

Brief History of Danish Oil & Gas Exploration 1984 - 2011 -Licensing Rounds 1-6

Renewed Interest in Hydrocarbon Exploration in Denmark Ahead of the 7th Round in 2013

Summary

As seen in Table 1 below, Danish exploration and appraisal drilling in Licensing Rounds 1-6 during the period 1984-2011 has been successful proving up oil and gas reserves in the order of 0.75-1 billion boe. The average E&A technical success rate for the Central Graben area (79 wells) has been around 60 % with a commercial exploration success rate for the same area (57 wells) of around 25 %. The average finding cost including all onshore and offshore exploration wells (79 wells) is estimated at around 3 USD (2011) per boe. It is noteworthy, that the most attractive area - the A. P. Møller Sole Concession area - is not included in the presented statistics.

Table 1

| Licensing Round | Year | Number of Licences | Exploration Wells | Technical Discoveries | Probable/ (Possible) Development | Fields in Production | Reserves MMboe(****) | |
|--|-----------|--------------------|-------------------|-----------------------|----------------------------------|----------------------|----------------------|------------------|
| 1 st Round | 1984 | 15 | 12 | 1 | (1) | 0 | | |
| Out of Round | 1985 | 1 | 0 | - | - | - | | |
| 2 nd Round | 1986 | 9 | 11 | 2 | (1) | 0 | | |
| 3 rd Round | 1989 | 12 | 9 | 3 | 0 | 1 | | |
| Out of Round | 1990 | 3 | 2 | 2 | 0 | 1 | | |
| Out of Round | 1992 | 1 | 1 | 0 | 0 | 0 | | |
| 4 th Round | 1995 | 9 | 19 | 7 | 0 | 2 | | |
| 5 th Round | 1998 | 17 | 14 | 4 | 1-(2) | 1 | | |
| Out of Round | 1999 | 1 | 1 | 0 | 0 | 0 | | |
| 6 th Round | 2006 | 14 | 6 | 5 | 4-(5) | 0 | | |
| Out of Round | 2009 | 1 | 1 | 1 | 1 | 0 | | |
| Sub Total | - | 83 | 76 | 25 | 6-(10) | 5 | | 775-(940) |
| Open Door | 1997-2011 | 25 | 3 | 0 | 0 | 0 | | 0 |
| Total | - | 108 | 79 (*) | 25 (**) | 6-(10) | 5 (***) | | 775-(940) |
| (*) Incl. 22 exploration wells outside the Central Graben Area (**) Exploration wells with technical success are here defined as wells with moveable hydrocarbons, which have either been tested directly in the wells or proved indirectly by later evaluation of collected data (***) Comprising 10 separate oil accumulations (****) Estimated ultimate recovery for fields in production + probable development (rounded numbers) | | | | | | | | |
| 22 appraisal wells drilled 1987-2011 all of which proved oil (100% technical success rate) Total E&A technical success rate = 47% (101 wells incl. 22 exploration wells outside Central Graben Area) E&A technical success rate for Central Graben Area = 59% (79 wells) Commercial exploration success rate so far for Central Graben Area = ca. 25% (57 wells) | | | | | | | | |

On average, four wells (three exploration and one appraisal) have been drilled per year over the period with a spread from zero (1990 and 1994) to nine wells (2001) in individual years (Figs. 1 and 2).

Fig. 1

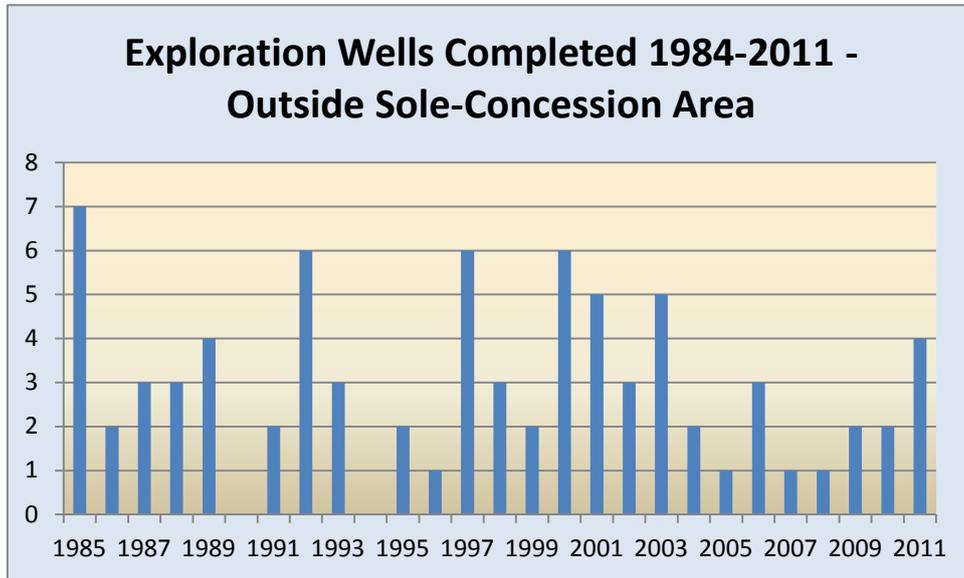
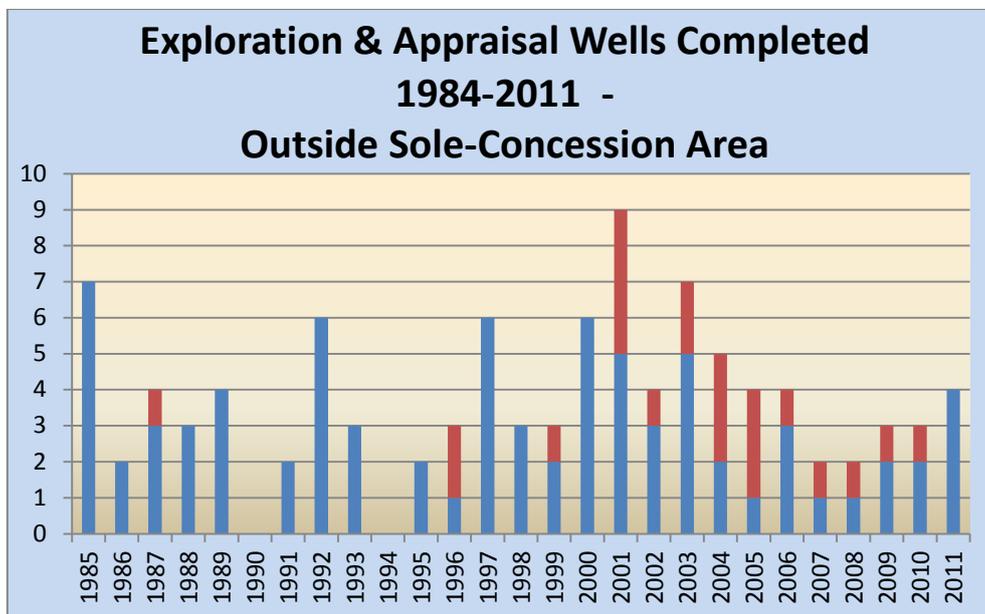


Fig. 2



The exploration discovery rate (technical success rate) for all areas (79 offshore and onshore wells) has seen a significant increase from just around 10 % in the first round to more than 80 % in the 6th round (Fig. 3). A similar trend is observed for the exploration discovery rate for the Central Graben area (57 wells) also with a significant increase from around 20 % in the first round to more than 80 % in the 6th round (Fig. 4).

Fig. 3

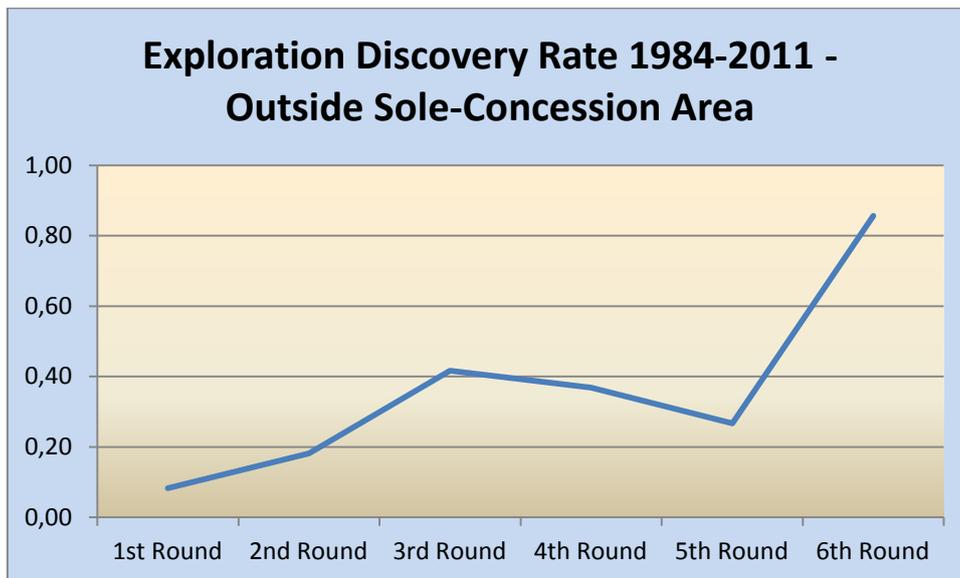
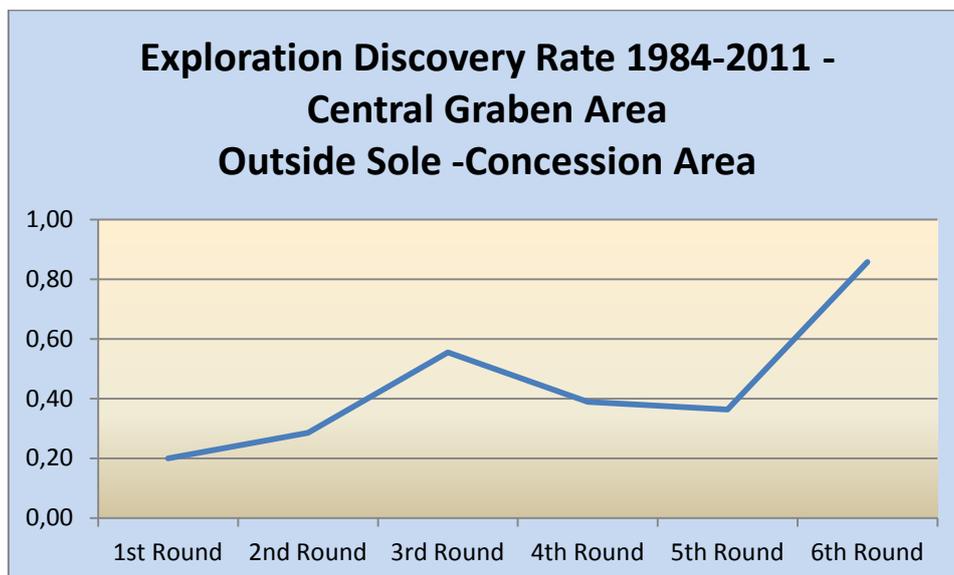


Fig. 4



The Central Graben Area = the Central Graben proper and the Siri Fairway

The exploration and appraisal discovery rate (E&A technical success rate) for all areas (101 offshore and onshore wells) has seen a significant increase from just around 20 % in the first

round to more than 80 % in the 6th round (Fig. 5). A similar trend is observed for the exploration and appraisal discovery rate for the Central Graben area (79 wells) also with a significant increase from around 30 % in the first two rounds to more than 80 % in the 6th round (Fig. 6).

Fig. 5

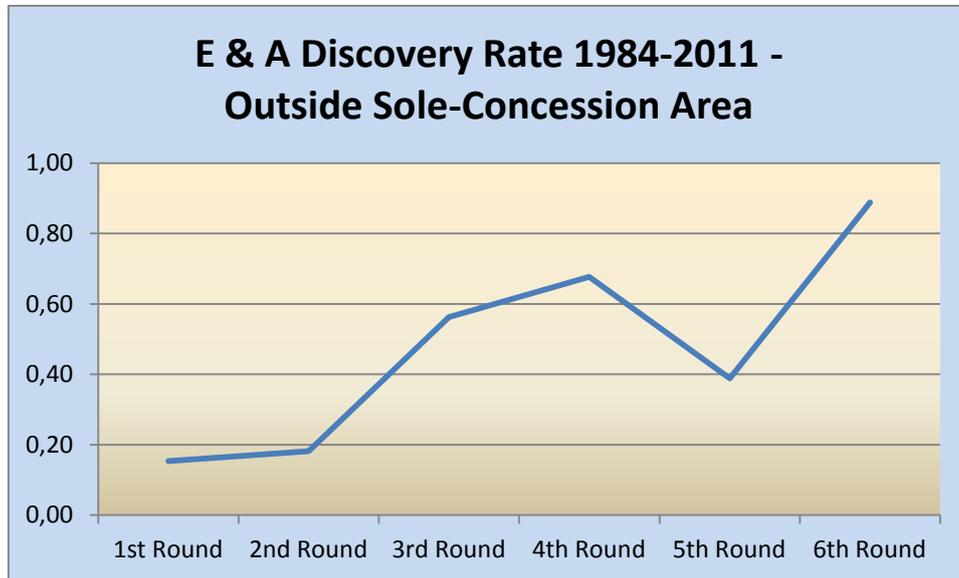
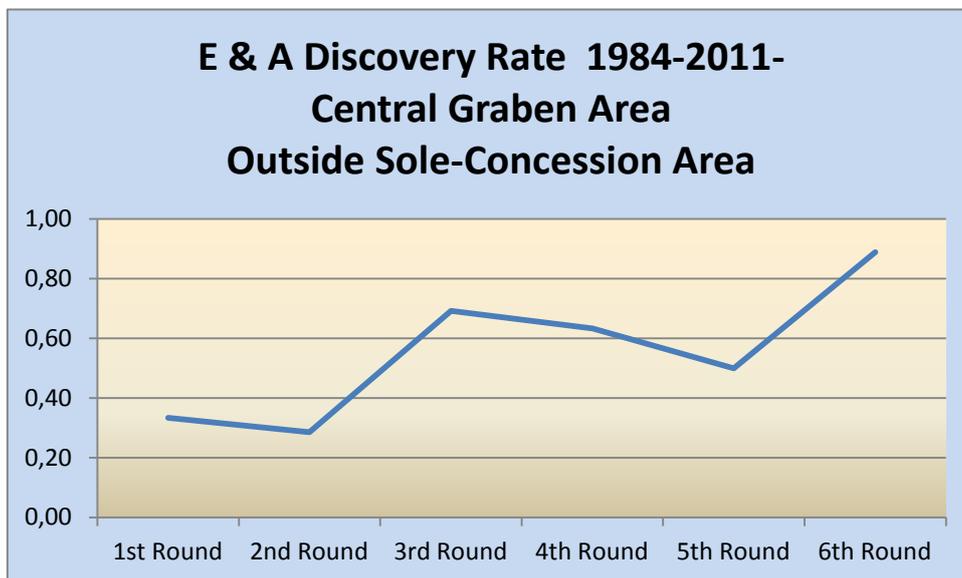
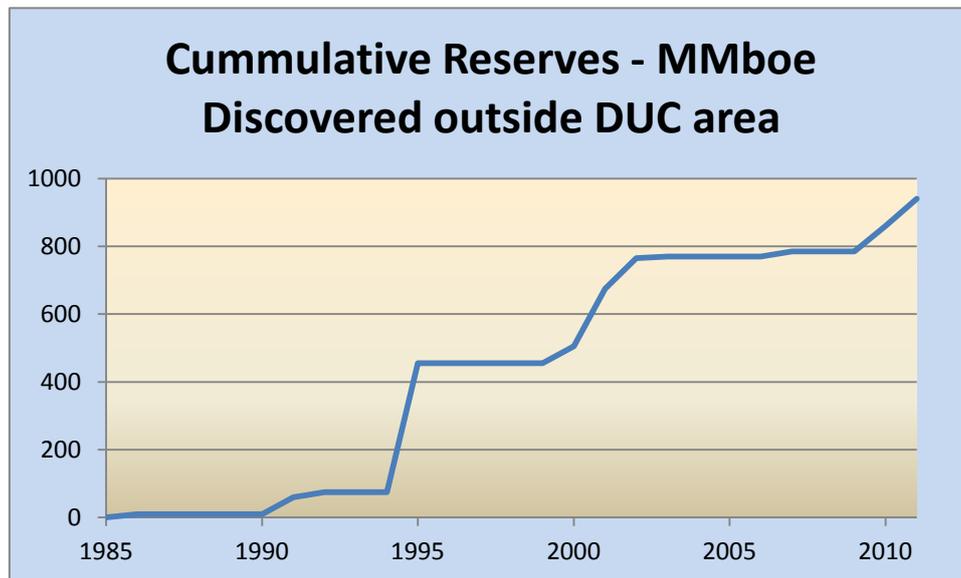


Fig. 6



As seen in Fig. 7 below, it was not until the mid nineties, that significant oil and gas reserves were discovered outside of the DUC Sole Concession. It can also be seen that the three periods: 1995, 2000-2002 and 2010-2011 account for the vast majority of the ¾-1 billion boe discovered.

Fig.7



The Early Exploration Period - 1935-1983

Onshore oil and gas exploration in Denmark was initiated as early as 1935, encouraged by oil discoveries in Northern Germany, south of the Danish border. During the following period until the late fifties, Gulf and later Esso drilled some 30 exploration wells exclusively in the onshore area, where a number of wells found shows of oil and gas in Zeichstein carbonates, unfortunately without any commercial potential.

The first offshore exploration well was not drilled until 1966 under the so-called A. P. Møller Sole Concession and actually resulted in the very first oil discovery in the North Sea.

During the first almost 50 years, exploration was carried out under such sole-right concessions. Competitive licensing rounds were not introduced until 1983, and the first licences with more than one concession holder were awarded in 1984.

The 1th Round - 1984

In the 1st round a total of 15 licences were awarded to seven groups comprising 23 companies. In addition, one out-of-the-round licence was awarded in 1985. 12 exploration wells were drilled, but only five of these were drilled in the Central Graben Area resulting in just one discovery – the Ravn oil accumulation. The Ravn discovery is still considered a probable candidate for future development.

The 2nd Round - 1986

In the 2nd round, which included additional relinquished North Sea acreage from the A. P. Møller Sole Concession and also comprised all unlicensed acreage outside of the North Sea, a total of nine licences were awarded to four groups comprising 18 companies. 11 exploration wells were drilled with seven of these located in the Central Graben Area. Two technical discoveries were made in the Amalie-1 and Tabita-1 wells. Of the two discoveries only Amalie is considered a possible candidate for future development.

One of the reasons for the very low overall discovery rates in the first two rounds is the fact that to qualify for blocks in the Central Graben Area, applicants were obliged to also apply for and explore high-risk blocks in the area outside of the prolific Central Graben Area.

The 3rd Round - 1989

In the 3rd round, which also included additional relinquished acreage from the A. P. Møller Sole Concession and comprised all relinquished offshore and onshore areas, a total of 12 licences were awarded to seven groups comprising 23 companies. In addition, four out-of-the-round licences were awarded in 1990 and 1992. 12 exploration wells were drilled in the 16 licences. Nine of these wells were drilled in the Central Graben Area resulting in five technical discoveries: Lulita-1, Bertel-1, Rita-1, Rigs-1 (Syd Arne) and Francisca-1. Two of these discoveries have been developed, whereas the remaining three are currently unlikely to be developed.

The Lulita field commenced production from Mid Jurassic sandstone reservoirs in 1998 and has produced more than 6 MMbbls of oil and 0.6 billion m³ of gas by the end of 2011.

The Rigs-1 well resulted in the Syd Arne field, which commenced production from Late Cretaceous and Danian chalk reservoirs in 1999 and has produced some 140 MMbbls of oil and more than 5 billion m³ of gas by the end of 2011.

The 4th Round - 1995

The 4th round was the first round to comprise only the Central Graben and immediately adjacent area. A total of nine licences were awarded to four groups comprising 18 companies. 19 exploration wells have so far been drilled. Seven technical discoveries were made: Siri-1 (Siri Central), Siri-3 (Stine Segment 1), SCA-4 (Siri Nord), Nini-1 (Nini Main), Nini-4 (different Paleogene reservoir) Sofie-1 and Sara-1. Five of these discoveries have been developed in two fields. Sara and Sofie are currently under evaluation in order to determine if the oil discoveries can be produced commercially.

The Siri field commenced production from Paleocene sandstone reservoirs in 1999 and has produced close to 75 MMbbls of oil and 1.3 billion m³ of gas (all reinjected or used as fuel) by the end of 2011.

The Nini field commenced production from Paleocene sandstone reservoirs in 2003 and has produced more than 30 MMbbls of oil and 0.4 billion m³ of gas (all reinjected or used as fuel in Siri) by the end of 2011. The production numbers include Nini East, which started oil production in 2010.

The 5th Round - 1998

In the 5th round a total of 17 licences were awarded to 11 groups comprising 16 companies. In addition, one out-of-the-round licence was awarded in 1999. A total of 15 exploration wells have so far been drilled with 11 of these located in the Central Graben Area. Four technical discoveries were made: Cecilie-1, Connie-1, Hejre-1 and Svane-1. Two of these discoveries have been developed in the Cecilie field, a field development plan has been approved for Hejre, and Svane may possibly be developed in the future.

The Cecilie field commenced production from Paleocene sandstone reservoirs in 2003 and has produced 6.5 MMbbls of oil and less than 0.1 billion m³ of gas (all reinjected or used as fuel in Siri) by the end of 2011.

The 6th Round - 2006

In the 6th round a total of 14 licences were awarded to 10 groups comprising 20 companies. In addition, one out-of-the-round licence was awarded in 2009. A total of seven exploration wells has been drilled so far, all of which are located in the Central Graben Area. Six technical discoveries were made: Rau-1, Gita-1X, Luke-1X, Solsort-1, Broder Tuck-2 and Lille John-1. Four

of these discoveries are likely to be developed, one possibly to be developed and only one discovery is unlikely to be developed.

New Discoveries Since the Opening of the 6th Round

Rau-1

The Rau-1 exploration well was drilled as a vertical well and reached total depth in chalk of Danian age at 2504 meters below mean sea level. The well discovered oil bearing sandstones of Paleocene age. In order to appraise the lateral extent and size of the oil discovery, additionally three sidetracks were drilled, and coring was performed in one of the sidetracks. An extensive logging and sampling programme including testing of reservoir productivity was carried out.

The oil bearing sandstones, discovered in Rau-1 and the three sidetracks, confirmed the geological model for the area, but due to the marginal size of the oil discovery (12 MMbbls have been estimated and published by the operator), no development plans have been made so far. A possible development of the oil find could be as a tie-back to the Cecilie facilities, which are already prepared for this.

Gita-1X

As operator for the companies in Licence 9/95 Mærsk Olie og Gas drilled the Gita-1X (5604/22-5) exploration well about 10 kilometres south of the Harald field in the northern part of the Danish Central Graben.

Gita-1X was drilled as a vertical well and reached its total depth at 5162 metres below mean sea level in layers of Middle Jurassic age. The well encountered Mid Jurassic sandstone layers containing hydrocarbons. A number of measurements were carried out for further evaluation of the results of the well.

The well was drilled in cooperation between the licensees in licence 9/95 and the adjacent licence 9/06. The two groups participated with 50 pct. each.

Contingent resources of some 240 MMboe for the Gita discovery have been estimated and published by licence partner Noreco.

There are currently no plans of developing the Gita discovery.

Luke-1X

As operator for the companies in Licence 8/06 Mærsk Olie og Gas drilled the Luke-1X (5504/6-6) exploration well in the westernmost part of the Danish part of North Sea. The well discovered gas/condensate in sandstone of Mid Jurassic age.

Luke-1X was drilled as a vertical well and reached its total depth at 4572 metres below mean sea level in layers of presumed Early Jurassic age. The well encountered hydrocarbons in sandstones of the Mid Jurassic Bryne Formation. Cores were taken and measurements carried out. In order to further appraise the discovery a side-track - Luke-1XA - was drilled towards the north. Additional measurements were carried out in the side-track and samples of gas/condensate were taken.

Luke-1X was drilled just east of the Elly gas/condensate field situated in the A.P. Møller - Mærsk Sole Concession. The well was drilled based on a cooperation agreement between Licence 8/06 and the Sole Concession.

The necessary work to determine if the gas/condensate discovery can be produced commercially is ongoing.

Solsort-1

As operator of Licence 4/98 DONG drilled the Solsort-1 (5504/26-5) exploration well in the northern part of the Danish Central Graben. The well discovered oil in sandstone of Paleogene age.

Solsort-1 was drilled as a vertical well and reached its total depth in chalk at 3041 metres below mean sea level. The well encountered oil in sandstones above the chalk. Cores were taken, measurements carried out and oil samples were collected. In order to further appraise the extent and quality of the discovery three side-tracks were drilled in different directions - the longest with a reach of more than 1½ km. Coring and comprehensive measurements were carried out in the side-tracks as well.

Solsort-1 was drilled in cooperation between the licensees in the two licences 4/98 and 3/09, who both paid 50 % of the well. Licence 3/09 was awarded in 2009 as a so-called neighbouring block to licence 4/98.

The oil companies are now evaluating the results of Solsort-1 and planning for the additional work that is necessary to determine, how the oil discovery is best developed.

Sara-1

As operator of Licence 6/95 DONG drilled the Sara-1 (5604/16-1) exploration well east of the Danish Central Graben. The well discovered oil in sandstone of Paleocene age.

Sara-1 was drilled as a deviated well and reached its total depth in chalk at 2075 metres below mean sea level. The well encountered oil in sandstones above the chalk and measurements were carried out in the well. In order to further appraise the extent and quality of the oil discovery a side-track was drilled to a position approximately 1½ kilometre away from the main well. Coring and comprehensive measurements were carried out and fluid samples were taken in the side-track.

Not all the companies in licence 6/95 wanted to participate in the well, and consequently Sara-1 was drilled as a sole risk operation by DONG only.

DONG is now evaluating the results of Sara-1 and making plans for the additional work that is necessary to determine if the oil discovery can be produced commercially.

Broder Tuck-2

As operator of Licence 12/06 PA Resources drilled the Broder Tuck-2 (5504/20-04) exploration well in the south-westernmost part of the Danish North Sea. The well discovered hydrocarbons (gas with condensate) in sandstones of Mid Jurassic age.

Broder Tuck-2 was drilled as a vertical well and reached its total depth in Triassic shale at 3658 metres below mean sea level. The well encountered natural gas and condensate in sandstones of Mid Jurassic age. A core was taken, samples were collected, and extensive measurements carried out. In order to further appraise the extent and quality of the gas discovery a sidetrack, Broder Tuck-2A, was drilled to a position approximately 680 metres from the main wellbore. The Mid Jurassic sandstone also contained hydrocarbons in the sidetrack and extensive measurements were carried out. The sidetrack reached a total depth of 3799 metres below mean sea level in layers of Triassic age.

Broder Tuck-2/2A confirm the presence of hydrocarbons approximately 290m deeper than encountered in the U-1X well which was drilled in 1975 some 70 m below the crest of the same structure, but which showed only a limited hydrocarbon column.

The results of Broder Tuck-2/2A are now being evaluated and plans made for the additional work that is necessary to determine, if the gas discovery can be produced commercially.

Lille John-1

As operator of Licence 12/06 PA Resources drilled the Lille John-1 (5504/20-05) exploration well in the south-westernmost part of the Danish North Sea. The well discovered oil in sandstones of Miocene age as well as weak hydrocarbon indications in chalk of presumed Danian age. The Miocene play is fairly underexplored in the Danish sector and the exciting Lille John-1 discovery may become the first development of hydrocarbons from a Miocene reservoir in Denmark.

Lille John-1 was drilled as a near-vertical well and encountered oil in sandstones of Miocene age. Sidewall cores and samples were collected and extensive measurements carried out. When drilling the Lower Paleocene section, the well had to be sidetracked twice, as Lille John-1A and Lille John-1B, respectively. The Lille John-1B well was drilled through the chalk section, where weak hydrocarbon indications were found in non-reservoir rock and reached its total depth in Zechstein salt at 1307 metres vertically below mean sea level.

The results of Lille John-1 are now being evaluated and plans made for the additional work that is necessary to determine, if the oil discovery can be produced commercially.

New Play Types

In addition to the well established hydrocarbon plays, below is a brief introduction to the many new play types either presently being explored or potentially to be explored in Denmark in the 7th Round:

Shallow Tertiary (Pliocene) Sandstone Gas Play

Traditionally, the shallow Pliocene gas accumulations seen on seismic in the Danish North Sea have been considered as drilling risks rather than opportunities. Gas is typically found in low relief structures with relatively low pressure biogenic gas (methane) and is, therefore, very different from “normal” gas accumulations.

A number of Pliocene gas discoveries in the A and B blocks in the Netherlands during the late eighties and early nineties did, however, open up this new play. Several of the discoveries have been developed into commercial gas fields.

Potentially, this play may also extend northwards into the Danish North Sea area.

Miocene Sandstone Oil Play

With the recent Miocene oil discovery in the Lille John-1 exploration well a new play has been established in the Central Graben Area.

The Lille John-1 exploration well, located approximately 17 kilometres south of the Gorm Field encountered approximately 5 meters of hydrocarbon pay in an overall Miocene sandstone/shale interval of 25 meters thickness at a depth of approximately 900 meters below mean sea level. Analyses of logs and samples confirm a sweet, light oil of 34-35 degrees API gravity with a gas:oil ratio of approximately 350 scf/bbl and no water.

The Miocene sandstones in Lille John are well-imaged on seismic data as an extensive seismic amplitude anomaly which was interpreted pre-drill to reflect gas or oil in a sandstone reservoir. The Lille John-1 well was drilled for a primary chalk target and as a result was not optimally located at Miocene sandstone level, being just outside of the main part of the seismic anomaly and very close to the mapped limit of the Miocene sandstones. The well encountered modest reservoir development as expected at this location marginal to the seismic anomaly, but has confirmed the anomaly to represent oil-bearing sandstone, with an apparent column height in excess of 300 meters.

A sidetrack - Lille John-1A - also penetrated the Miocene sandstones some 180 meters away from the Miocene interval that was found to be oil-bearing in the initial Lille John well. Again the Miocene sandstones were oil-bearing in the sidetrack at a depth approximately 930 meters below mean sea level, with improved reservoir quality compared to the original well which confirmed oil of gravity 34-35 degrees API. Both penetrations were primarily located for the chalk target and as such lie outside of the well-imaged Miocene seismic amplitude anomaly interpreted to reflect better developed oil-bearing sandstone.

In addition to the Lille John well, oil has also been discovered in Miocene sandstones in the T-1 exploration well (Nord Arne) above the Svend oil field in the northern part of the Central Graben.

As with the shallow Pliocene seismic anomalies, strong amplitudes associated with probable Miocene sandstones have traditionally been considered as drilling risks rather than opportunities. In addition to the new oil play, a potential gas play could also be considered.

Oligocene Sandstone Gas Play

As with the shallow Pliocene and Miocene seismic anomalies, strong amplitudes associated with probable Oligocene sandstones have traditionally been considered as drilling risks rather than opportunities.

However, one exploration well - Francisca-1 - did target shallow gas in Oligocene sandstone reservoirs in the greater Siri area and discovered a relatively small (< 1 Bcm³) gas accumulation, which at the time (1998) was considered uneconomic. Since then no further exploration for this gas play has been pursued.

Early Cretaceous/Late Volgian Sandstone Play

A number of exploration wells in the northern part of the Central Graben have found hydrocarbon-filled sandstones of Early Cretaceous/Late Volgian age:

- The Amalie-1 well found 5-10 m of presumed Early Cretaceous sandstone/conglomerates with good porosity, permeability and oil saturation. A DST was carried out with very high oil flow rates, but also with a rapid pressure drop.
- The Svane-1 well encountered 8 m of oil-bearing sandstones of presumed Late Volgian age with good porosities and high oil saturation.
- The Iris-1 well also encountered 4 m of hydrocarbon bearing sandstone of presumed Late Volgian age.

Exploration after this play is currently taking place.

As the sandstones have so far not been easy to recognise on seismic, only one exploration well (Tabita-1) has been targeting this play.

In addition to the sandstones mentioned above, deeply seated Early Volgian low stand turbidite sandstones may also prove to be a viable play in the axial parts of the Central Graben.

Triassic Sandstone Play

Although Triassic producing reservoirs (Skagerrak and Bunter sandstones) are well known from the UK, Norwegian, Dutch and north German sectors only one well (Olga-1) in the Danish Central Graben area had its primary target in the Triassic, but a production test failed to produce hydrocarbons from the drilled Triassic reservoir.

Producible oil was, however, recovered from a Triassic sandstone reservoir in the Bertel-1 well at the edge of the Feda Graben west of the Tail End Graben. So far this is the only well in the Danish Central Graben area, which has proved the play.

Zechstein Limestone Play

Zechstein basins stretches from Britain across the North Sea to Denmark and Poland; and Zechstein carbonate deposits have been successfully explored for hydrocarbons in Great Britain, the Netherlands, Germany and Poland.

Also in Denmark Zechstein carbonates have been explored, and several wells found shows of oil, but so far without commercial success. Exploration of this play in Denmark has almost exclusively taken place onshore.

The play is still target for new exploration with several active licenses on- and offshore.

Rotliegendes Sandstone Play

More than 20 Danish exploration wells have been drilled through the pre-Zechstein. The Rotliegendes strata penetrated comprise eolian sandstone, siltstone as well as volcanoclastic and volcanic rocks.

No hydrocarbons have so far been found in the Rotliegendes strata in Denmark, but only few of the wells drilled into the Rotliegendes have been targeting this level.

Palaeozoic Shale Gas Play

Production from Shale Gas has revolutionised the North American energy picture and largely eliminated the dependence on imported gas. The North American success has kick-started exploration for similar unconventional hydrocarbons in Europe. Also in Denmark active licences are targeting this new play type with emphasis on the Early Palaeozoic Alum shale.

Established Play Types

In addition to the above new play types in Denmark, the following commercial hydrocarbon plays have been proved:

- Paleocene Sandstone Play (e.g. Siri, Nini and Cecilie)
- Late Cretaceous and Danian Chalk Play (e.g. Dan, Halfdan, Gorm, Skjold, Tyra, Syd Arne)
- Early Cretaceous Chalk Play (e.g. Valdemar)
- Kimmeridgian (Late Jurassic) Sandstone Play (e.g. Hejre)
- Mid Jurassic Sandstone Play (e.g. Harald W and Lulita)

Concluding Remarks

Danish exploration and appraisal drilling in Licensing Rounds 1-6 outside the A. P. Møller Sole Concession area during the period 1984-2011 has been successful proving up oil and gas reserves in the order of 0.75-1 billion boe.

The remaining oil and gas potential also outside of the established play types is believed to be significant, which has been proved by recent discoveries. In particular, the Jurassic turbidite sandstones are considered to hold a large reserve potential in the Danish Central Graben. The use of improved geophysical methods is likely to unravel this oil and gas potential in the near future.

With an average E&A technical success rate of around 60 % for the Central Graben area, a commercial exploration success rate for the same area of around 25 % and an average finding cost around 3 USD₍₂₀₁₁₎ per boe Denmark is still considered an attractive place to explore for oil and gas in many years to come.