the use of mobile offshore installations that have not previously been employed in Danish territory. This is because the international regulations focus primarily on basic safety conditions, including the buoyancy, power supply and life-saving appliances of the installations, while only covering the layout of living quarters and the industrial work stations to a limited extent.

Therefore, compliance with Danish regulations may require major alterations to the installations. However, in practice, existing physical conditions on the installations will sometimes make it impossible to comply with specific requirements in the Danish regulations. In such cases, permission to work in Danish territory will depend on whether the result of an overall assessment of health and safety conditions on board the installation, taking into account the duration of the operations, shows that the work can be performed under satisfactory conditions.

Pipe-laying barges in particular may encounter major difficulties in complying with Danish regulations, as concerns the layout of the barges and arrangement of the work on board. A contributory factor may be that pipe-laying barges are not encompassed by offshore regulations in our neighbouring countries, and that consequently, the relevant public authorities do not set up specific requirements for the layout of the work stations or the duration of the employees' work periods offshore.

Throughout 1996, the drilling rigs *Shelf Explorer, Mærsk Endeavour, Mærsk Exerter* and *Neddrill 10* performed drilling operations for Mærsk Olie og Gas AS in Danish territory. In 1996, following improvements to its living quarters and working environment conditions, the *Neddrill 10* was granted a five-year permission for use.

For parts of the year, Dansk Operatørselskab (Danop) employed the drilling rig *Mærsk Enhancer* to drill wells for Statoil and Amerada Hess.

During two periods in 1996, Mærsk Olie og Gas AS employed the crane barge *DB 102* for various lifting operations and construction works connected with the installation of new platforms and facilities on existing platforms. Likewise, the cranes on board the vessels *DSV Well Servicer* and *DSV Seaway Pelican* were used during some periods for minor, subsea installation works.

The pipe-laying barge *Lorelay* was employed for a period in 1996 to carry out work for Mærsk Olie og Gas AS.

Finally, Mærsk Olie og Gas AS employed the flotels *Mærsk Explorer* and *Neddrill Kolskaya* throughout 1996. These flotels were used at different locations where the new installation or conversion of fixed offshore installations temporarily required additional manpower.

New Regulations

In cooperation with representatives from the oil industry serving on the Coordination Committee, the Danish Energy Agency drafted a number of Executive Orders in 1996, e.g. to implement various EU Directives. No Parliamentary Acts or amendments to existing Acts regarding health and safety matters were issued in 1996.

In 1996, the Danish Energy Agency issued the following Executive Orders:

Executive Order No. 64 of 7 February 1996 on Substances and Materials Used on Offshore Installations.

This Executive Order sets up a number of requirements for employers who use dangerous substances and materials on offshore installations, including requirements as to the labelling on packaging and instructions for use. The Executive Order also stipulates that the supplier or importer is to register the products with the Danish Health and Safety Executive for inclusion in its product register, and is to prepare instructions for use.

Executive Order No. 127 of 6 March 1996 on the Performance of Work, etc. on Offshore Installations.

This Executive Order includes detailed requirements as to the content of the safety assessment to be prepared in connection with the design and operation of fixed offshore installations, and in connection with the use of mobile offshore installations, as well as requirements for the so-called workplace assessment (WPA).

Safety assessments were previously discussed in the Danish Energy Agency's 1992 Report on Oil and Gas Production in Denmark. Their objective is to evaluate the risk of major accidents on offshore installations, whereas the working environment assessment evaluates the risk associated with the performance of the work. The latter assessment includes an evaluation of the workplace risks connected with the work, e.g. noise, chemicals and heavy lifting operations, as well as the measures that can reasonably be taken to reduce such risks as much as possible.

Executive Order No. 128 of 6 March 1996 on the Design of Workplaces, etc. on Offshore Installations.

This Executive Order lays down requirements for the layout of the installations, including lighting, ventilation and temperature conditions in working areas, as well as alarm systems, life-saving appliances, access routes, escape routes, fire and smoke detectors, communications equipment and mustering stations.

Executive Order No. 270 of 17 April 1996 on the Design of Technical Equipment on Fixed Offshore Installations.

This Executive Order is an updating of the information contained in the Machinery Directive (amendments to Council Directive 89/392/EEC made in 1991 and 1993) and deals with the direct import of technical appliances for fixed offshore installations from a non-EU country.

Executive Order No. 271 of 17 April 1996 on the Design of Technical Equipment for Use in an Explosive Atmosphere on Fixed Offshore Installations.

This Executive Order includes special requirements as to the technical appliances imported directly to a fixed offshore installation from a non-EU country that are to be used in an explosive atmosphere (classified areas).

Guidelines

The Danish Energy Agency did not issue any guidelines in 1996, but finalized its work on the following guidelines, issued at the beginning of 1997:

Guidelines Regarding the Safety Organization on Mobile Offshore Installations.

Notification of Industrial Injuries

As previously, the statistics on industrial injuries offshore fall into two categories: statistics of work-related accidents reported and statistics of presumed or recognized work-induced conditions reported.

Work-Related Accidents

All industrial injuries sustained offshore must be reported to the Danish Energy Agency. The criterion for reporting a work-related accident is that the injured person is unfit for work for one day or more in addition to the day of the accident.

Table 7.1 Accidents per million Working Hours

Year	Fixed Installations	Mobile Installations
1988	10.3	31.0
1989	3.4	12.7
1990	7.9	9.9
1991	9.0	7.4
1992	7.1	11.5
1993	8.9	5.7
1994	5.5	13.5
1995	3.3	5.3
1996	6.3	5.4

Fig. 7.1 Accident Frequency on Offshore Installations

In 1996, the Danish Energy Agency received 27 reports on accidents offshore, broken down as 18 accidents on fixed offshore installations including flotels, and nine on mobile offshore installations, including drilling rigs, pipe-laying barges and crane barges. The reports filed for fixed offshore installations concern accidents occurring in connection with operation and maintenance, and the construction of new installations. None of the accidents resulted in death or serious personal injury.

When the 18 reported work-related accidents on fixed offshore installations are related to the number of hours worked (2.8 million hrs.), it yields an accident frequency of 6.3 per million working hours. Moreover, when the nine work-related accidents on mobile offshore installations, excluding flotels, reported in 1996 are related to the number of hours worked on these installations (1.7 million hrs.), it yields an accident frequency of 5.4 per million working hours.

The number of working hours is calculated on the basis of information received from the companies and the person-on-board lists, based on an average workday of 13 hours.

Table 7.1 and Fig. 7.1 show the accident frequency for each year in the period from 1988 to 1996 for mobile and fixed offshore installations, together with flotels, indicated as the number of reported work-related accidents per million working hours. The figures shown comprise accidents related to all work functions, including the operation and maintenance of the above-mentioned facilities and installation works performed on them.

It appears from the above-mentioned statistics that the low accident frequency of previous years has been maintained for both fixed and mobile offshore installations.

By way of comparison, the accident frequency for Danish onshore industries has hovered around 50 per million working hours since 1988. In 1995, the accident frequency for onshore industries was 51.7 per million working hours. *(The Danish Employers' Confederation, Work-Related Accidents 1995.)*

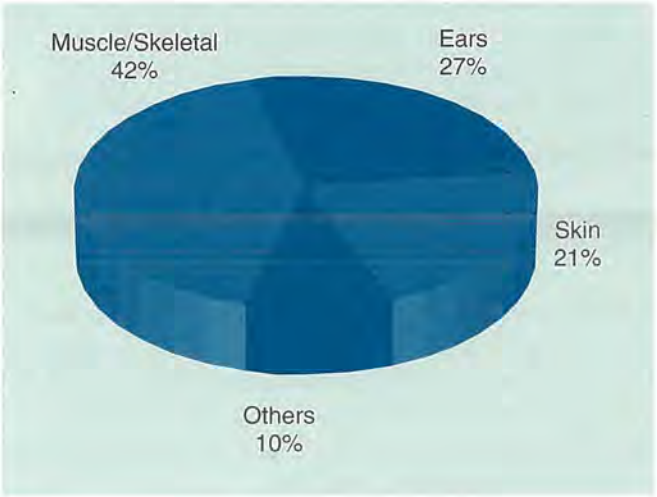
The number of hours worked on fixed offshore installations increased somewhat in 1996 as compared to 1995, as the works performed in 1996 were a continuation of the major installation and construction works involved in the development of the fields in the northern part of the Danish sector, which was initiated in 1995. For mobile offshore installations, the number of working hours increased in 1996 by about 23% in relation to the number of working hours in 1995, but the figure is about 17% lower than the number of hours worked in 1993.

Work-Induced Conditions

If a doctor suspects or ascertains that a condition has been induced by work on offshore installations, the Danish Energy Agency must be notified. To date, such notifications have been few and far between. Thus, in 1996 the Danish Energy Agency received no notifications.

Since 1993, the Danish Energy Agency has been notified of ten presumed or recognized work-induced conditions. These conditions are distributed on the following main diagnostic groups: muscle/skeletal conditions, ear conditions, skin diseases and other conditions. Muscle/

Fig. 7.2 Work-Induced Conditions Reported, 1985-1996



skeletal conditions denote conditions in the back, shoulders, arms or legs. Not all of the notifications received can be attributed directly to fixed or mobile offshore installations. Consequently, the figure above shows injuries sustained on both fixed and mobile offshore installations. Fig. 7.2 shows the distribution of work-induced conditions in the period 1985-1996.

International Cooperation

Over the years, the Danish Energy Agency has built up a close working relationship with the supervisory authorities from other countries in the North Sea area within safety and working environment matters. In 1996, the Danish Energy Agency held the usual, annual meetings with supervisory authorities from the individual countries. In addition, the Danish Energy Agency participated in cooperation within the North Sea Offshore Authorities Forum (NSOAF) on safety training and safety assessments.

The Danish Energy Agency also continued its work under the auspices of the Safety and Health Commission for the Mining and other Extractive Industries under the EU Commission (SHCMOEI).

In environmental matters, the Danish Energy Agency, in cooperation with the National Agency of Environmental Protection, participated in the Paris/Oslo Commission's Offshore Forum (GOP).

8. Environment

In recent years, environmental considerations have had an increasing impact on decision-making in the community. This has led to more focus on protecting the environment in connection with the award of licences and the location, design and operation of offshore installations.

In Denmark, the environmental matters relating to offshore installations are regulated primarily by the Subsoil Act, the Act on the Marine Environment and the Act on Certain Marine Installations. Danish legislation imposes obligations on both the National Agency of Environmental Protection and the Danish Energy Agency for protection of the environment.

The obligations of the National Agency of Environmental Protection relate primarily to discharges from platforms, etc. and their effect on the surrounding environment, as well as the preparedness to contain oil spills. The obligations of the Danish Energy Agency relate mainly to the design, equipment and operation of offshore installations. The two agencies cooperate to ensure coordinated efforts.

As a result of the amendments made to the Subsoil Act in 1995, which implemented the EU Licensing Directive on the assessment of the effects of certain public and private projects on the environment, such an assessment is to be made prior to establishing offshore installations for the production of oil and gas.

In keeping with the trend in other areas of society, the methods used for regulating environmental conditions are undergoing change. Where regulation previously took place mainly by setting specific limits for the nature and amount of emissions, the main focus is now increasingly being placed on limiting environmental impact as much as possible by having the companies involved use the best available techniques and working methods from an environmental point of view.

In this context, increased focus is placed on the operators' assessment of the impact of the offshore activities on the environment, and the associated control procedures.

The increased interest in the environmental aspect of activities in offshore territory is not exclusive to Denmark. Internationally, increasing interest in controlling the marine environment has been shown in the past few years, and consequently in limiting the environmental impact of offshore installations.

Danish efforts in this area are made in cooperation between several institutions, coordinated by the National Agency of Environmental Protection. The Danish Energy Agency provides assistance within its areas of expertise and participates in the international fora of significance to Danish oil and gas activities. The Danish Energy Agency bases its approach on the premise that integrated protection of environmental and safety matters will optimize results in both areas.

CO_2 Emissions

Fuel Consumption and Gas Flaring

Considerable amounts of energy are used in the production, processing and transportation of oil and natural gas, and it is also necessary to flare any gas that cannot be utilized for safety or technical reasons. Therefore, the installations in the North Sea emit carbon dioxide (CO_2) in quantities that depend on the scope of production and, in particular, nature-given and technical conditions related to the installations.

Many production facilities have been established in the North Sea relative to the size of Danish production. This limits the possibilities for utilizing the energy effectively.

Fig. 8.1 Fuel Consumption Broken down into Processing Centres and the Dagmar Field

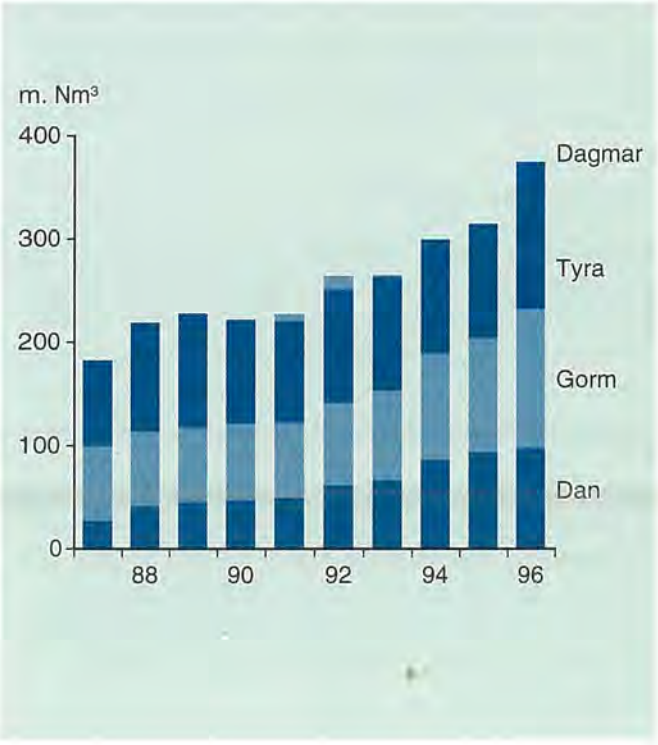
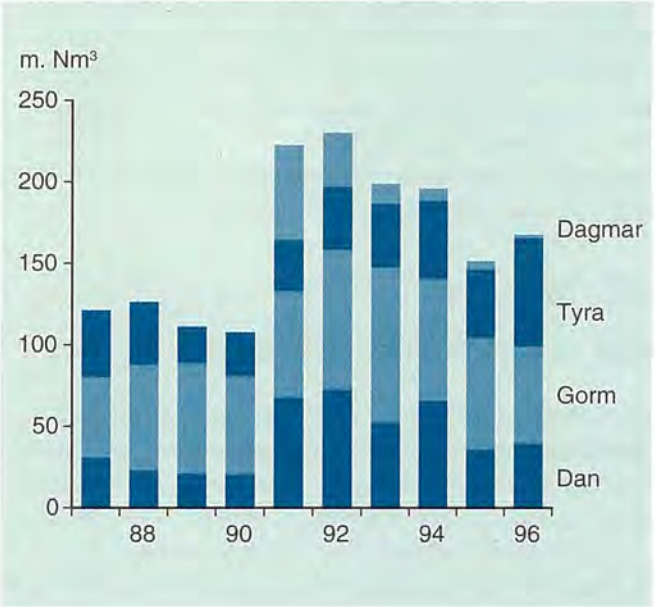


Fig. 8.2 Gas Flaring Broken down into Processing Centres and the Dagmar Field



Carbon dioxide is mainly emitted as a result of using the produced gas for fuel in gas turbines that drive electric generators, compressors and water-injection pumps. Figs. 8.1 and 8.2 illustrate the consumption of fuel in the respective processing facilities and the amount of gas flared through the past ten years.

While the amount of fuel used in Danish oil and gas production facilities escalated during the past decade, only a moderate increase was recorded in the amount of gas flared during the same period. This development is chiefly due to the fact that the flaring of gas in Danish oil fields has been reduced considerably in recent years.

CO_2 Emissions in 1996

Fig. 8.3 shows the development in CO_2 emissions from the production facilities in the North Sea since 1987. It appears that total emissions amounted to about 1.2 million tonnes of CO_2 in 1996. As compared to the average emissions in the past five years, this represents a minor increase of about 0.15 million tonnes.

Further, the figure shows that while CO_2 emissions from gas flaring were reduced from a level of about 0.5 million tonnes in 1991/92 to about 0.35 million tonnes in 1995/96, the CO_2 emissions derived from energy production on the platforms climbed from a level of about 0.5 million tonnes in 1988-91 to about 0.8 million tonnes in 1996.

The development in CO_2 emissions described above must be viewed in light of the substantial growth in oil and natural gas production in recent years. Thus, oil and natural gas production doubled from about 8.4 million t.o.e. in 1989 to about 16.3 million t.o.e. in 1996. It is worth noting that this development was only made possible by the introduction of energy-intensive, improved recovery methods in the three large oil fields, where production has been ongoing for 15-20 years.

The improved recovery methods involve injecting large amounts of water into the Dan, Gorm and Skjold reservoirs. As described in the section on *Production,* water injection was initiated in the Skjold Field in 1986, and on a smaller scale in the Dan and Gorm Fields in 1989. In recent years, the successful use of this recovery method has led to the application of water injection on a much larger scale in all the above-mentioned oil fields. Thus, in 1996, about 22 million m^3 of water was injected into the three fields combined, against only about 5 million m^3 in 1992.

Therefore, the Dan and Gorm processing facilities have been extended considerably in the past few years, with the installation of injection facilities for sea water and new separating and water-processing facilities for handling the large amounts of water now associated with oil production. The Dan Field installations are still being further expanded. Accordingly, the injection capacity in the Dan Field will be increased by 140% to a total of 360,000 barrels of water per day, equal to about 20 million m^3 of water a year.

Fig. 8.3 CO_2 Emissions from Production Facilities in the North Sea

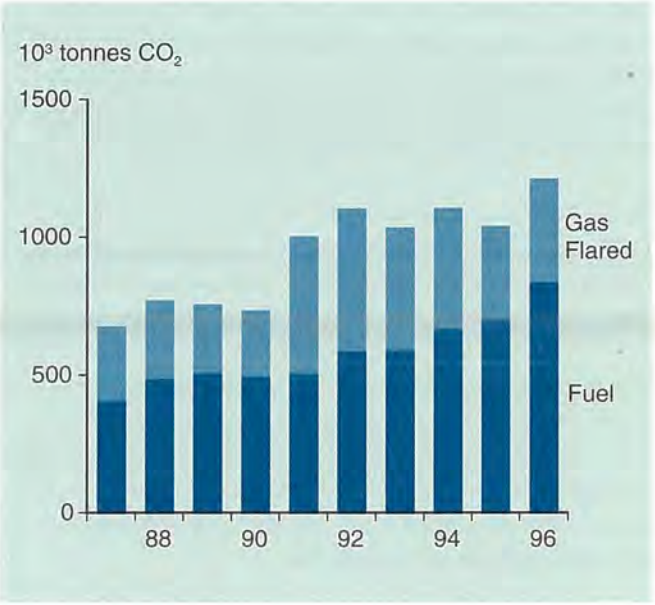
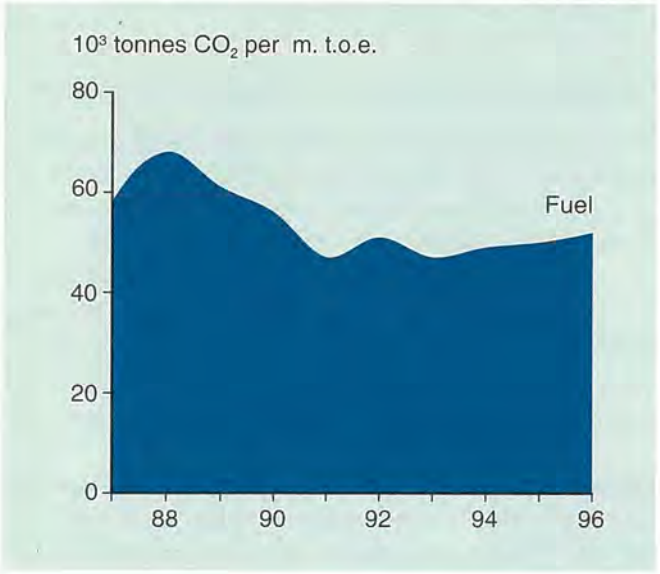


Fig. 8.4 CO_2 Emissions from Consumption of Fuel



The major extension of oil production facilities of recent years has been accompanied by an ever increasing demand for supplies of natural gas from the fields in the North Sea. The increase in gas supplies has stepped up the consumption of energy for processing and compressing the gas.

The development in CO_2 emissions reflects the fact that in 1996, new processing and compression facilities were put into service in the Tyra Field, as an element in the upgrading of contractual gas supplies from the North Sea planned from 1997.

CO_2 Emissions in Relation to Production

The consumption of fuel in the processing facilities in the North Sea and the resulting CO_2 emissions have increased on a par with oil and gas production over the past few years, see Fig. 8.4.

The above figure thus illustrates that since the beginning of the 1990s, CO_2 emissions from fuel consumption, related to the amount of hydrocarbons produced, have stabilized at a level of about 50,000 tonnes of CO_2 per produced million t.o.e. The upsurge in the amount of oil and gas produced during this time has therefore not triggered a comparable increase in CO_2 emissions, despite the introduction of considerably more energy-intensive recovery methods and, in particular, the heavier load on natural gas export compressors.

If a similar calculation is made of the amount of gas flared on the offshore installations and the resultant contribution to CO_2 emissions, Fig. 8.5 shows that the CO_2 emissions deriving from gas flaring, related to the amount of hydrocarbons produced, have steadily declined since the beginning of the 1990s to a level of about 23,000 tonnes of CO_2 per million t.o.e. in 1996. The rapid growth in oil and gas production and the associated greater load on production installations have thus not given rise to a comparable increase in the amount of gas flared.

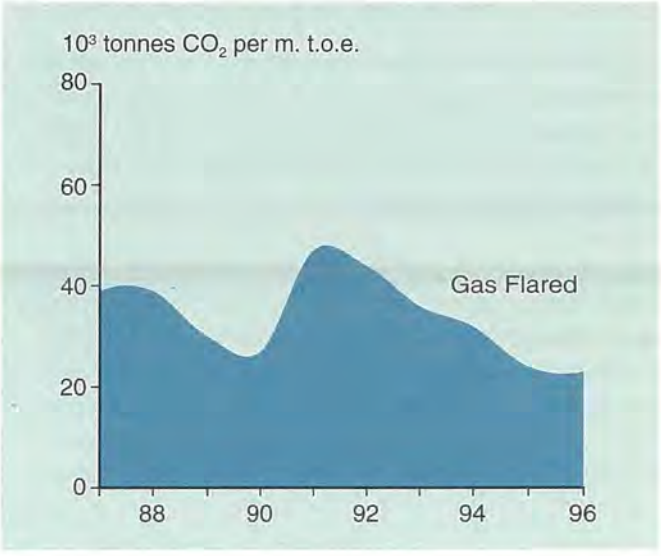
CO_2 Emissions Offshore and Energy Policy Objectives

If the CO_2 emissions from the Danish offshore production of oil and natural gas are assessed in terms of the objective to cut total Danish CO_2 emissions, the offshore sector has had less impact than could be expected considering the overall reduction in Danish territory resulting from the large-scale replacement of other fossil fuels by natural gas.

As mentioned above, large amounts of energy are required for the production and transportation of oil and natural gas, and the scope for cutting CO_2 emissions offshore is limited by these energy requirements and by the fundamental design of the existing installations.

However, the installation of new facilities or the major alterations of existing facilities offer a good opportunity to introduce the best possible technology. Nevertheless, CO_2 emissions are not the only consideration involved in the evaluation of new technology for this sector. It is also necessary to consider the safety and reliability of operations, manning conditions and maintenance, as well as investments and operating costs.

Fig. 8.5 CO_2 Emissions from Gas Flaring



As mentioned below, the alterations of production facilities and the installation of new offshore facilities are subject to the requirement that an assessment of the effects on the environment is made beforehand. Information about CO_2 emissions from projected installations forms part of this assessment, on a line with other matters of importance to the environment.

A detailed assessment of the new projects and of relevant alternatives, as well as their impact on CO_2 emissions, will therefore constitute an important part of the application material to be submitted for the approval of future projects. Against this background, it can be ensured that future installations will be designed in such a way as to meet the requirement for using the most appropriate technology.

Assessment of Effects on the Environment

As a result of the amendments made to the Danish Subsoil Act in 1995, projects assumed to have a significant impact on the environment can only be approved following an assessment of the effects on the environment. In future, applications for the approval of such projects are to be accompanied by *an assessment of the effects on the environment.* At present, no general rules exist for implementing the environmental impact procedure in connection with the issuance of approvals under the Subsoil Act.

Further, in spring 1997, the Danish Parliament adopted an amendment to the Danish Continental Shelf Act that authorizes the Danish Energy Agency to stipulate that an environmental impact procedure must be implemented for projects involving the installation of pipelines for transporting oil and natural gas from one country to another across the Danish continental shelf.

Present Environmental Impact Assessments

For the first time in Danish offshore history, an actual environmental impact procedure will be implemented in connection with the development of oil and gas fields and the establishment of transit pipelines across the Danish continental shelf.

The companies responsible for developing the Siri and South Arne Fields in the Danish sector of the North Sea have thus prepared environmental impact assessments for the relevant projects. In addition, Statoil has made an environmental impact assessment in connection with the establishment of the Norwegian transit gas pipeline, *Europipe II.* This pipeline, which is planned to traverse the Danish continental shelf, is to transport gas from Norway to the European continent as from 1999.

Content of Environmental Impact Assessments

The environmental impact assessments for the Siri and South Arne Field developments contain an evaluation of all significant effects on the environment that are expected to result from the development of the fields. Moreover, they contain a description of the equipment to be used on the production facilities. This description makes it possible to determine whether the project provides for the best technical solutions for obtaining a cleaner environment *(BAT - Best Available Technology).*

Further, the environmental impact assessments describe the impact of the relevant projects on the environment in the area where the projects are to be implemented (area of impact). The environmental description of the area includes information about the physical and biological environment, as well as a description of the likely impact of the relevant project on commercial activities, such as fishing.

Finally, the environmental impact assessments contain a section discussing whether the environmental consequences of the project may have a socio-economic impact.

Representatives of the Danish Energy Agency, the National Forest and Nature Agency and the National Agency of Environmental Protection have formed an advisory group that has monitored and advised the oil companies in their work on the environmental impact assessments prepared in 1996.

Consultation Procedure for Environmental Impact Assessments

The environmental impact assessments will be given a public hearing, so that the authorities and organizations affected and the general public are given an opportunity to comment on the relevant projects. The general public will be notified of the environmental impact assessments through advertisements in the national papers stating how information can be obtained on the contents of the application and the associated assessment. A time limit of eight weeks will be fixed for putting forward any comments.

9. Research

Energy Research Programme 1997

The Energy Research Programme (ERP 97) is financed by funds provided for in the Danish Finance Act. In 1996, funding in the amount of DKK 108 million was granted for 55 energy projects. Of these, four concerned research projects within subjects related to oil and natural gas, with budgeted costs totalling DKK 32 million. Actual funding in the amount of DKK 13 million was granted for these projects, equal to approx. 41% of the total amount budgeted. In addition, two oil and gas projects were granted funding in the amount of DKK 5 million out of the special funds earmarked for energy research cooperation with Eastern European and developing countries.

The Danish Energy Agency has the administrative and professional responsibility for considering and evaluating project applications submitted. The Agency evaluates projects in cooperation with the *Advisory Oil and Natural Gas Research Committee*, which offers the Danish Energy Agency advice on the scientific value of the projects, etc.

As in past years, the principal criterion for funding is the importance of the projects to society and their relevance in terms of energy. Priority has been accorded to projects within the following four areas of research: *exploration, recovery, equipment and installations* as well as *arctic oil and gas problems.*

Within these areas, high priority is given to the following studies:

- Research and development promoting the interest in drilling wells in untested formations and traps on the Danish continental shelf.
- Determining petrophysical parameters and scaling methods.
- Geostatic and geophysical modelling methods.
- The inversion and geophysical modelling of the movement of fluid fronts.
- Optimizing seismic surveys by combining geostatic and geophysical models.
- Experimental and computational analysis of displacement processes.
- Optimizing and extending the life of installations and facilities.
- Simple, flexible satellite developments and floating production facilities.
- Projects to catalyze the interest in exploration in Arctic areas and decisions to initiate production.

In addition, funding was granted for projects to be undertaken in cooperation with Eastern European and developing countries. Emphasis was placed on projects that incorporate research and development activities that can be carried out and later used in cooperation with businesses and institutions in the countries in question.

International Cooperation

Over the years, the Danish Energy Agency has promoted international energy research cooperation, both through its representation on international committees and by supporting the integration of national projects into major international projects.

Within the area of oil and natural gas, the most important international cooperative activities relate to the Chalk Research Programme, the Nordic Energy Research Programme, the non-nuclear EU programmes JOULE and THERMIE, as well as the IOR cooperation under the auspices of the International Energy Agency (IEA).

Chalk Research Programme

This research programme was started in 1982 on the initiative of Norwegian and Danish authorities. The objective is to find solutions to the special problems associated with oil recovery from chalk formations. The expenses for the programme are shared between seven companies carrying on oil production in the North Sea, including Mærsk Olie og Gas AS.

In autumn 1996, the fourth phase of the programme was completed with a symposium held in Reims, France, where the results achieved were reviewed.

The cooperation within chalk research is expected to continue, with the start-up of a fifth phase in 1997. The oil companies and authorities are currently deliberating on which specific topics research is to be continued.

EU Research and Development Programmes

The fourth EU framework programme for research, technological development and demonstration was announced in 1994, and runs until the end of 1998. Total funding under the programme amounts to about DKK 100 billion. Within the energy area, two non-nuclear

sub-programmes have been initiated, *JOULE* (research and development) and *THERMIE* (demonstration). The area dealing with hydrocarbons has been given what Denmark considers satisfactory prominence, as the priority given to most subjects coincides with Danish priorities.

Generally, the benefits derived from the first and second rounds of the framework programme were highly satisfactory for Denmark. However, the proportion of Danish projects within subjects related to hydrocarbons was not satisfactory in both rounds of applications. According to EU authorities, the quality of the Danish projects did not meet the level of former programme rounds, and only a few projects could be expected to result in the development of any real novelties.

The Nordic Energy Research Programme

Under the Nordic Energy Research Programme, funds are allocated to senior researchers and students carrying on research who participate in inter-Nordic research cooperation at Nordic universities. The Danish participation in this cooperation is financed by the Energy Research Programme (ERP), and the Danish Energy Agency is represented on the executive research committee in charge of the programme. In addition, researcher representatives from Denmark serve on all the expert committees.

The Petroleum Technology Expert Committee considers applications for funding within the area of oil and gas activities. In 1996, the Expert Committee awarded grants for 12 PhD scholarships (including four Danish) and one professorship.

The Nordic Energy Research Programme launched a new four-year programme in 1995. The following topics related to hydrocarbons are given priority by this new programme: *petroleum fluids, oil technology and petrophysics* (upstream operations), as well as *catalytic processes, separation processes and reactive distillation* (downstream operations).

A mid-term evaluation of the programme will be made in May 1997.

Licences in Denmark

Dansk Undergrunds Consortium (DUC):

The Sole Concession of 8 July 1962

Blocks: 5504/5 and 6 (Elly)
Blocks: 5603/27 and 28 (Gert)
Blocks: 5504/10 and 14 (Rolf)
Block: 5604/25 (Svend)
Blocks: 5604/21 and 22 (Harald)
Blocks: 5504/7, 8, 11, 12, 15 and 16
5505/13, 17 and 18 (the Contiguous Area)

Shell Olie- og Gasudvinding Danmark BV	46.000%
A.P. Møller (Concessionaires)	39.000%
Texaco Denmark Inc.	15.000%

Mærsk Olie og Gas AS is operator

2nd and 3rd Round Groups:

The Amalie share of licence 7/86

Blocks: 5604/22 and 26

Statoil Efterforskning og Produktion A/S	33.544%
DOPAS	25.317%
DENERCO OIL A/S	20.731%
LD Energi A/S	11.194%
Amerada Hess Energi A/S	9.214%

Statoil is operator and *Danop* will be operator in a development phase

The Lulita share of licence 7/86

Block: 5604/22

Statoil Efterforskning og Produktion A/S	33.544%
DOPAS	25.317%
DENERCO OIL A/S	24.882%
LD Energi A/S	11.194%
Amerada Hess Energi A/S	5.063%

Statoil is operator and *Danop* will be operator in a development phase

Licence 7/89

Block: 5504/2
Blocks: 5604/25, 29 and 30

Amerada Hess A/S	65.690%
DOPAS	25.000%
DENERCO OIL A/S	7.500%
Danoil Exploration A/S	1.810%

Amerada Hess is operator

Licence 8/89

Block: 5603/32
Block: 5604/29

Amerada Hess A/S	63.263%
DOPAS	23.624%
DENERCO OIL A/S	10.564%
Danoil Exploration A/S	2.549%

Danop is operator and *Amerada Hess* is co-operator

Licence 10/89

Blocks: 5603/27 and 31

A.P. Møller	26⅔%
Shell Olie- og Gasudvinding Danmark BV	26⅔%
Texaco Denmark Inc.	26⅔%
DOPAS	20.000%

Mærsk Olie og Gas AS is operator

Licences awarded in 1990:

Licence 1/90

Block: 5604/18

Statoil Efterforskning og Produktion A/S	33.544%
DOPAS	25.317%
DENERCO OIL A/S	24.882%
LD Energi A/S	11.194%
Amerada Hess Energi A/S	5.063%

Statoil is operator and *Danop* is co-operator

Licence 2/90

Blocks: 5604/23 and 24

Statoil Efterforskning og Produktion A/S	50.985%
DENERCO OIL A/S	17.316%
LD Energi A/S	14.003%
DOPAS	10.000%
Amerada Hess Energi A/S	7.696%

Danop is operator

Licence 3/90

Block: 5603/28

Shell Olie- og Gasudvinding Danmark BV	36.800%
A.P. Møller	31.200%
DOPAS	20.000%
Texaco Denmark Inc.	12.000%

Mærsk Olie og Gas AS is operator

Appendix A

4th Round Groups:

Licence 1/95

Blocks: 5503/2 and 3
Blocks: 5603/30 and 31

Amerada Hess A/S	40.000%
Premier Oil BV	20.000%
DENERCO OIL A/S	20.000%
DOPAS	20.000%

Amerada Hess is operator and *Danop* is co-operator

Licence 2/95

Blocks: 5503/3 and 4
Block: 5603/31
Block: 5604/29

Amerada Hess A/S	63.263%
DOPAS	23.624%
DENERCO OIL A/S	10.564%
Danoil Exploration A/S	2.549%

Danop is operator and *Amerada Hess* is co-operator

Licence 3/95

Blocks: 5604/19 and 20
Block: 5605/21

Statoil Efterforskning og Produktion A/S	50.497%
DOPAS	20.000%
DENERCO OIL A/S	13.232%
LD Energi A/S	10.169%
Amerada Hess Energi A/S	6.102%

Danop is operator and *Statoil* is co-operator

Licence 4/95

Block: 5604/20
Blocks: 5605/4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17
Blocks: 5606/1, 5 and 9

Mobil Erdgas-Erdöl GmbH	27.500%
RWE-DEA AG	20.000%
Wintershall AG	20.000%
DOPAS	20.000%
EWE AG	12.500%

Danop is operator

Licence 5/95

Blocks: 5603/30 and 31

Phillips Petroleum Int. Corp. Denmark	35.000%
Amerada Hess Efterforskning A/S	20.000%
DOPAS	20.000%
Pelican A/S Danmark	15.000%
DENERCO OIL A/S	5.000%
Premier Oil BV	5.000%

Phillips is operator

Licence 6/95

Blocks: 5604/16 and 20
Blocks: 5605/13 and 17

Statoil Efterforskning og Produktion A/S	40.000%
Enterprise Oil Exploration Ltd.	20.000%
DOPAS	20.000%
Phillips Petroleum Int. Corp. Denmark	12.500%
DENERCO OIL A/S	7.500%

Statoil is operator and *Danop* is co-operator

Licence 7/95

Block: 5505/22

A.P. Møller	26⅔%
Shell Olie- og Gasudvinding Danmark BV	26⅔%
Texaco Denmark Inc.	26⅔%
DOPAS	20.000%

Mærsk Olie og Gas AS is operator

Licence 8/95

Blocks: 5504/3 and 4

Shell Olie- og Gasudvinding Danmark BV	36.800%
A.P. Møller	31.200%
DOPAS	20.000%
Texaco Denmark Inc.	12.000%

Mærsk Olie og Gas AS is operator

Licence 9/95

Blocks: 5604/21, 22, 25 and 26

Shell Olie- og Gasudvinding Danmark BV	36.800%
A.P. Møller	31.200%
DOPAS	20.000%
Texaco Denmark Inc.	12.000%

Mærsk Olie og Gas AS is operator

Moreover, reference is made to the map of the Danish licence area at the back of the report.

Exploration and Appraisal Wells, 1986-1996

Well Number	Operator Drilling Rig	Lat. North Long East	Total Depth Formation	Spudded Completed
Lulu-2	Mærsk Olie og Gas AS	56°19'06"	3603 metres	1985-12-15
5604/22-2	Mærsk Endeavour	04°17'31"	U. Permian	1986-03-18
Diamant-1	Phillips	56°00'23"	4204 metres	1986-01-11
5603/32-2	Glomar Labrador 1	03°53'44"	L. Permian	1986-03-18
East Rosa-3	Mærsk Olie og Gas AS	55°35'37"	1569 metres	1986-01-20
5504/15-5	Dyvi Epsilon	04°36'31"	U. Permian	1986-03-19
East Rosa Fl.-1	Mærsk Olie og Gas AS	55°33'51"	3037 metres	1986-03-24
5504/15-6	Mærsk Endeavour	04°37'54"	U. Jurassic	1986-04-30
Ravn-1	Amoco	55°52'36"	4968 metres	1986-03-24
5504/01-2	Dyvi Epsilon	04°13'52"	L. Permian	1986-07-21
Mi. Rosa Fl.-1	Mærsk Olie og Gas AS	55°35'27"	3035 metres	1986-05-04
5504/15-7	Mærsk Endeavour	04°31'33"	L. Cretaceous	1986-06-11
West Lulu-4	Mærsk Olie og Gas AS	56°19'05"	3814 metres	1986-07-28
5604/21-6	Mærsk Endeavour	04°10'17"	L. Triassic	1986-09-13
Gwen-2	Mærsk Olie og Gas AS	56°06'52"	4363 metres	1986-09-30
5604/29-3	Mærsk Endeavour	04°04'10"	L. Triassic	1986-12-15
Mejrup-1	Phillips	56°22'39"	2481 metres	1987-03-22
5608/19-1	Kenting 36	08°40'36"	U. Triassic	1987-04-29
Felicia-1	Statoil	57°26'18"	5280 metres	1987-07-04
5708/18-1	Mærsk Guardian	08°18'41"	L. Permian	1987-12-03
Gert-3	Mærsk Olie og Gas AS	56°12'43"	5003 metres	1987-07-21
5603/28-2	Mærsk Endeavour	03°45'49"	Palaeozoic	1987-10-28
Ibenholt-1	Phillips	56°23'26"	2558 metres	1987-08-11
5605/20-1	Dyvi Sigma	05°58'29"	Precambrian	1987-09-24
Deep Gorm-1	Mærsk Olie og Gas AS	55°34'04"	3823 metres	1987-08-18
5504/16-5	Zapata Scotian	04°45'50"	Triassic	1987-12-04
Ravn-2	Amoco	55°50'34"	4466 metres	1987-09-16
5504/05-1	Dan Earl	04°13'40"	Triassic	1987-11-17
Elly-2	Mærsk Olie og Gas AS	55°47'19"	4104 metres	1987-11-15
5504/06-2	Neddrill Trigon	04°19'04"	Triassic	1988-05-31
Jeppe-1	Norsk Hydro	56°11'04"	5047 metres	1987-12-10
5603/28-3	Mærsk Guardian	03°54'36"	L. Permian	1988-03-02
Borg-1	Danop	55°02'57"	3063 metres	1988-04-18
5508/32-2	Kenting 34	08°48'23"	Palaeozoic	1988-05-29
Gulnare-1	Statoil	56°10'13"	4735 metres	1988-06-04
5604/26-1	Mærsk Endeavour	04°26'41"	U. Jurassic	1988-09-19
Tordenskjold-1	Danop	55°56'19"	3702 metres	1988-12-14
5503/03-2	Neddrill Trigon	03°32'31"	L. Permian	1989-02-04
Pernille-1	Norsk Hydro	55°00'54"	3589 metres	1989-04-09
5514/30-1	Glomar Moray Firth	14°18'43"	Silurian	1989-06-06
Stina-1	Amoco	54°47'20"	2482 metres	1989-06-12
5414/07-1	Glomar Moray Firth	14°37'44"	Silurian	1989-07-11
Falk-1	Amoco	55°50'01"	4200 metres	1989-07-24
5504/06-3	Glomar Moray Firth	04°18'50"	U. Triassic	1989-09-05
Gert-4	Mærsk Olie og Gas AS	56°13'18"	5363 metres	1989-11-02
5603/27-4	Mærsk Endeavour	03°43'48"	U. Permian	1990-05-16
Alma-1	Mærsk Olie og Gas AS	55°28'58"	3882 metres	1990-03-18
5505/17-10	Mærsk Giant	05°12'33"	Triassic	1990-08-16
Amalie-1	Statoil	56°14'39"	5320 metres	1990-08-01
5604/26-2	Neddrill Trigon	04°22'02"	M. Jurassic	1991-06-17
E-5	Mærsk Olie og Gas AS	55°40'25"	2166 metres	1991-02-05
5504/12-4	West Sigma	04°53'11"	U. Cretaceous	1991-05-11
Skjold Fl.-1	Mærsk Olie og Gas AS	55°33'23"	4550 metres	1991-05-10
5504/16-6	West Kappa	04°53'51"	Triassic	1991-09-22
Eg-1	Agip	55°57'09"	4500 metres	1991-06-24
5503/04-2	Neddrill Trigon	03°58'25"	Permian	1991-09-23
Baron-1	Norsk Hydro	56°01'44"	999 metres	1991-07-25
5604/30-2	Mærsk Jutlander	04°15'29"		1991-08-01
Baron-2	Norsk Hydro	56°01'44"	5100 metres	1991-08-01
5604/30-3	Mærsk Jutlander	04°15'29"	U. Jurassic	1992-01-13
Elly-3	Mærsk Olie og Gas AS	55°47'19"		1991-09-12
5504/06-5	Mærsk Endeavour	04°22'02"		1992-02-12
TWC-3P	Mærsk Olie og Gas AS	55°42'56"	2734 metres	1991-09-14
5504/11-3	Mærsk Giant	04°44'56"	L. Cretaceous	1991-11-24
S.E.Adda-1	Mærsk Olie og Gas AS	55°47'56"		1992-01-26
5504/08-5	Mærsk Giant	04°55'07"		1992-03-05
Dagmar-6	Mærsk Olie og Gas AS	55°35'04"		1992-02-22
5504/15-8	Mærsk Endeavour	04°35'50"		1992-04-11
E-6	Mærsk Olie og Gas AS	55°40'29"		1992-03-12
5504/12-5	Mærsk Giant	04°53'22"		1992-05-12
Lulita-1	Mærsk Olie og Gas AS	56°20'46"	3749 metres	1992-05-17
5604/22-3	Mærsk Giant	04°16'24"	M. Jurassic	1992-12-20
E-7	Mærsk Olie og Gas AS	55°40'43"		1992-06-11
5504/12-6	West Sigma	04°49'24"		1992-07-18
Bertel-1	Danop	56°02'12"	4810 metres	1992-06-27
5603/32-3	West Omikron	03°58'03"	Triassic	1992-10-07
Ida-1	Amoco	56°32'11"	1663 metres	1992-09-14
5606/13-1	Ross Explorer	06°06'58"	Triassic	1992-09-30
Rita-1	Mærsk Olie og Gas AS	56°09'09"	4758 metres	1992-09-18
5603/27-5	Mærsk Endeavour	03°34'13"	Triassic	1993-03-03
Skarv-1	Amoco	55°43'14"	3935 metres	1992-10-04
5504/10-2	Ross Explorer	04°24'58"	Triassic	1992-11-17
Jelling-1	Danop	55°44'22"	1933 metres	1992-10-05
5509/10-1	Kenting 31	09°22'33"	Precambrian	1992-10-24
Alma-2	Mærsk Olie og Gas AS	55°29'50"		1992-10-18
5505/17-11	Shelf Explorer	05°13'37"		1993-02-06
Løgumkloster-2	Danop	55°02'00"	2768 metres	1993-09-01
5508/32-3	Kenting 31	08°56'32"	L. Permian?	1993-10-17
Tabita-1	Statoil	56°13'37"	4313 metres	1993-09-13
5604/26-3	Glomar Moray Firth	04°23'47"	U. Jurassic	1993-12-10
E-8	Mærsk Olie og Gas AS	55°05'22"		1994-04-10
5504/12-7	West Kappa	04°59'12"		1994-06-06
Rigs-1	Amerada Hess	56°05'22"	3050 metres	1994-12-26
5604/29-4	Mærsk Giant	04°12'53"	L. Cretaceous	1995-02-25
Siri-1	Statoil	56°29'11"	2197 metres	1995-11-28
5604/20-1	Deepsea Bergen	04°54'57"	L. Tertiary	1995-12-24
Rigs-2	Amerada Hess	56°05'52"		1996-05-11
5604/29-5	Mærsk Enhancer	04°13'09"	U. Cretaceous	1996-07-29
Siri-2	Statoil	56°29'41"	2294 metres	1996-08-03
5604/20-2	Mærsk Enhancer	04°52'13"	L. Tertiary	1996-08-27
MFB-2E	Mærsk Olie og Gas AS	55°28'47"		1996-08-09
5505/17-12	Shelf Explorer	05°06'31"	U. Cretaceous	1996-12-21
Siri-3	Statoil	56°30'35"		1996-08-30
5605/13-1	Mærsk Enhancer	05°03'48"	L. Tertiary	1996-10-11

Appendix C

Exploratory Surveys 1996

Survey Licence	Operator Contractor	Type	Initiated Completed	Area Block	Collected in 1996
PAG95 1/95 + 5/95	Phillips/Amerada Geco-Prakla	Offshore 3D	1995-12-04 1996-04-07	CG 5503, 5603	11,915 km
SIRINOR 6/95	Statoil Geco-Prakla	Offshore 3D	1996-01-29 1996-04-25	NDB 5604, 5605	22,505 km
DN96C 8/89 + 2/95	Danop Geco-Prakla	Offshore 3D	1996-04-10 1996-05-14	CG 5503, 5504, 5603, 5604	13,456 km
SIRIWEST	Geco-Prakla Geco-Prakla	Offshore 3D	1996-09-02 1996-09-20	NDB 5604	8,635 km
SET96	PGS-Nopec SMNG	Offshore 2D	1996-01-27 1996-04-05	NDB 5604, 5605	482 km
DN96N 2/90 + 3/95	Danop Geoteam	Offshore 2D	1996-04-04 1996-04-07	NDB 5604, 5605	103 km
UCG96	Geoteam Geoteam	Offshore 2D	1996-06-20 1996-07-14	NDB & RFH 5604, 5605, 5606, 5504, 5505	2,200 km
NDT96	CGG Geoteam	Offshore 2D	1996-07-15 1996-08-05	NDB 5604, 5605, 5606	284 km
DN9602N 2/90 + 3/95	Danop Geoteam	Offshore 2D	1996-08-06 1996-08-18	NDB 5604, 5605	835 km
SIRI-RCM	Geco-Prakla Geco-Prakla	Offshore 2D	1996-09-16 1996-09-21	NDB 5604, 5605	28 km
DT97	Geoteam Geoteam	Offshore 2D	1996-11-15 1996-12-12	NDB & RFH 5604, 5605, 5504, 5505	2,351 km
CGME96	PGS Nopec SMNG	Offshore 2D	1996-11-15 1996-12-02	NDB 5604, 5605	14 km
UCGE97	Geoteam Geoteam	Offshore 2D	1996-12-13 1997-01-09	NDB & RFH 5605, 5606, 5505, 5506	1,552 km
 4/95	Danop Alluvial Mining	Offshore Geochemical	1996-03-22 1996-04-02	NDB 5604, 5605, 5606	100 cores
	Geological Survey of Norway	Offshore Aeromagnetic	1996-04-21 1996-06-27	NDB 5604-5608, 5706-5710, 5810	approx. 15,000 km

CG = Central Graben, NDB = Norwegian-Danish Basin, RFH = Ringkøbing-Fyn High

New Field Developments

Field name	Harald
Prospect:	Lulu/West Lulu
Location:	Blocks 5604/21 and 22
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas AS
Discovered:	1980 (Lulu) 1983 (West Lulu)
Dev. plan approved:	1993
Year on stream:	1997 (at the latest)
Water depth:	64 m (210 ft)
Reservoir depth:	2,700 m (8,900 ft) 3,650 m (12,000 ft), resp.
Reservoir rock:	Chalk (Lulu) Sandstone (West Lulu)
Geological age:	Danian/Upper Cretaceous and Middle Jurassic, resp.

Field name	Siri
Location:	Block 5604/20
Licensee:	The Statoil group 6/95, see App. A
Operator:	Statoil, Danop is co-operator
Discovered:	1995
Dev. plan approved:	1997
Year on stream:	1998
Water depth:	60 m (197 ft)
Reservoir depth:	2,060 m (6,760 ft)
Reservoir rock:	Sandstone
Geological age:	Paleocene

Field name	South Arne
Location:	Blocks 5604/29b, 30b
Licensee:	The Amerada Hess group 7/86, see App. A
Operator:	Amerada Hess A/S
Discovered:	1969
Dev. plan approved:	1997
Year on stream:	1999
Water depth:	60 m
Reservoir depth:	2,710-2,940 m (8,900-9,650 ft)
Reservoir rock:	Chalk
Geological age:	Lower Tertiary and Upper Cretaceous (Lower Cretaceous)

Field name	Adda
Location:	Block 5504/8
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas AS
Discovered:	1977
Dev. plan approved:	1990
Year on stream:	1999 (at the latest)
Water depth:	38 m (125 ft)
Reservoir depth:	2,200 m (7,200 ft) 2,300 m (7,500 ft), resp.
Reservoir rock:	Carbonates
Geological age:	Upper and Lower Cretaceous

Appendix D

Field name	Igor
Location:	Block 5505/13
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas AS
Discovered:	1968
Dev. plan approved:	1990
Year on stream:	1999 (at the latest)
Water depth:	50 m (164 ft)
Reservoir depth:	2,000 m (6,600 ft)
Reservoir rock:	Chalk
Geological age:	Danian and Upper Cretaceous

Field name	Elly
Location:	Block 5504/6
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas AS
Discovered:	1984
Dev. plan approved:	1995
Year on stream:	1999 (at the latest)
Water depth:	40 m (131 ft)
Reservoir depth:	3,200 m and 4,000 m (10,500 ft and 13,000 ft)
Reservoir rock:	Chalk and sandstone
Geological age:	Upper Cretaceous and Jurassic

Field name	Gert
Location:	Blocks 5603/27 and 28
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas AS
Discovered::	1984
Dev. plan approved:	1991
Water depth:	70 m (230 ft)
Reservoir depth:	4,900 m (16,100 ft)
Reservoir rock:	Sandstone
Geological age:	Upper Jurassic

Field name	Alma
Location:	Block 5505/17
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas AS
Discovered:	1990
Dev. plan approved:	1995
Year on stream:	2003
Water depth:	43 m (141 ft)
Reservoir depth:	3,600 m (11,800 ft)
Reservoir rock:	Sandstone
Geological age:	Middle Jurassic

Danish Oil Production 1972-1996, million m^3

Year	Dan	Gorm	Skjold	Tyra	Rolf	Kraka	Dagmar	Regnar	Valdemar	Roar	Svend	Total*
1972-1980	2.68*											2.68
1981	0.34	0.53										0.88
1982	0.31	1.64	0.02									1.97
1983	0.27	1.84	0.40									2.52
1984	0.36	1.62	0.65	0.07								2.71
1985	0.45	1.80	0.85	0.35								3.46
1986	0.47	1.72	1.07	0.57	0.47							4.29
1987	1.23	1.50	1.21	0.84	0.63							5.42
1988	1.50	1.35	1.37	0.95	0.40							5.57
1989	1.47	1.35	2.21	1.05	0.39							6.48
1990	1.58	1.44	2.63	1.08	0.27							7.00
1991	1.72	1.50	2.73	1.39	0.29	0.14	0.47					8.26
1992	2.70	1.66	2.28	1.67	0.30	0.21	0.31					9.12
1993	3.26	1.89	2.10	1.64	0.18	0.39	0.07	0.15	0.05			9.72
1994	3.50	2.42	1.72	1.75	0.09	0.49	0.03	0.43	0.30			10.73
1995	3.71	2.49	1.98	1.63	0.22	0.47	0.03	0.09	0.17			10.79
1996	3.80	2.88	2.02	1.45	0.22	0.34	0.02	0.04	0.16	0.32	0.84	12.09
Total	**29.37**	**27.64**	**23.26**	**14.43**	**3.46**	**2.04**	**0.94**	**0.70**	**0.68**	**0.32**	**0.84**	**103.69**

Danish Gas Production (net**) 1972-1996, billion m^3

Year	Dan	Gorm	Skjold	Tyra	Rolf	Kraka	Dagmar	Regnar	Valdemar	Roar	Svend	Total*
1972-1980	0.78*											0.78
1981	0.08	0.05										0.13
1982	0.08	0.05	0.00									0.14
1983	0.08	0.03	0.04									0.14
1984	0.13	-0.04	0.06	0.26								0.41
1985	0.21	-0.09	0.07	1.11								1.31
1986	0.24	0.11	0.10	1.63	0.02							2.10
1987	0.44	0.02	0.10	2.02	0.03							2.60
1988	0.60	0.12	0.11	1.77	0.02							2.62
1989	0.71	0.00	0.19	2.11	0.02							3.02
1990	0.80	0.03	0.22	2.02	0.01							3.08
1991	0.88	0.11	0.23	2.61	0.01	0.06	0.07					3.96
1992	1.06	0.13	0.21	2.57	0.01	0.09	0.05					4.12
1993	1.34	0.36	0.19	2.40	0.01	0.13	0.01	0.01	0.03			4.47
1994	1.26	0.85	0.19	2.28	0.00	0.12	0.01	0.03	0.10			4.83
1995	1.33	0.73	0.19	2.71	0.01	0.13	0.01	0.01	0.05			5.16
1996	1.25	0.65	0.16	2.62	0.01	0.09	0.00	0.00	0.06	1.33	0.08	6.25
Total	**11.26**	**3.10**	**2.06**	**26.11**	**0.15**	**0.61**	**0.14**	**0.04**	**0.23**	**1.33**	**0.08**	**45.12**

* Reference is made to previous editions of the Report on *Oil and Gas Production in Denmark*

** Reinjected gas has been deducted

Appendix E

Natural Gas Supplies from Danish Fields 1984-1996, billion Nm^3

Year	Dan	Gorm	Skjold	Tyra	Rolf	Kraka	Dagmar	Regnar	Valdemar	Roar	Svend	Total
1984	0.01	0.02	<0.01	0.19	-	-	-	-	-	-	-	**0.22**
1985	0.05	<0.01	<0.01	1.02	-	-	-	-	-	-	-	**1.06**
1986	0.21	0.12	0.01	1.46	<0.01	-	-	-	-	-	-	**1.80**
1987	0.38	0.02	<0.01	1.90	<0.01	-	-	-	-	-	-	**2.30**
1988	0.53	0.10	0.01	1.63	<0.01	-	-	-	-	-	-	**2.27**
1989	0.64	0.06	0.01	1.98	<0.01	-	-	-	-	-	-	**2.69**
1990	0.74	0.10	0.03	1.89	<0.01	-	-	-	-	-	-	**2.75**
1991	0.77	0.17	0.05	2.48	<0.01	0.05	-	-	-	-	-	**3.51**
1992	0.93	0.15	0.04	2.43	<0.01	0.08	-	-	-	-	-	**3.63**
1993	1.23	0.30	0.08	2.26	<0.01	0.12	-	0.01	0.02	-	-	**4.01**
1994	1.13	0.72	0.15	2.15	<0.01	0.10	-	0.02	0.06	-	-	**4.33**
1995	1.21	0.60	0.15	2.57	0.01	0.12	-	0.01	0.04	-	-	**4.70**
1996	1.12	0.49	0.12	2.48	0.01	0.09	-	<0.01	0.05	1.26	0.08	**5.71**
Total	**8.95**	**2.83**	**0.64**	**24.43**	**0.03**	**0.55**	**-**	**0.04**	**0.17**	**1.26**	**0.08**	**38.97**

Monthly Oil and Condensate Production 1996, thousand m^3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1996
Dan	310	298	319	309	325	240	338	345	320	326	323	347	**3799**
Kraka	35	32	33	27	31	16	29	23	26	27	22	36	**340**
Regnar	5	5	5	4	4	2	5	4	4	4	0	0	**41**
Gorm	191	210	261	237	240	237	264	252	250	261	238	238	**2879**
Skjold	212	168	170	162	177	151	167	155	150	161	176	173	**2023**
Rolf	22	20	18	18	12	15	18	20	21	19	16	17	**218**
Dagmar	2	1	3	2	2	2	2	2	2	2	2	2	**23**
Tyra	148	139	142	131	136	101	103	99	98	117	113	121	**1447**
Valdemar	12	16	12	18	15	12	7	15	13	11	14	16	**161**
Roar	6	14	27	33	22	18	19	27	33	41	39	40	**319**
Svend	-	-	-	-	25	38	74	117	131	150	150	153	**836**
Total	**943**	**903**	**989**	**942**	**990**	**833**	**1026**	**1058**	**1048**	**1119**	**1093**	**1143**	**12087**

Water Injection in Danish Fields, million m^3

Year	Dan	Gorm	Skjold	Total
1981				
1982				
1983				
1984				
1985				
1986			0.63	**0.63**
1987			1.04	**1.04**
1988			1.38	**1.38**
1989	0.08	0.36	2.90	**3.34**
1990	0.18	0.89	3.38	**4.45**
1991	0.18	1.01	3.24	**4.43**
1992	0.86	1.60	2.79	**5.25**
1993	1.53	2.14	2.84	**6.51**
1994	3.81	4.61	3.51	**11.93**
1995	5.88	5.75	3.99	**15.62**
1996	8.24	8.11	5.71	**22.07**
Total	**20.77**	**24.48**	**31.40**	**76.66**

Gas Injection in Danish Fields, billion Nm^3

Year	Gorm	Tyra	Total
1981	0.03		**0.03**
1982	0.22		**0.22**
1983	0.40		**0.40**
1984	0.55		**0.55**
1985	0.73		**0.73**
1986	0.67		**0.67**
1987	0.86	0.63	**1.50**
1988	0.86	1.59	**2.45**
1989	0.89	1.41	**2.30**
1990	0.78	1.28	**2.06**
1991	0.74	1.07	**1.80**
1992	0.71	1.37	**2.08**
1993	0.42	1.45	**1.87**
1994	0.07	1.37	**1.44**
1995	0.03	1.13	**1.16**
1996	0.03	1.22	**1.25**
Total	**7.98**	**12.53**	**20.50**

Producing Fields

The Dan Centre

Field name	Dan
Prospect:	Abby
Location:	Block 5505/17
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1971
Year on stream:	1972
Producing wells:	46 (33 horizontal)
Water injection wells:	31 (12 horizontal)
Abandoned wells:	6
Water depth:	40 m (131 ft)
Acreage:	20 km^2 (5,000 acres)
Reservoir depth:	1,850 m (6,070 ft)
Reservoir rock:	Chalk
Geological age:	Danian and Upper Cretaceous
Reserves at 1 January 1997:	
Oil:	73.1 million m^3 (460 MMbbls)
Gas:	11.8 billion Nm^3 (441 BSCF)
Cumulative production at 1 January 1997:	
Oil:	29.37 million m^3 (185 MMbbls)
Gas:	11.26 billion Nm^3 (419 BSCF)
Water:	6.23 million m^2 (39 MMbbls)
Cumulative injection at 1 January 1997:	
Water:	20.77 million m^3 (131 MMbbls)
Production in 1996:	
Oil:	3.80 million m^3 (24 MMbbls)
Gas:	1.25 billion Nm^3 (47 BSCF)
Water:	1.54 million m^3 (10 MMbbls)
Water injection in 1996:	8.24 million m^3 (52 MMbbls)
Total investments (nominal prices) at 1 January 1997:	DKK 11.4 billion

Review of Geology

Dan is an anticlinal structure partly induced through salt tectonics of the Zechstein/Triassic. A major fault divides the field into two reservoir blocks, which, in turn, are intersected by a number of minor faults. The chalk reservoir has high porosity, although low permeability. There is a gas cap in the field.

Production Strategy

Recovery from the field is based on the simultaneous production of oil and injection of water. Water injection was initiated in 1989. The most recent development plan from 1995 provides for the introduction of high-rate water injection. The high pressure involved causes the injected water to fracture the chalk, ensuring the rapid distribution of water throughout the reservoir. Injecting large amounts of water quickly stabilizes and builds up the reservoir pressure in the oil zone. The recovery of oil is optimized by flooding the largest possible reservoir volume with as much water as possible.

Production Facilities

The field installation comprises six wellhead platforms (DA, DD, DE, DFA, DFB and DFE), two processing/accommodation platforms (DB and DFC) and two gas flare stacks (DC and DFD).

At the Dan Field, there are reception facilities for the production from the Kraka and Regnar satellite fields.

The processing facilities on the DFC platform, which handle the combined production from the Dan, Kraka and Regnar Fields, consist of an oil stabilization plant and a gas dehydration plant. Final processing of the produced oil is performed prior to export ashore via the booster platform, Gorm E. The gas is pre-processed and transported to Tyra East for final processing. The water-injection capacity is 8.7 million m^3 per year (150,000 bbls per day).

The older processing facilities on the DB platform have since 1987 been used for well testing only.

In the Dan Field, there are accommodation facilities for 86 persons on the DFC platform and five persons on the DB platform.

Facilities under Construction

In connection with the ongoing further development of the Dan Field, the capacity of the oil, gas and water-processing facilities, as well as the water-injection facili-

ties, will be expanded. This expansion will be effected by upgrading the existing equipment on the existing Dan F platform complex, and by installing new processing facilities on a new platform, DFF, to be connected by a bridge to DFC. Initially, the DFF platform will be able to host 32 wells, but can be expanded to accommodate a total of 64 wells.

In conjunction with the expansion, three new pipelines will be laid and hooked up to the DD platform, to be used for transporting the hydrocarbons produced, injection water and lift gas.

The jacket for the DFF platform was installed in 1996. The processing facilities, etc., as well as the bridge connection to DFC are expected to be installed in 1997.

Field name	**Kraka**
Prospect:	Anne
Location:	Block 5505/17
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1966
Year on stream:	1991
Producing wells:	6 (all horizontal)
Water depth:	45 m (148 ft)
Acreage:	20 km^2 (5,000 acres)
Reservoir depth:	1,800 m (5,900 ft)
Reservoir rock:	Chalk
Geological age:	Danian and Upper Cretaceous
Reserves at 1 January 1997:	
Oil:	4.0 million m^3 (25 MMbbls)
Gas:	1.3 billion Nm^3 (49 BSCF)
Cumulative production at 1 January 1997:	
Oil:	2.04 million m^3 (13 MMbbls)
Gas:	0.61 billion Nm^3 (23 BSCF)
Water:	1.08 million m^3 (7 MMbbls)
Production in 1996:	
Oil:	0.34 million m^3 (2 MMbbls)
Gas:	0.09 billion Nm^3 (3 BSCF)
Water:	0.27 million m^3 (2 MMbbls)
Total investments (nominal prices) at 1 January 1997:	DKK 8.7 billion

Review of Geology

Kraka is an anticlinal structure induced through Zechstein salt tectonics, which to a certain degree has caused fracturing in the chalk. The chalk reservoir has high porosity, although low permeability. The thin oil pay zone is further characterized by high water saturations. There is a minor gas cap in the reservoir.

Production Strategy

Production from the field is based on primary recovery, meaning no secondary recovery techniques are used, either in the form of gas or water injection. Attempts are currently being made to optimize production so as to liberate as much oil and gas, and as little water, as possible from the tight chalk formation.

Production Facilities

Kraka is a satellite development to the Dan Field, with an unmanned production platform of the STAR type hosting seven wells. The produced oil and gas are transported to DFC in the Dan Field for processing and export ashore.

Field name	**Regnar**
Prospect:	Nils
Location:	Block 5505/17
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1979
Year on stream:	1993
Producing wells:	1
Water depth:	45 m (148 ft)
Acreage:	8 km^2 (2,000 acres)
Reservoir depth:	1,700 m (5,600 ft)
Reservoir rock:	Chalk and Carbonates
Geological age:	Upper Cretaceous and Zechstein
Reserves at 1 January 1997:	
Oil:	0.2 million m^3 (1 MMbbls)
Gas:	<0.1 billion Nm^3 (1 BSCF)
Cumulative production at 1 January 1997:	
Oil:	0.70 million m^3 (4 MMbbls)

Gas:	0.04 billion Nm^3 (2 BSCF)
Water:	0.94 million m^3 (6 MMbbls)
Production in 1996:	
Oil:	0.04 million m^3 (<1 MMbbls)
Gas:	<0.01 billion Nm^3 (<1 BSCF)
Water:	0.30 million m^3 (2 MMbbls)
Total investments (nominal prices) at 1 January 1997:	DKK 0.2 billion

Review of Geology

The Regnar field is an anticlinal structure, induced through Zechstein salt tectonics. The structure is heavily fractured, resulting in favourable reservoir conductivity (compare Skjold, Rolf, Dagmar and Svend).

Production Strategy

Production in the Regnar Field is carried on from a vertical well drilled in the crest of the structure. The oil is forced towards the production well by water flowing in from the water zone. The production strategy is to displace and produce as much of the oil as possible from the tight part of the formation, the matrix.

Production Facilities

The Regnar Field has been developed as a satellite to the Dan Field. Production takes place in a subsea-completed well. The hydrocarbons produced are conveyed by pipeline in multi-phase flow to Dan FC for processing and export ashore.

The well is remotely monitored and controlled from the Dan FC platform.

The Gorm Centre

Field name	Gorm
Prospect:	Vern
Location:	Blocks 5504/15 and 16
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1971
Year on stream:	1981
Producing wells:	30 (7 horizontal)
Gas injection wells:	2
Water injection wells:	14 (9 horizontal)
Abandoned wells:	1
Water depth:	39 m (128 ft)
Acreage:	12 km^2 (3,000 acres)
Reservoir depth:	2,100 m (6,900 ft)
Reservoir rock:	Chalk
Geological age:	Danian and Upper Cretaceous
Reserves at 1 January 1997:	
Oil:	19.7 million m^3 (124 MMbbls)
Gas:	3.2 billion Nm^3 (121 BSCF)
Cumulative production at 1 January 1997:	
Oil:	27.64 million m^3 (174 MMbbls)
Net gas:	3.10 billion Nm^3 (115 BSCF)
Water:	9.19 million m^3 (58 MMbbls)
Cumulative injection at 1 January 1997:	
Gas:	7.98 billion Nm^3 (297 BSCF)
Water:	24.48 million m^3 (154 MMbbls)
Production in 1996:	
Oil:	2.88 million m^3 (18 MMbbls)
Net gas:	0.65 billion Nm^3 (24 BSCF)
Water:	1.92 million m^3 (12 MMbbls)
Injection in 1996:	
Gas:	0.03 billion m^3 (1 BSCF)
Water:	8.11 million m^3 (51 MMbbls)
Total investments (nominal prices) at 1 January 1997:	DKK 6.5 billion

Review of Geology

Gorm is an anticlinal structure partly due to Zechstein salt tectonics. A major fault extending north-south divides the field into two reservoir blocks. The western reservoir block is intersected by numerous, minor faults. Initially, there was no gas cap in the Gorm Field, but

since the field was brought on stream, the injection of gas has resulted in the formation of an artificial gas cap in the western block.

Production Strategy

In 1989, water injection was initiated in the reservoir. Oil production from the field is based on extending the use of water injection to the whole field. In the western reservoir block, oil is recovered from the mid-flank areas of the reservoir, with simultaneous water injection in the flanks. In a later phase, recovery will be moved towards the crest of the structure, while water injection will be initiated in the areas where oil was produced previously. In the eastern reservoir block, oil is recovered from the mid-flank areas of the reservoir, with simultaneous water injection in the water zone under the reservoir. The recovery of oil is optimized by flooding the largest possible reservoir volume with as much water as possible.

The injection of gas, which was initiated in the western reservoir block at the time of production start-up, has virtually been phased out.

Production Facilities

The Gorm Field consists of two wellhead platforms (GA and GB), one processing/accommodation platform (GC), one gas flare stack (GD), one riser/booster platform (GE), owned by Dansk Olierør A/S, and one combined wellhead/processing/booster platform (GF).

Gorm receives production from the adjacent satellite fields, Skjold, Rolf and Dagmar. The Gorm Field installations supply the Skjold Field with injection water and lift gas and the Rolf Field with lift gas. Most of the gas produced is now sent to Tyra East. The stabilized oil from the processing facilities at the Dan, Tyra and Gorm Centres is transported ashore via the booster platform GE.

The processing facilities on the GC platform consist of an oil stabilization plant, where the oil from the Rolf Field is processed, plants for the final processing of gas and for purifying the water produced, as well as compression facilities for reinjecting and exporting gas.

The processing facilities on the GF platform consist of two oil stabilization plants, one receiving the sour oil and gas from the Dagmar Field, and the other receiving the production from the Gorm and Skjold Fields.

The water-injection capacity at the Gorm Centre constitutes 12.2 million m^3 per year (210,000 bbls per day).

In 1996, a fourth deck was installed on the GF platform, which houses wellhead compression facilities to reduce the wellhead pressure in the Gorm and Skjold wells. In addition, a new test separator has been installed on this deck.

There are accommodation facilities on the GC platform for 98 persons.

Field name	**Skjold**
Prospect:	Ruth
Location:	Block 5504/16
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1977
Year on stream:	1982
Producing wells:	13 (10 horizontal/parallel with the strata)
Water injection wells:	7 (2 horizontal)
Abandoned wells:	1
Water depth:	40 m (131 ft)
Acreage:	10 km^2 (2,500 acres)
Reservoir depth:	1,600 m (5,200 ft)
Reservoir rock:	Chalk
Geological age:	Danian, Uper Cretaceous and Zechstein
Reserves at 1 January 1997:	
Oil:	14.3 million m^3 (90 MMbbls)
Gas:	1.2 billion Nm^3 (45 BSCF)
Cumulative production at 1 January 1997:	
Oil:	23.26 million m^3 (146 MMbbls)
Gas:	2.06 billion Nm^3 (77 BSCF)
Water:	6.08 million m^3 (38 MMbbls)
Cumulative injection at 1 January 1997:	
Water:	31.40 million m^3 (198 MMbbls)
Production in 1996:	
Oil:	2.02 million m^3 (13 MMbbls)
Gas:	0.16 billion Nm^3 (6 BSCF)
Water:	2.67 million m^3 (17 MMbbls)

Water injection in 1996:	5.71 million m^3 (36 Mmbbls)

Total investments (nominal prices) at 1 January 1997: DKK 2.9 billion

Review of Geology

The Skjold Field is an anticlinal structure, induced through Zechstein salt tectonics. The structure is delineated by a series of ring faults along most of the flank. The reservoir is intersected by numerous, minor faults in the central part of the structure. The reservoir is less fractured in the flanks of the structure. Unusually favourable production properties have been shown to exist in the reservoir.

Production Strategy

During the first years after production start-up, oil was produced from individual wells drilled in the crestal, central part of the reservoir. Water injection was initiated in the reservoir in 1986. The water is injected through delineated and horizontal wells drilled at the flanks of the structure. Today, oil from the Skjold Field is mainly produced from horizontal wells at the flanks of the reservoir. The production and injection wells are placed alternately in a radial pattern from the platform. The recovery of oil is optimized by flooding the greatest possible part of the reservoir with as much water as possible. The injection of water has stabilized the reservoir pressure above the bubble point of the oil.

Production Facilities

The Skjold Field comprises a satellite development to the Gorm Field, including two wellhead platforms, Skjold A and B, as well as an accommodation platform, Skjold C. The two latter platforms are connected by bridges to Skjold A.

There are no processing facilities at the Skjold Field, and the production is transported to the GF platform in the Gorm Field for processing there. The Gorm facilities provide the Skjold Field with injection water and lift gas.

At Skjold C, there are accommodation facilities for 16 persons.

Field name: Rolf

Prospect:	Middle Rosa
Location:	Blocks 5504/14 and 15
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1981
Year on stream:	1986
Producing wells:	2
Abandoned wells:	1
Water depth:	34 m (112 ft)
Acreage:	8 km^2 (2,000 acres)
Reservoir depth:	1,800 m (5,900 ft)
Reservoir rock:	Chalk and Carbonates
Geological age:	Danian, Upper Cretaceous and Zechstein

Reserves at 1 January 1997:

Oil:	1.8 million m^3 (12 MMbbls)
Gas:	0.1 billion Nm^3 (3 BSCF)

Cumulative production at 1 January 1997:

Oil:	3.46 million m^3 (22 MMbbls)
Gas:	0.15 billion Nm^3 (5.6 BSCF)
Water:	2.56 million m^3 (16 MMbbls)

Production in 1996:

Oil:	0.22 million m^3 (1 MMbbls)
Gas:	0.01 billion Nm^3 (<1 BSCF)
Water:	0.49 million m^3 (3 MMbbls)

Total investments (nominal prices) at 1 January 1997: DKK 0.6 billion

Review of Geology

Rolf is an anticlinal structure created through Zechstein salt tectonics. The chalk reservoir is heavily fractured resulting in highly favourable reservoir conductivity (compare Skjold, Dagmar, Regnar and Svend).

Production Strategy

Production from the Rolf Field takes place from wells drilled in the crest of the structure. The oil is forced towards the producing wells by the water flowing in from an underlying water zone. The natural influx of water from the water zone corresponds to the volume removed due to production in the central part of the structure. To date, it has not been found necessary to add energy to the reservoir by water injection.

Appendix F

Production Facilities

The Rolf Field is a satellite development to the Gorm Field with an unmanned wellhead platform. The production is transported to the GC platform in the Gorm Field for processing. Rolf is supplied with lift gas from the Gorm Field.

Field name	Dagmar
Prospect:	East Rosa
Location:	Block 5504/15
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1983
Year on stream:	1991
Producing wells:	2
Water depth:	34 m (112 ft)
Acreage:	9 km^2 (2.200 acres)
Reservoir depth:	1.400 m (4.600 ft)
Reservoir rock:	Chalk and Carbonates
Geological age:	Danian, Upper Cretaceous and Zechstein
Reserves at 1 January 1997:	
Oil:	0.6 million m^3 (4 MMbbls)
Gas:	0.1 billion Nm^3 (5 BSCF)
Cumulative production at 1 January 1997:	
Oil:	0.94 million m^3 (6 MMbbls)
Gas:	0.14 billion Nm^3 (5 BSCF)
Water:	1.96 million m^3 (12 MMbbls)
Production in 1996:	
Oil:	0.02 million m^3 (<1 MMbbls)
Gas:	<0.01 billion Nm^3 (<1 BSCF)
Water:	0.51 million m^3 (3 MMbbls)
Total investments (nominal prices) at 1 January 1997:	DKK 0.3 billion

Review of Geology

The Dagmar field is an anticlinal structure, induced through Zechstein salt tectonics. The uplift is so pronounced that the Dagmar reservoir is situated closer to the surface than any other hydrocarbon reservoirs in Danish territory. The reservoir is heavily fractured (compare Skjold, Rolf, Regnar and Svend). However, the water zone does not appear to be particularly fractured.

Production Strategy

Initially, the oil production rates were high in the Dagmar Field, but it has not been possible to sustain the good production performance characterizing the Skjold and Rolf Fields. Production is based on primary recovery techniques. It is uncertain whether the entire reservoir is being drained from the existing wells, or whether the structure is divided into several, minor reservoirs.

Production Facilities

The Dagmar field is a satellite development to Gorm including one unmanned production platform of the STAR type. The unprocessed production is transported to the GF platform in the Gorm Field, where special facilities for handling the sour gas from the Dagmar Field have been installed. The relatively small amount of gas produced from Dagmar is flared due to the high content of hydrogen sulphide.

The Tyra Centre

Field name	Tyra
Prospect:	Cora
Location:	Blocks 5504/11 and 12
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1968
Year on stream:	1984
Producing wells:	46 (20 horizontal)
Producing/injection wells:	10
Water depth:	37-40 m (121-131 ft)
Acreage:	90 km^2 (22,200 acres)
Reservoir depth:	2,000 m (6,600 ft)
Reservoir rock:	Chalk
Geological age:	Danian and Upper Cretaceous
Reserves at 1 January 1997:	
Oil:	2.4 million m^3 (15 MMbbls)
Condensate:	4.3 million m^3 (27 MMbbls)
Gas:	50.1 billion Nm^3 (1,866 BSCF)

Cumulative production at 1 January 1997:	
Oil:	6.78 million m^3 (43 MMbbls)
Condensate:	7.65 million m^3 (48 MMbbls)
Net gas:	26.11 billion Nm^3 (972 BSCF)
Water:	8.05 billion m^3 (51 MMbbls)
Cumulative injection at 1 January 1997:	
Gas:	12.53 billion Nm^3 (467 BSCF)
Production in 1996:	
Oil:	0.86 million m^3 (5 MMbbls)
Condensate:	0.59 million m^3 (4 MMbbls)
Net gas:	2.62 billion Nm^3 (98 BSCF)
Water:	2.16 million m^3 (14 MMbbls)
Gas injection in 1996:	1.22 billion Nm^3 (45 BSCF)
Total investments (nominal prices) at 1 January 1997:	DKK 13.8 billion

Review of Geology

The Tyra Field is an anticlinal structure created by tectonic uplift. The accumulation consists of free gas containing condensate, overlying a thin oil zone. A pronounced permeability barrier covering a large part of the reservoir separates the Danian chalk layers from those of Upper Cretaceous age. The reservoir is slightly fractured.

Production Strategy

As far as natural gas supplies are concerned, the Tyra Field acts as a buffer, so that if the other Danish oil and gas fields do not produce sufficient gas to meet the contractual obligation to supply gas to Dansk Naturgas A/S, the balance is supplied from the Tyra Field.

Excess production capacity in the Tyra Field is used to reinject produced gas, thereby increasing the recovery of liquid hydrocarbons. All vertical gas wells at Tyra West and some of the gas wells at Tyra East are to be converted into injection wells.

Attempts are made not to deteriorate condensate and oil production conditions by reducing the reservoir pressure in the gas zone at too early a stage. Increased gas production from the other fields, in particular the Harald and Roar gas fields, meets the objective of optimizing the recovery of liquid hydrocarbons from the Tyra Field by stabilizing the Tyra reservoir pressure.

Production Facilities

The Tyra Field installations comprise two platform complexes, Tyra West (TW) and Tyra East (TE).

Tyra West consists of two wellhead platforms (TWB and TWC), one processing/accommodation platform (TWA) and one gas flare stack (TWD), as well as a bridge module installed at TWB and supported by a four-legged jacket (TWE). The bridge module became serviceable in 1996.

The Tyra West processing facilities include plant for preprocessing production from the wells at Tyra West. Moreover, the Tyra West complex houses processing and compression facilities for the injection and/or export of gas and processing facilities for the water produced. Oil and condensate are transported to Tyra East for final processing.

Tyra East consists of two wellhead platforms (TEB and TEC), one processing/accommodation platform (TEA), one gas flare stack (TED), and one riser platform (TEE), as well as a bridge module supported by a STAR jacket (TEF). The bridge module became serviceable in 1996.

The Tyra East complex includes facilities for the final processing of gas, oil, condensate and water. The bridge module houses the facilities for receiving and handling production from the satellite fields, Valdemar, Roar and Svend, and from the future installations in the Harald Field.

The two platform complexes in the Tyra Field are interconnected by pipelines in order to generate the maximum operational flexibility and reliability of supply.

The oil and condensate produced at the Tyra Centre are transported to shore via the GE platform in the Gorm Field, while the gas produced at the Tyra Centre, together with the gas production from the Gorm and Dan Centres, is transported to shore via the TEE platform.

The TEA platform has accommodation facilities for 96 persons, while there are accommodation facilities for 80 persons on the TWA platform.

Appendix F

Field name	Valdemar
Prospects:	Bo/North Jens
Location:	Blocks 5504/7 and 11
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1977 (Bo), 1985 (North Jens)
Year on stream:	1993 (North Jens)
Producing wells:	4 (all horizontal)
Water depth:	38 m (125 ft)
Late Cretaceous reservoir:	
Acreage:	15 km^2 (3,700 acres)
Reservoir depth:	2,000 m (6,600 ft)
Early Cretaceous reservoir:	
Acreage:	15 km^2 (3,700 acres)
Reservoir depth:	2,600 m (8,500 ft)
Reservoir rock:	Chalk
Geological age:	Danian, Upper and Lower Cretaceous
Reserves at 1 January 1997:	
Oil:	1.8 million m^3 (12 MMbbls)
Gas:	0.9 billion Nm^3 (32 BSCF)
Cumulative production at 1 January 1997:	
Oil:	0.68 million m^3 (4 MMbbls)
Gas:	0.23 billion Nm^3 (9 BSCF)
Water:	0.08 million m^3 (1 MMbbls)
Production in 1996:	
Oil:	0.16 million m^3 (1 MMbbls)
Gas:	0.06 billion Nm^3 (2 BSCF)
Water:	0.03 million m^3 (<1 MMbbls)
Total investments (nominal prices) at 1 January 1997:	DKK 1.0 billion

Review of Geology

The Valdemar Field consists of a northern reservoir called North Jens and a southern reservoir called Bo, which are both anticlinal chalk structures associated with tectonic uplift.

Valdemar comprises several separate reservoirs. Oil and gas have been discovered in Danian and Upper Cretaceous chalk. In the Lower Cretaceous reservoir, vast amounts of oil-in-place have been identified in Aptian/Barremian chalk. While the properties of the Upper Cretaceous reservoirs are comparable to other Danish fields like Gorm and Tyra, the Lower Cretaceous chalk although featuring high porosity, possesses very difficult production properties due to its extremely low permeability.

Production Strategy

Production from the Valdemar Field is based on primary recovery. The development of a recovery technique based on drilling long horizontal wells with numerous large sand-filled, artificial fractures has made it possible to exploit the Lower Cretaceous reservoir commercially. Expectations for production from the North Jens area are subdued. It is uncertain which recovery techniques may enhance the recovery of oil from this extremely tight reservoir.

Production Facilities

The Valdemar Field (the North Jens area) has been developed as a satellite to Tyra, including an unmanned production platform of the STAR type. The production is transported to Tyra East for processing and export ashore.

Field name	Roar
Prospect:	Bent
Location:	Block 5504/7
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1968
Year on stream:	1996
Producing wells:	2 (both horizontal)
Water depth:	46 m (151 ft)
Acreage:	14 km^2 (3,500 acres)
Reservoir depth:	2,070 m (6,800 ft)
Reservoir rock:	Chalk
Geological age:	Danian and Upper Cretaceous
Reserves at 1 January 1997:	
Condensate:	2.3 million m^3 (15 MMbbls)
Gas:	12.9 billion Nm^3 (481 BSCF)
Cumulative production at 1 January 1997:	
Condensate:	0.32 million m^3 (2 MMbbls)

Net gas:	1.33 billion Nm^3 (50 BSCF)
Water:	0.01 million m^3 (<1 MMbbls)
Production in 1996:	
Condensate:	0.32 million m^3 (2 MMbbls)
Net gas:	1.33 billion Nm^3 (50 BSCF)
Water:	0.01 million m^3 (<1 MMbbls)

Total investments (nominal prices) at 1 January 1997: DKK 0.4 billion

Review of Geology

Roar is an anticlinal structure, induced through tectonic uplift. The accumulation consists of free gas containing condensate, overlying a thin black oil zone. The chalk formation is only slightly fractured.

Production Strategy

Production from the Roar Field is based on the aim of optimizing the production of liquid hydrocarbons in the Tyra Field. This presupposes that the reservoir pressure is stabilized through injecting as much gas as possible, including gas from the Roar Field. Therefore, increased production from the Roar Field helps optimize the Tyra production conditions.

Production Facilities

The Roar Field has been developed as a satellite to the Tyra Field with an unmanned wellhead platform of the STAR type. The hydrocarbons produced are separated at the Roar platform and conveyed to Tyra East for processing and export ashore.

Field name	Svend
Prospect:	North Arne/Otto
Location:	Block 5604/25
Licence:	Sole Concession
Operator:	Mærsk Olie og Gas AS
Discovered:	1975 (North Arne) 1982 (Otto)
Year on stream:	1996
Producing wells:	2 (both horizontal)
Water depth:	65 m (213 ft)
Acreage:	25 km^2 (6,200 acres)
Reservoir depth:	2,500 m (8,200 ft)
Reservoir rock:	Chalk
Geological age:	Danian and Upper Cretaceous
Reserves at 1 January 1997:	
Oil:	5.5 million m^3 (35 MMbbls)
Gas:	0.5 billion Nm^3 (20 MMbbls)
Cumulative production at 1 January 1997:	
Oil:	0.84 million m^3 (5 MMbbls)
Gas:	0.08 billion Nm^3 (3 BSCF)
Water:	0.00 million m^3
Production in 1996:	
Oil:	0.84 million m^3 (5 MMbbls)
Gas:	0.08 billion Nm^3 (3 BSCF)
Water:	0.00 million m^3

Total investments (nominal prices) at 1 January 1997: DKK 0.5 billion

Review of Geology

The Svend Field is an anticlinal structure, induced through Zechstein salt tectonics. This has led to fracturing of the chalk in the reservoir. The Svend Field consists of a northern reservoir called North Arne, and a southern reservoir called Otto. The Otto reservoir is situated 250 metres deeper than the North Arne reservoir. The North Arne reservoir has proved to have unusually favourable production properties.

Production Strategy

Oil and gas production from the Svend Field is currently based on primary recovery at a pressure above the bubble point of the oil in the reservoir. The natural drive mechanism supplied by the underlying water zone has not yet been evaluated. The field has only produced for a short period, and it is uncertain as yet which recovery technique will result in optimal oil production from the field in the longer term.

Production Facilities

The Svend Field has been developed as a satellite to the Tyra Field, with an unmanned STAR wellhead platform. The hydrocarbons produced are conveyed to Tyra East for processing and export ashore. The Svend Field is connected to the 16" pipeline from Harald to Tyra East.

Appendix G1

Domestic Energy Consumption 1975-1996, Distributed on Fuels, as well as Energy Production (PJ) and Degree of Self-Sufficiency (per cent)

	Oil	Natural Gas[1])	Coal	Renewable Energy, etc.	Total	Energy Production	Self-Sufficiency A	B	C
1975	656	-	86	15	**757**	22	1	1	3
1976	668	-	120	15	**803**	23	1	1	3
1977	677	-	137	16	**830**	37	3	3	4
1978	671	-	169	17	**857**	35	3	2	4
1979	654	-	199	20	**873**	38	3	2	4
1980	547	-	239	25	**811**	37	2	2	5
1981	484	1	249	31	**765**	64	7	4	8
1982	458	1	263	34	**756**	107	16	10	14
1983	437	2	280	37	**756**	130	21	12	17
1984	432	7	300	39	**778**	148	25	14	19
1985	426	27	305	37	**795**	208	8	22	26
1986	425	48	308	41	**822**	272	49	28	33
1987	401	61	322	44	**828**	338	64	35	41
1988	379	69	322	47	**817**	346	67	37	42
1989	371	78	323	52	**824**	401	78	42	49
1990	356	83	325	55	**819**	425	84	45	52
1991	350	88	331	54	**823**	499	102	54	61
1992	348	93	322	59	**822**	543	109	59	66
1993	340	103	312	59	**814**	580	118	64	71
1994	355	114	286	60	**815**	631	122	70	77
1995	367	132	266	65	**829**	653	118	71	79
1996*)	-	-	-	-	**-**	749	-	-	-

Energy consumption has been corrected for climatic variations and the import/export of electricity

A) Oil and gas production vs domestic oil and gas consumption

B) Oil and gas production vs domestic oil and energy consumption

C) Total energy production vs domestic energy consumption

*) Estimate. Corrected energy consumption figures for 1996 had not been published at the time this report went to press

[1]) Including fuel consumption offshore

Financial Key Figures

	Investments in Field Development DKK million	Operating Costs for Fields [1] DKK million	Exploration Costs [2] DKK million	Crude Oil Price [3] USD/bbl	Exchange Rate DKK/USD	Inflation Rate [4] per cent	Net Foreign-Currency Expenditure on Energy Import DKK billion
1972	105	32	28	3.0	7.0	6.6	3.3
1973	9	34	83	4.6	6.1	9.3	4.3
1974	38	58	76	11.6	6.1	15.2	9.8
1975	139	64	118	12.3	5.8	19.6	9.4
1976	372	71	114	12.3	6.1	9.0	10.3
1977	64	88	176	14.0	6.0	11.2	11.4
1978	71	128	55	14.0	5.5	10.0	10.9
1979	387	146	78	20.4	5.3	9.6	15.5
1980	956	169	201	37.5	5.6	12.3	21.2
1981	1651	402	257	37.4	7.1	11.7	25.9
1982	3948	652	566	34.0	8.4	10.2	25.9
1983	3528	615	1264	30.5	9.1	6.9	21.9
1984	1596	1405	1211	28.2	10.4	6.3	22.8
1985	1953	1677	1373	27.2	10.6	4.7	23.4
1986	1695	1533	747	14.7	8.1	3.6	11.2
1987	908	1560	664	18.3	6.8	4.0	8.7
1988	897	1550	424	14.8	6.7	4.6	6.7
1989	1153	1819	366	18.2	7.3	4.8	7.4
1990	1738	1924	592	23.5	6.2	2.6	5.7
1991	2260	2176	986	20.0	6.4	2.4	5.1
1992	2402	2080	983	19.3	6.0	2.1	3.6
1993	3358	2324	442	16.8	6.5	1.2	3.8
1994	3140	2395	151	15.6	6.4	2.0	2.1
1995	4167	2176	272	17.0	5.6	2.1	2.2
1996*	4199	2535	400	20.7	5.8	2.1	-1.1

Nominal Prices [1] Including transportation costs, including profit element [2] All licences [3] Danish crude oil [4] Consumer prices
*) Estimate

Appendix H

Organization

The Danish Energy Agency is an institution under the Ministry of Environment and Energy. The Agency handles all technical matters, administrative and political tasks within the energy area, in which connection the Agency prepares all energy-related matters to be submitted to the Minister, and handles relations and coordination with external parties.

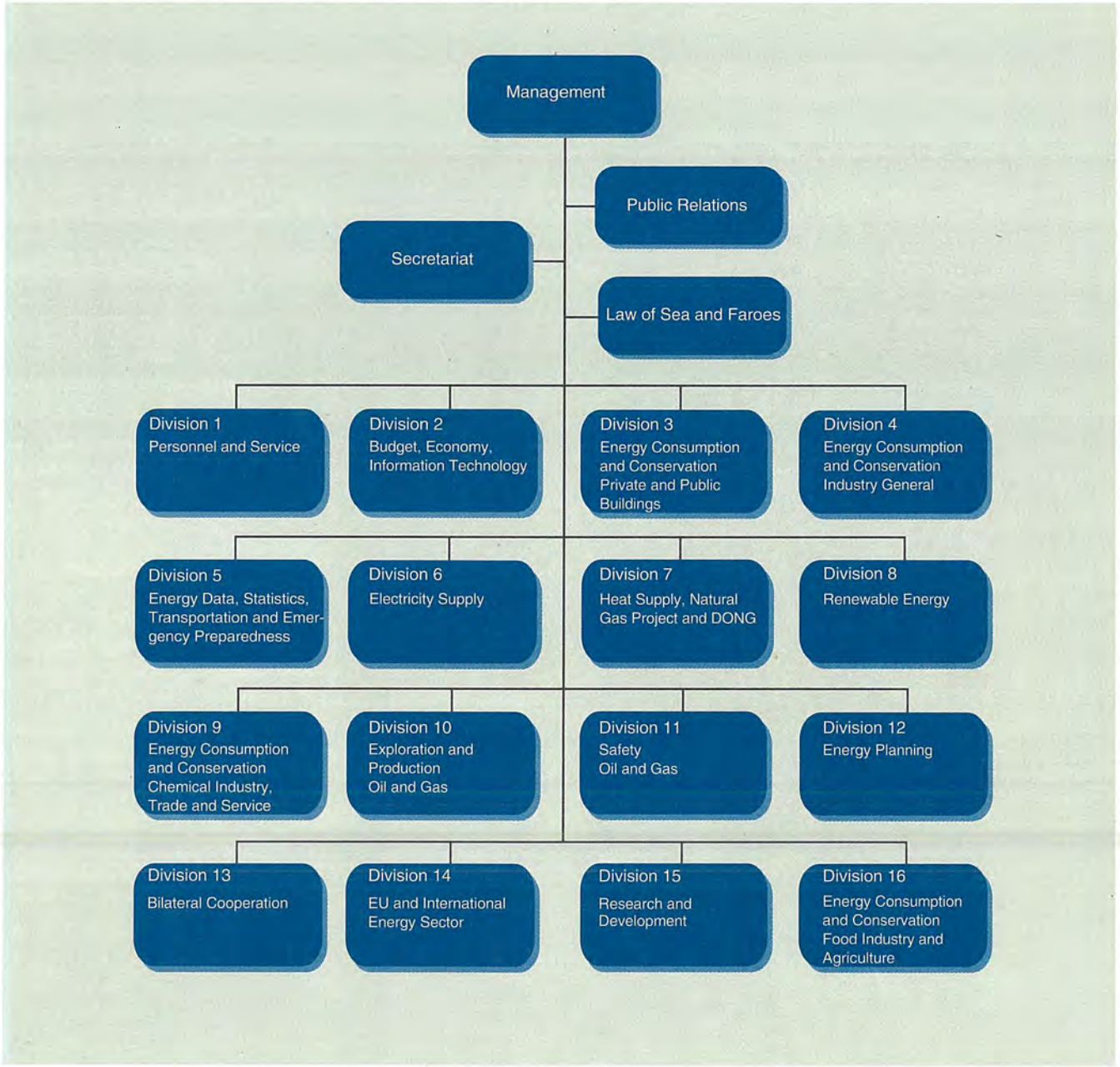
The organization of the Danish Energy Agency is shown by Fig. H.1.

The Danish Energy Agency has 16 divisions, in addition to the special unit responsible for matters relating to the law of the sea and advising the Faroese Home Rule authorities. The Agency also acts as secretariat for the Mineral Resources Administration for Greenland.

The administration of oil and gas activities is handled by the 10th and 11th divisions of the Agency, assisted by the 7th and 15th divisions and the Law of the Sea and Faroe Islands Unit to some extent. How responsibilities between the oil and gas divisions are divided is dealt with in more detail on the next page.

At the turn of the year 1996/97, the Agency employed the equivalent of about 270 full-time employees, about 40 of whom are involved in the administration of oil and gas activities.

Fig. H.1 Organizational Chart of the Danish Energy Agency



The administration of oil and gas activities is handled by:

The Tenth Division: Exploration and Production of Oil and Gas

Head of division: Søren Enevoldsen

Supervising exploration and production activities in terms of resources, as well as financial and legal aspects. Licensing policy and administration, licensing rounds and the awarding of licences. Approving appraisal programmes and work programmes. Evaluating declarations of commerciality. Approving development plans and production profiles. Addressing matters concerning the obligation to connect production facilities to existing pipelines and exemptions from payment of the pipeline tariff. Matters concerning unitization. Geological evaluations and reservoir engineering. Preparing analyses, evaluating the potential and making forecasts of Danish oil and gas reserves. Evaluating commercial viability, including work on energy plans. Considering political and administrative issues related to DOPAS. Responsibility for the Danish Energy Agency's oil/gas-related system exports.

The Eleventh Division: Safety in the Oil/Gas Sector

Head of division: Uffe Danvold

Activities concerning safety, working environment and other environmental issues under the provisions of the Danish Act on Certain Marine Installations, the Subsoil Act and the Continental Shelf Act. Approving mobile and fixed installations as well as pipelines. Supervising the safety, working environment and other environmental aspects of offshore installations and pipelines, as well as monitoring drilling operations in terms of safety. Approving and supervising manning tables and organizational charts, as well as undertaking the tasks related to membership of the Action Committee, the Coordination Committee and the Average Commission for Offshore Installations. Monitoring supplies conveyed through the transmission systems belonging to Dansk Naturgas A/S and supervising the technical safety aspects of the gas storage facilities established by Dansk Naturgas A/S. Considering political and administrative issues related to DORAS and the Danish Oil Pipeline Act. Moreover, the division draws up regulations in this area.

The Seventh Division: Heat Supply, the Natural Gas Project and DONG

Head of division: Thomas Bastholm Bille

Matters concerning the DONG group and the regional natural gas companies. The financial, legal, technical and organizational matters related to the implementation of the natural gas project. Parliamentary Acts on natural gas supplies. Matters concerning the purchase and export of natural gas. Activities under the provisions of the Danish Heat Supply Act. Expanding decentralized heat and power systems and using environmentally friendly energy sources. Legal/administrative and financial issues. Approving projects and hearing appeals under the Heat Supply Act. The Danish Act on Subsidies for the Generation of Electricity. Agenda 21 planning and work on the 'Brundtlandby' project.

The Fifteenth Division: Research and Development

Head of division: Henrik Andersen

National and international activities regarding energy research. The national activities include administering energy research programmes, research policy proposals and statements, as well as acting as the secretariat of the Advisory Oil and Natural Gas Research Committee. The international activities relate mainly to the EU research programmes, the IEA and the Nordic Energy Research Programme.

The Law of the Sea and Faroe Islands Unit

Commissioner: Jørgen Nørgaard

Participating in international cooperation on the law of the sea regarding the extraction of resources on the seabed. Issues relating to the Convention on the Law of the Sea, the delimitation of the continental shelf, including participating in negotiations about the borders of Denmark's continental shelf. Advising the Faroese Home Rule authorities on the mineral resources development in the Faroe Islands.

Danish Licence Area January 1997

The Western Area