NIRAS

Danish Energy Agency

Environmental report

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Strategic Environmental Assessment in connection with licensing rounds west of 6° 15' E in the Danish part of the North Sea for exploration and production of hydrocarbons, and licensing of permits for injection of CO_2 in existing oil fields for the purpose of EOR.

PROJECT

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CONTENT

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1 NON TECHNICAL SUMMARY

1.1 Context of the plan and purpose of the Environmental Report

The Danish Energy Agency is planning new rounds of licensing in the area west of 6° 15' E with a view to exploration and production of oil and gas and a separate possible licensing round of permits for injection of CO_2 (to enhance oil recovery) in existing oil fields west of 6° 15' E. The plan will lead to an increase in the current levels of activity in the area but not to initiation of new types of activity. There is however today no injection of CO_2 with the purpose to enhance oil recovery.

The plan includes various activities that are described in detail in chapter 3. These are exploration activities (primarily geological investigation), production activities and injection of CO_2 in existing oil fields to stimulate the production of hydrocarbons. Such CO_2 will also be disposed in the oil field.

The report is elaborated in compliance with the Danish Act on Environmental Assessment of Plans and Programmes (LBK no. 936 of 24.09.2009) with Guideline (no. 9664 of 18.06.2006). The purpose is to identify, describe and evaluate the likely significant effects of the plan on the environment.

1.2 Scoping

The first stage in this SEA process was scoping: deciding on the scope and level of detail of the Environmental Report and identify the impacts that might have a significant effect on the environment. Consultation of the scoping among affected authorities in Denmark and neighbouring countries was carried out in an early stage in the SEA process. A summary of the scoping consultation responses is given in Annex A.

It was concluded that the Environmental Report should emphasize on the impacts on marine mammals and fish eggs and larvae as a result of noise from seismic surveys and the hammering of conductors at the start of well construction operations. In addition to this, impacts on birds as a result of increased noise levels, light, disturbance from shipping, and collisions with fixed structures required more detailed impact assessments. Impacts on fisheries and other socio-economic activities were also concluded to be of significance. The probable impacts are likely to have transboundary effects, and this aspect was also considered to be of significance. Impacts on water and air quality and on other fauna groups were not considered to be significant.

1.3 Baseline data and environmental issues

Data has been gathered concerning the current status of the marine environment in the area covered by the plan. Data were collected from scientific journals, databases, published surveys and baseline investigations carried out in connection with Environmental Impact Assessments for projects regarding the extension of the existing oil and gas fields in the area. The summary includes the groups of organisms, which are considered to be the most important for the impact assessment of the plan.

There are no Natura 2000 sites designated in the plan area; the nearest located area is situated in the German sector of the North Sea (Doggerbank - DE1003301) and touches the southern boundary of the plan area.

Harbour porpoise is the most common cetacean found in the North Sea. It is considered to be both resident and breeding in the North Sea (Reijnders & Lankester, 1990). A study conducted by Mærsk Oil and Gas A/S over a three year period (2006-2009) showed that the species occurs within the plan area (Mærsk Olie og Gas A/S, 2011).

White-beaked dolphin and minke whale were also observed in the plan area during the three year survey performed by Mærsk Oil and Gas A/S (Mærsk olie og Gas A/S, 2011). Other whales are also commonly observed in the North Sea. The most frequently observed species are grey seal and common/harbour seal (common seals breed along the UK coast and in the Wadden Sea). Grey seals breed in the northern UK and in the Dutch and German part of the Wadden Sea.

Designated Important Bird Areas (IBA) are not found within the plan area, but surrounding areas like Skagerrak/ the Norwegian Trench, German Bight, the Wadden Sea and parts of Dogger Bank are considered important. Birds mainly exploit the plan area from autumn to spring, especially northern fulmar, kittiwake, auks and skua's. But none of these occur in numbers of regional importance (Stone *et al.* 1995). Guillemot and Kittiwake can though occur in moderate to high numbers locally within the plan area (Ollason *et al.* 1997). Common for all these species is, that they are widely distributed over the North Sea from autumn to spring, and that the population within the plan area is relatively small compared to other parts of the North Sea. However also summer appearances of post breeding Guillemot are likely to occur within the area.

More than 10 million land birds migrate every year between breeding grounds in Scandinavia and Russia and wintering areas in south and western Europe and Africa. The migration is generally widespread and neither land nor water birds use concentrated routes which pass through the plan area.

The fish populations in the North Sea have been divided into six fish communities based on statistical analysis of ICES International Bottom Survey Database (Callaway *et al*. 2002). Three of these communities were identified in the plan Area including the most common commercial species at 50-100 m water depth: herring, haddock, whiting, grey gurnard, long rough dab, dab and plaice. In the southern part of the North Sea at water depths less than 50 m the most common commercial species are: herring, sprat, whiting, horse mackerel, common dragonet, sand goby, grey gurnard, dab and solenette/yellow sole.

The Dogger Bank area has many species in common with the southern North Sea, however herring and sprat are not common here whereas plaice and mackerel occur frequently.

Eggs and larvae from cod, plaice, long rough dab, dab, grey gurnard and common dragonet were found within the plan area (Mærsk Olie og Gas, 2011). Spawning areas of sandeel (Ammodytidae) has also been reported in the Norwegian sector close to the border of the plan area (DONG Energy, 2011).

Dogger Bank, close to the plan area, and Fisher Bank are areas with high abundance of fish eggs and larvae, predominantly of the species cod, plaice and long rough dab. All stages of eggs and larvae are found, suggesting that the area is both spawning and nursing ground, with limited transport from nearby spawning areas (Munk *et al.,* 2009).

1.4 Assessment of impacts

The expected likely impacts of the plan have been predicted based on activities described in chapter 3, the summary of existing data in chapter 4 and the international and national objectives of the plan area summarized in chapter 5.

Intensive exploration and production activities have been carried out over the last 50 years in the area, and the marine environment is already under pressure due to other activities. Therefore the predictions and assessments of impacts of this plan are carried out with emphasize on the existing situation in the area today.

The pressures and impacts were identified during the scoping process and include:

- Impact on marine mammals caused by increased level of noise and disturbance
- Impact on birds caused by increased level of noise and increased attraction to platforms, vessels and other structures
- Impact on fish (including eggs and larvae) caused by increased level of noise

- Impact on the Natura 2000 habitat type “reef” caused by increased sediment dispersal

- Impact on fisheries caused by increased level of disturbance and prohibition zones

It has been concluded that the plan can have impacts at marine mammals, birds and fish, but none of them are assessed as being significant. The plan will add a pressure on the marine environment which in combination with other plans can cause cumulative impacts. The increased level of noise from seismic surveys, drilling operations and noise from vessels can have potential effects on especially mammals, fish, fish larvae and birds.

In addition it has been concluded that it is not likely that there will be significant on the nearest Natura 2000 areas.

The main socio-economic aspect of the plan is the impact on fisheries. The plan will further constrain the fishery in the license area due to prohibition zones around platforms, pipelines and during construction work. The license area is not particularly important to the fishery and that alone limits the effect of the constraints. The area affected will be less than 1 % of the total area of the license area, and the impact is assessed as minor.

The seismic surveys and pile driving can affect mammals tens to hundreds of kilometres away, and will cross borders into neighbouring countries. But it is not expected that the plan will increase the levels significantly compared to the existing situation.

1.5 Mitigation

No specific mitigation measures are proposed in the plan. However mitigation measures are important to reduce impacts on the marine environment from the different activities included in the plan. These activities will require Environmental Impact Assessment and/or other permissions regulated according to different legislations from the Danish Energy Agency and the Danish Environment Protection Agency. These permissions will include different requirements as mitigation measures to be implemented before launching any new activity in the area.

1.6 Alternatives

The 0-alternative has been defined as the situation in the area where activities are carried out at a day to day level with no increase in activity. In this case the current state of environment will be unchanged if the Plan is not adopted. No other alternatives to the Plan have been taken into consideration.

1.7 Monitoring

No specific monitoring of the plan is proposed. However cumulative impacts can occur due to plans for large scale off shore wind farms at Dogger Bank con-

ducted by Germany and United Kingdom. In connection with this it could be considered to establish a monitoring program for mammals and birds in a defined area of the south western part of the Plan Area if the English and German plans are going to be carried out..

In addition to this it is a prerequisite that the licensees of licenses granted after the Subsoil Act provides the necessary data to be able to evaluate if planned exploration and production activities have an effect on the environment in the area, including:

1) reject any damage on Natura 2000 sites (also in neighbouring countries)

2) ensure that breeding or resting areas for species listed on the Habitats Directive Annex 4 will not be damaged or destroyed

3) ensure that birds are not affected to an extent that will affect the population of the species

The data must be adequate to be able to evaluate the possible impacts over a year.

1.8 Consultation

The Environmental Report is published for consultation together with the draft plan for the licensing rounds. The public consultation period is scheduled to last for 11 weeks following the publication of this Environmental Report. Following consultation on the Environmental Report, the plan will be revised and updated taking into account the comments of stakeholders and the public.

The consultation period is scheduled for 11 weeks in the period from July 10 to September 25 2012.

An SEA Statement will be prepared and made available to the Consultation Authorities (and made public) setting out how the findings of the public and stakeholder consultation exercise and the environmental assessment have been incorporated into the development of the plan for the licensing round before the plan is finalized for adoption.

Any queries regarding the SEA of the plan should be addressed to:

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2 INTRODUCTION

The Danish Energy Agency is planning new rounds of licensing in the area west of 6° 15' E with a view to exploration and production of oil and gas and in a separate possible licensing round for permits for injection of CO_2 (to enhance oil recovery) in existing oil fields west of 6° 15' E (see the delimitation of the area in figure 1). The plan will lead to an increase in the current levels of activity in the area but not to initiation of new types of activity.

In accordance with the SEA Directive (Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment) a Strategic Environmental Assessment has been prepared and reported in this Environmental Report.

The EU-SEA Directive has been transposed into Danish legislation in the Act on Environmental Assessment of Plans and Programmes (LBK no. 936 of 24.09.2009) with Guideline (no. 9664 of 18.06.2006). This report is elaborated in compliance with the Danish legislation and it identifies, describes and evaluates the likely significant effects on the environment of the Plan and its alternatives.

In order to establish the extent and content of the environmental report a scoping note has been produced. In the scoping note the environmental aspects of the Plan, that are expected to be most affected, were identified as well as the factors which required further examination in order to rule out the risk of an impact, or in order to assess the nature and scope of the expected impact. These are described in more detail in chapter 6 as well as the probable impacts are likely also to have a transboundary impact. A summary of the scoping consultation responses are shown in Annex A.

3 OUTLINE OF THE PLAN

3.1 Introduction

The plan comprises the activities resulting from awards of licenses in the Danish EEZ area west of 6° 15' E with respect to:

- Exploration and production of oil and gas.
- Injection of CO_2 in existing oil fields with the purpose to enhance oil recovery (EOR).

Figure 1 shows the delimitation of the plan area. This area comprises all the currently producing Danish oil and gas fields, where intensive exploration and production activities have been carried out over the last 50 years. The plan will

thus lead to an increase in the current levels of activity but not to the initiation of new types of activity. Up to now there has been no injection of CO_2 with the purpose of enhanced oil recovery (EOR).

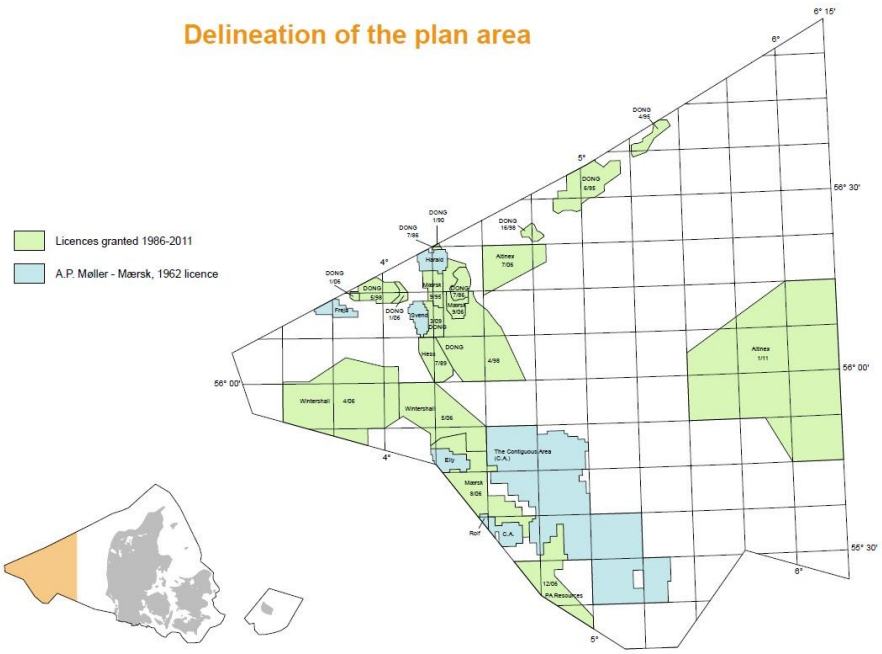

Figure 1: The deliniation of the plan area.

3.2 Exploration and production

Exploration activities consist primarily of geological investigations using:

- Evaluation and interpretation of existing data
- Seismic and other pre-investigation surveys
- Exploration drilling

Production activities are initiated in structures where geological investigations and exploration drilling have demonstrated the presence of hydrocarbons, and consist primarily of:

- Drilling of wells for production and production support
- Construction of platforms and other structures for processing and transportation of hydrocarbons

- Laying pipelines etc. for export of hydrocarbons
- Seismic surveys (3D/4D) throughout the production phase.

These activities are described in greater detail in sections 3.4 and 3.5.

3.3 Injection of CO_2 to enhance oil recovery (EOR)

Injection of CO_2 in existing oil fields can be carried out for two reasons: to stimulate the production of hydrocarbons, or to dispose of CO_2. As long as the field remains in production, a proportion of the injected CO_2 will return to the surface together with the produced hydrocarbons. This CO_2 will be separated from the hydrocarbons before these are being exported, and the CO_2 will be reinjected in the reservoir. When production ceases, the field will contain a given quantity of CO_2, and assuming that all wells in the field are sealed satisfactorily and the natural hydrocarbon seal in the structure is still intact, this quantity of CO_2 will be retained in the field, in theory for an indefinite length of time.

With the exception of the activities related to the transport of the CO_2 to (and possibly also from) the field, and assuming that the above-mentioned assumptions hold, there do not appear to be other environmental impacts related to injection of CO_2-injection than those arising in connection with exploration and production of hydrocarbons. Risks arising from accidents with consequent large-scale release of CO_2 are considered to be more safety-related (i.e. risk to human life) than environmental. This report disregards any effects of such accidents on the national CO_2 emission budget.

The environmental effects of CO_2 injection are thus also included in the following account.

3.4 Seismic surveys and other pre-investigation surveys

Seismic surveys are used to gather knowledge about the geological structures under the seabed. They are used both in the exploration phase and also in the production phase where 3D/4D seismic surveys are used to follow developments in the producing reservoir so that production can be optimized.

Under current legislation, seismic surveys are not subject to requirements for a formal Environmental Impact Assessment (EIA) but such surveys are not permitted without either a pre-investigation permit (§ 3) or a sole licence permit (§ 5) from the Danish Energy Agency. In addition, the methodology and programme for the seismic survey shall be approved by the Danish Energy Agency in accordance with § 28 of the Danish Subsoil Act. The Danish Energy Agency usualy sets up a number of conditions with regard to seismic surveys among other things with the aim to protect the environment.

Seismic surveys in the offshore oil and gas industry are carried out by means of airguns, either installed on the survey vessel or towed behind it. The airguns

send out regular sound impulses that are reflected from the seabed and from the geological strata beneath. The reflected impulses are picked up by a large number of sensors (hydrophones) towed on parallel cables (streamers) behind the survey vessel. In some situations the cables may be laid on the seabed. The reflected sound impulses are recorded and subsequently analyzed to create a ”picture” of the geology below the seabed.

For research purposes, seismic surveys of the deeper geological strata under the earth’s surface are sometimes performed using explosives as the sound source. Explosives are today not used in the oil and gas industry today, where interest is focused primarily on the accessible strata down to about 6.000 m depth. For these depths airguns are sufficient.

The standard requirements for offshore seismic surveys laid down by the Danish Energy Agency include amongst other things a set of recommendations elaborated by Danish Center for Environment and Energy (DEC) including the protection of marine mammals from harmful acoustic effects. It is a general condition for the approval of seismic surveys that companies use a so-called soft start procedure which gives marine mammals such as porpoises and dolphins a chance to leave the area before the pressure waves reach their operational level. Execution of seismic surveys can also interfere with fishing activities, and therefore there are requirements for notification in advance, presence of a fisheries liaison officer on board the survey vessel, etc.

Pre-investigation surveys (“site surveys”) are performed to ensure that drilling operations can be performed safely. They may include 2D and 3D seismic surveys of the proposed site for the drilling rig, seabed core penetration tests, sidescan sonar, and magnetometer or gradiometer surveys. Small-scale retrieval of seabed sediment samples might also be included in certain situations. These surveys are performed to gather data about the nature of the seabed and shallow subsurface at the proposed drilling site to ensure that the drilling rig can be deployed at the site and the drilling operation safely performed. Such surveys affect a relatively small area of the seabed and are not considered to embody any significant environmental impacts.

3.5 Exploration drilling

Exploration drilling is performed to demonstrate the presence or otherwise of hydrocarbons, based on the information about the geological structures below the seabed that amongst other things the seismic surveys have built up. If hydrocarbons are found to be present, samples may be taken, or – in the best possible outcome – a production test may be performed.

In the area covered by the plan the sea depths are typically from 30 to 70 m, and here the work can be carried out by a drilling rig of the jack-up type, which has three or four extendable legs supporting it on the seabed. (A more detailed de-

scription of such operations may be found in Mærsk Olie og Gas, 2011, and elsewhere).

The environmentally relevant aspects of drilling operations are:

- Physical presence of the drilling rig (emissions from energy production and accommodation area on the rig, physical impact of the rig's legs on the seabed, possible releases of chemicals from the rig, including lubricants on the extendable legs of the rig).

- Discharge of materials from the drilling operation: drilling cuttings, drilling mud, surplus cement and completion fluids, emissions to air/water from the drilling activity, evaporation of volatiles from oil-based drilling mud and any hydrocarbons emerging from the well.

- Noise arising from the drilling operation, well testing and associated ship activity (including other vessels than drilling rigs) and seismic survey in connection to well testing. Prior to conduction of a test drilling a site survey is performed, which involves acoustic exploration (3D/4D seismic survey) of the topmost layers of the sea bed. Although not nearly as powerful as a seismic survey, the sound levels emitted are still sufficient to cause potential impacts.

These are discussed in greater detail in the following sections.

With the exception of the physical impact on the seabed, the use of other types of drilling rigs (semi-submersible, drill ship etc.) gives different noise profiles but similar types of environmental impact.

3.5.1 Physical presence of the drilling rig

The legs of the drilling rig rest on the seabed. The legs are equipped with a type of shoe, known as "spud cans", to distribute the weight and prevent the legs penetrating into the seabed. The three "spud cans" can cover a combined area of several hundred square meters, and they can sink several meters into the seabed. The legs of the rig are lowered and raised by means of motors with a rack and pinion system. This system requires periodic lubrication, and some of the lubricant on the submerged parts of the legs will be released to the sea. For this reason there may be requirements as to the permitted composition of the lubricant.

The drilling rig in itself comprises a point source for emissions to air and discharges to the sea. Disregarding the emissions arising in connection with the drilling and well-testing activities, emissions to air are primarily those arising from power production, typically by means of diesel engines as well as evaporation from oil based mud. If marine diesel is used as fuel, the exhaust gases will con-

tain SO_2 in addition to CO_2 and NOx. The use of low-sulphur fuel reduces the SO_2 emissions significantly.

Disregarding the discharges arising from the drilling operation itself (see 3.5.2), discharges to the sea from the drilling rig will mainly consist of wastewater from the accommodation area and drainage water from the decks and machinery areas. The plan area lies in the North Sea where it is not permitted to discharge drainage water with an oil content higher than 10 mg/l, and the rig must be equipped with separator tanks or other equipment that ensures that this requirement can be met.

The drilling rig is assisted by tugs, anchor handling vessels, supply vessels and helicopters, all with their associated emissions of noise and exhaust gases and - for the vessels – discharges of sanitary wastewater and bilge water to the sea.

3.5.2 Discharges of materials

Danish marine pollution legislation forbids discharges of waste to the sea. Permits may however be issued by the Danish Environment Agency for discharge of materials in connection with drilling operations. Such a permit normally contains a set of conditions fulfilling Denmark's obligations under a number of international conventions for the protection of the marine environment to which Denmark is signatory. The most important in this respect is the Oslo and Paris Convention ("OSPAR"), whose commission has adopted a considerable number of Decisions and Recommendations which amongst other things protect the marine environment against pollution by chemicals.

Drilling operations produce cuttings - fragments of material from strata penetrated by the hole. For lubrication and cooling during the drilling operation, to transport cuttings out of the hole and to hold back the formation and fluids from the borehole, drilling mud is circulated down the hole. The cuttings are separated from the drilling mud prior to discharge, but will retain a residue of drilling mud. In addition, it may become necessary to discharge surplus drilling mud during the drilling operation.

Exploration wells are normally drilled using water-based drilling mud, but in certain situations, and when drilling deviated production wells, it may be desirable or mandatory to use oil-based drilling muds. OSPAR regulations do not permit the discharge of oil-based muds to the sea, so surplus oil-based mud is either collected and transported to land for disposal or injected downhole. Usually it is not possible to inject drilling mud into an exploration well fro disposal.

In addition to discharges of cuttings and drilling mud, drilling operations may give rise to discharges of other substances such as surplus cement from installation of well casings, liners and plugs, or surplus completion fluids.

All discharged substances and materials are subject to OSPAR's evaluation rules, on the basis of which they are (in Denmark) assigned to three categories, green, yellow and red. Danish authorities require discharges of the "red" category substances and materials to be limited as much as possible and that efforts are made to use primarily "green" substances and materials.

The standard conditions set by the Danish Environment Agency for discharges in connection with drilling operations include requirements for reporting of the types and quantities of discharged substances.

Emissions to air from the drilling activity consist mainly of the emissions from power-generating machinery (turbines or diesel engines), and volatile hydrocarbons evaporating from the drilling mud or emerging directly from the well. Emissions to air are not in themselves subject to regulation; however, the Danish Energy Agency has established health and safety regulations for emissions relating to the use of oil-based muds. Inspection and approval of drilling rigs prior to start of operations in the Danish sector ensure that power-generating machinery conforms to current emissions control regulations. Official or voluntary restrictions may also apply to the permitted types of fuel with a view to reducing emissions of SO_2 etc.

3.5.3 Noise arising from drilling operations

Drilling operations give rise to vibrations and noise which spread from the drilling string to the surrounding water. Ship activity will also generate noise, and prior to drilling an exploration well a site survey is performed. This involves acoustic exploration of the topmost layers of the seabed which generates noise. During the drilling operation sound may also be generated at the seabed if VSP (Vertical Seismic Profiling) is used to obtain higher resolution seismic profiles.

The most important source of noise during a drilling operation however is that arising from the installation of the first casing tube, the conductor. This is a steel tube, typically about 70 cm diameter (Mærsk Olie og Gas, 2011), which is hammered into the seabed using a hydraulic hammer. Alternatively it can be drilled into the seabed. The hammering operation can last several days; the well can then be drilled in the conventional way from inside the conductor.

The sound level caused by hammering is high enough to be dangerous for marine mammals, and therefore several requirements have been put in place to prevent injury to nearby marine mammals.

3.5.4 Construction of production wells and wells for production support

In order to produce a hydrocarbon discovery, one or more wells must be established to bring the fluids up from the reservoir to a production installation. It may also be necessary to drill wells in order to pump water or gas into the reservoir to support the flow of hydrocarbons, because the pressure in the reservoir declines as production continues. In recent years the use of CO_2 for production support

has been considered, because CO_2 injection both increases the formation pressure and also reduces the crude oil viscosity, thus assisting the flow of hydrocarbons towards the production wells.

Production wells are in principle drilled in the same way as exploration wells, except that:

- Production wells will typically have a longer and more deviated profile than exploration wells. A production well can be deviated to a horizontal direction or even upwards, and at target depth may extend up to 10 km from the starting point, so that from one production installation it is possible to produce from a wide area – or from several reservoirs within this area.

- Oil-based muds are often used when drilling production wells in order to optimize drilling performance and maximize the reach of the well. In some circumstances wells can be utilized for disposal of oily cuttings and spent oil-based mud: after slurrification these can be pumped down the well to disposal into the formation.

-. In order to optimize the production characteristics of the well stimulation may also be performed – liquids are pumped out from the well into the formation under high pressure to enhance the flow of hydrocarbons towards the well (these techniques are sometimes also used in exploration wells).

During the lifetime of a production well the need may arise for maintenance in order to maintain or optimize production. Scale and wax deposits have to be removed. Damaged or worn equipment in the well may need replacing, the well may require stimulation, or sidetracks may be drilled from the main track in order to drain new parts of the reservoir.

3.5.5 Construction of platforms etc. for processing produced hydrocarbons

Within the plan area, fixed platforms have been used up to now for treatment of the produced hydrocarbons. Floating production installations have so far not been used, and there are only three production installations on the seabed (Regnar, Stine SCB-1, Stine SCB-2). Several production platforms treat hydrocarbons from a number of satellite fields, which send their produced hydrocarbons to the production platform through pipelines on or under the seabed. It is expected that future production installations will follow this general pattern.

Production installations can consist of a single platform or several platforms connected by gangways. In addition to gaseous emissions and fluid discharges from the accommodation area, which are largely similar to emissions from drilling rigs and vessels in general, there will be emissions and discharges from the production and treatment of the hydrocarbons.

Production-related emissions and discharges usually comprise:

- emissions arising from energy production (gas turbines, diesel engines)

- emissions from safety-related combustion of hydrocarbons with or without combustion (flaring or cold venting)

- discharges of formation water from the reservoir after separation of the hydrocarbons (produced water) and of surplus injection water

- occasional discharges (directly or via the produced water separation system) of surplus stimulation fluids etc. when re--stimulated wells are brought back into production

Discharges of production chemicals are only allowed under permit from the Danish Environment Agency and such permits follow the same OSPAR chemicals evaluation guidelines and reporting requirements as for exploration drilling.

During the last thirty years much interest has focused on the discharge of produced water. The permitted oil content has been gradually reduced (currently 30 mg dispersed oil per liter of produced water) and requirements have also been set for a reduction in the absolute quantities discharged. The latter has received increasing attention in step with the steadily increasing age of the producing fields, which results in a steadily rising proportion of water ("water cut") in the produced fluids. In theory an oil reservoir can continue producing until the water content of the fluids has reached 100 %, and some Danish fields have now reached a water cut of more than 90 %.

Dissolved substances from the crude oil are also present in produced water, including aromatic hydrocarbons and in particular PAHs. This has been a subject of discussion leading to calls for reduction. It has not yet been established whether the discharge of produced water under the conditions prevailing in the Danish North Sea sector can lead to negative impacts on the environment, but the inherent characteristics of these substances (some of them being carcinogenic and/or mutagenic) have given rise to concern.

As an alternative to discharge, the produced water may be pumped back into the subsoil, either to the producing formation – if conditions are favorable – or to an alternative geological structure if such is available. In some of the Danish limestone reservoirs (the Dan field for example) it is not possible with current technology to reinject into the reservoir due to its limited porosity. In such circumstances discharge may be the only practical possibility.

In connection with construction of production installations, floating cranes and other vessels are used. Typically the pre-constructed installation is sailed out to the site and lifted into position, after which the platform legs are pinned to the

seabed using metal piles up to 2 m in diameter. This operation leads to noise impacts on any marine mammals nearby.

The physical presence of fixed installations also leads to a risk of bird collisions, for example when seabirds or migrating land-birds are attracted towards the lights of the installation or seek to use the installation as a resting point or ”stepping stone” on their migration route.

3.5.6 Establishment of pipelines etc. for hydrocarbon export

Production installations may be linked to satellite platforms and to shore by means of steel pipelines laid on or buried under the seabed. In addition to oil- and gas pipelines there may also be pipelines for injection water, lift-gas or hydraulic fluids. The produced and treated hydrocarbons may also be sent via a short pipeline to a loading buoy or floating storage vessel and from there to a tanker for export.

Prior to installation of pipelines a survey of seabed conditions is almost always made, often in the form of a side scan survey. Installation of buried pipelines requires excavation of the seabed and it may also be necessary to stabilise and protect the pipeline by depositing stones on top of it (”rock dumping”).

Oil and gas pipelines are cleaned and pressure tested before commissioning, and this can result in discharges of chemicals such as oxygen scavengers, corrosion inhibitors etc. Discharges of this nature require a permit from the Danish Environment Agency and are subject to the OSPAR rules mentioned above.

If the crude oil is exported by tanker instead of through an export pipeline to shore, emissions of volatile hydrocarbons (nmVOC) may occur from the tanker while the tanks are being filled. Modern tankers may be equipped with equipment for capture and reuse of these volatile hydrocarbons. NnmVOC is also a normal part of the combustion emissions from power-generating equipment (turbines, diesel engines) on vessels and production installations.

It may also be necessary to lay communications or power cables in the seabed. Examples of satellite platforms supplied from cables are found both in the Danish and Norwegian sectors.

Safety zones are usually set up around all fixed and floating installations and pipelines on the seabed. Shipping is excluded from safety zones around installations and anchoring and fishing is usually prohibited in the vicinity of pipelines. It is probable that production from new oil and gas fields will be sent to shore through existing export pipelines, since there is expected to be adequate capacity.

3.5.7 Disposal

International agreements in OSPAR and elsewhere require fixed production installations to be removed when activities cease. Furthermore, guidelines prepared by the International Maritime Organization (IMO), which is the United Nations' specialized agency with responsibility for the safety of shipping and the prevention of marine pollution by ships, has established general restrictions on disposal at sea.

No oil and gas installations have yet been removed in the Danish sector of the North Sea, but experience from platform decommissioning and removal in the Norwegian and British sectors show that this can be carried out without problems and without significant environmental impacts. Removal usually takes place by cutting the legs of the installation and lifting the upper part ("topsides") in one piece or several pieces by crane to a transport barge, which transports them to a suitable shipbreaking facility. The remaining parts of the legs are cut and removed down to several meters below the seabed, so that no fragments remain as a hazard for seabed fishing gear such as trawls.

These operations are performed after the installation has been decommissioned and cleaned so there is no risk of residues of oil or chemicals being released during the removal operation. The license of construction also includes requirements to protect the marine environment under decommission. Based on experience so far it is expected that removal of fixed installations will have very limited environmental effects. However, it is difficult to predict the exact circumstances that will prevail during the removal operation. It is also difficult to evaluate to what extent a given installation will have provided a positive artificial reef effect.

The environmental effects of platform removal will therefore require evaluation in accordance with the rules applying at the time of removal.

3.5.8 Unforeseen events / major accidents

Major environmental accidents can comprise loss of chemicals during transport to/from installations, uncontrolled discharge of hydrocarbons from a well ("blow-out") and fires and/or explosions on a drilling rig or production installation. Oil or gas pipelines can also suffer damage/corrosion with release of hydrocarbons as a consequence.

From an environmental point of view the greatest impacts will probably arise from spillages of chemicals and oil in connection with these types of accidents.

The effects of large-scale spills are difficult to predict since it is difficult to evaluate the probable scale of such an event and how it will develop over time. However, the risk evaluations that have been made so far of the impact of major accidents arising from production of hydrocarbons in the North Sea have concluded that it is unlikely that such events will have significant long-term effects on

populations of fish, marine mammals, birds etc. (Mærsk Olie og Gas, 2011; Dong Energy, 2011).

It is likely that minor emissions can occur without being controlled or mitigated, but it is difficult to estimate the magnitude of the potential impact.

4 CURRENT STATE AND ENVIRONMENTAL CHARACTERISTICS OF THE PLAN AREA

4.1 The plan area

The plan area is located in the Danish part of the North Sea bordered by longitude 6° 15' E and the Exclusive Economic Zone (EEZ) boundaries towards Norway, Great Britain and Germany (**Fejl! Henvisningskilde ikke fundet.**). The depth gradient is relatively small and the water depth varies from ca. 40 m in the Southern part of the area to ca. 70 m in the Northern part (Mærsk Olie og Gas, 2011).

The oceanographic circulation in the North Sea is dominated by incoming water from the North Atlantic which runs north of the Shetland Islands (primary inflow route) and through the English Channel (secondary inflow route). A number of large European rivers discharge fresh water into the North Sea, e.g. the Elbe, Rhine and Thames. Like the out flowing waters from the Baltic Sea through Kattegat/Skagerak has a reduced salinity.

The circulation in the North Sea is counter clockwise and currents run primarily along the coasts. The incoming Atlantic Water flows south along the British east coast, turns towards Denmark and flows north along the Danish west coast. The circulation in the central part of the North Sea, including the plan area, is weak and induced by tidal movement and wind induced surface currents (Mærsk olie og Gas, 2011).

The salinity is relatively stable through the water column in the plan area (34,5 - 35 ‰) throughout the year. However, a thermocline develops during the summer months. The stratification in the plan area contrasts with the mixed water across Dogger Bank and it is likely that an oceanographic front is created between the two water masses during the summer months. This can lead to upwelling of nutrient rich water and possible plankton blooms and associated presence of organisms from higher trophic levels, i.e. fish, birds, marine mammals.

4.2 Natura 2000

The plan area contains no Marine Protection Areas. The nearest Natura 2000 protection site is the German part of the Dogger Bank (DE 1003-301), which borders the plan area to the south (figure 2). The Dogger Bank area extents into the Dutch part of the North Sea (NL 2008-001). Part of the Dogger Bank is located in British territorial waters, which has been submitted to the European Commission as a candidate Special Area of Conservation (SAC) in August 2011 (JNCC).

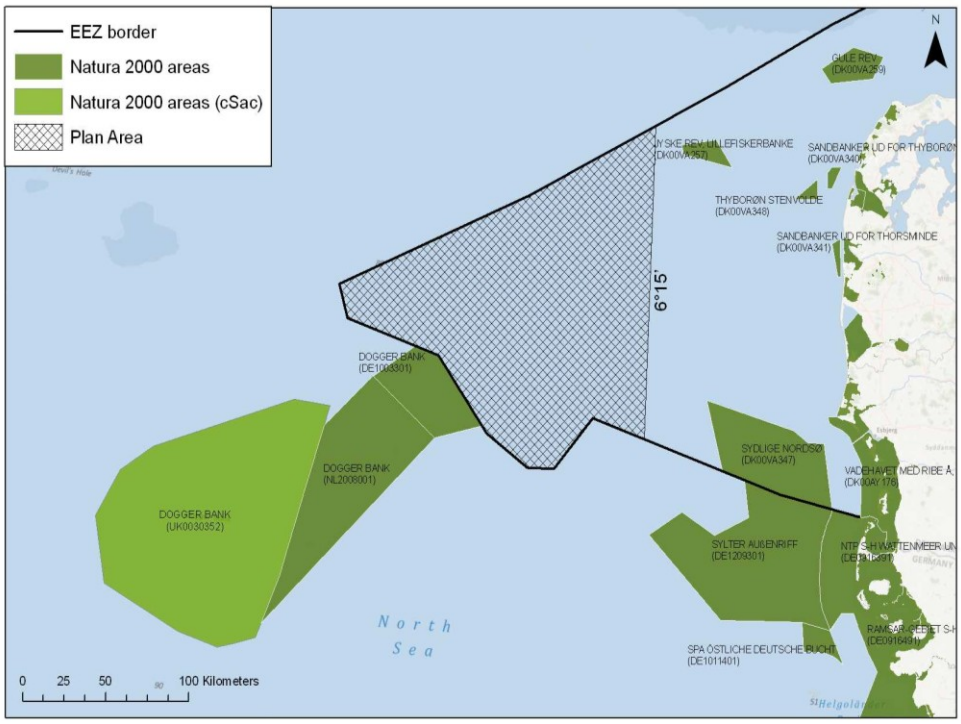

Figure 2. Map showing the location of the plan area and surrounding designated areas.

At Dogger Bank the habitat sandbank (1110) is designated as protected areas in Germany, Netherlands and possible United Kingdom. The nature type “sandbank” which are slightly covered by sea water all the time” and the following species listed in the EU Habitat Directive are part of the designation: Harbour porpoise (1351), common seal (1365) and grey seal (1364), only Dutch part of Dogger Bank) (Mærsk Olie og Gas, 2011).

The water mass at Dogger Bank is mixed throughout the year. It consists of warmer waters from the English Channel mixed with riverine input. To the north cold Atlantic water dominates and a front is created to the north of the bank where the cold saline Atlantic water meets the warmer less saline water from the channel and rivers. Phytoplankton production occurs throughout the year supporting a high biomass of species at higher trophic levels year-round (JNCC, 2011).

Other nearby Natura 2000 sites are the Danish ‘Sydlig Nordsø’ (DK00VA347) and the German ‘Sylter Außenriff’ (DE1209301) located about 50 km away from the southeastern corner of the plan area. The classification for the two areas is nature type 1110, and harbor porpoise and common seal occur. In addition to the EU Habitats Directive, the area is recognized as a special bird protection area (EU’s Bird Directive) designated to protect Red-throated and Black-throated Diver as well as Little Gull.

The Natura 2000 site, 'Jyske Rev, Lillefiskebanke' (DK00VA257) is located northwest of the plan area approximately 25 km away. It is classified as nature type 1170 (reef).

4.3 Plankton

The central part of the North Sea including the plan area can be characterized as medium to high productivity areas with great local variations. The primary production is estimated to be 150-250g and 200-1400mg carbon per square meter sea surface per year and per day, respectively (Skogen & Moll, 2000; North Sea Task Force, 1993).

Copepods are the most significant zooplankton component in the North Sea. The highest concentration is found at oceanographic fronts where the primary production is also greatest.

Fish eggs and larvae, larvae from mussels and cephalopods etc. are transported by ocean currents and are per definition part of the plankton.

4.4 Benthic fauna and flora

ICES (2007) identified several different benthic communities in the North Sea. Within the plan area two benthic communities were identified:

- The Amphiura/Spiophanes community, located around the Dogger Bank area at 35-50 m water depth
- The Myriochele/Paramphinome community, located in the central and northern North Sea at water depths greater than 50 m.

4.5 Fish and spawning grounds

The fish populations in the North Sea have been divided into six fish communities based on statistical analysis of ICES International Bottom Survey Database (Callaway *et al*. 2002).

Three of these communities were identified in the plan area:

- The most common commercial species at 50-100 m water depth are: herring, haddock, whiting, grey gurnard, long rough dab, dab and plaice.
- In the southern part of the North Sea at water depths less than 50 m the most common commercial frequent species are: herring, sprat, whiting, horse mackerel, common dragonet, sand goby, grey gurnard, dab and solenette/yellow sole.
- The Dogger Bank area has many species in common with the southern North Sea, however, herring and sprat are not common here whereas plaice and mackerel occur frequently.

Eggs and larvae from cod, plaice, long rough dab, dab, grey gurnard and common dragonet were found within the plan area (Mærsk Olie og Gas, 2011). Spawning areas of sandeel (Ammodytidae) has also been reported in the Norwegian sector close to the border of the plan area (DONG Energy, 2011).

Spawning in the North Sea is often concentrated along frontal zones between water masses, e.g. salinity fronts occurring between less saline coastal water and more saline central water. Fronts can be distinguished off Great Britain, the Netherlands, Germany, Denmark (dominated by outflow from major rivers) and off Norway (dominated by the Baltic outflow) in addition a front extends south of Dogger Bank and further north along 5°E (Munk *et al*. 2009).

Dogger Bank, close to the plan area, and Fisher Bank are areas with high abundance of fish eggs and larvae, predominantly of the species cod, plaice and long rough dab. All stages of eggs and larvae were found, suggesting that the area is both spawning and nursing ground, with limited transport from nearby spawning areas (Munk et al., 2009).

Spawning occurs generally in winter and early spring, but it differs between species. The species specific spawning season are (Mærsk Olie og Gas, 2011):

- Cod (January-April)
- Plaice (December-May)
- Dab (January-August)
- Long rough dab (January-May)
- Grey gurnard (April-August)
- Common dragonet (January-August)

4.6 Cephalopods

The most common species of cephalopod in the North Sea is the European Common Squid, *Alloteuthis subulata.* Studies of winter (Jan/Feb 2008, 2009) data from ICES International Bottom Trawl Survey (IBTS) and summer data (July/Aug 2007, 2008) from IBTS and German Small Scale Bottom Trawl Survey (GSBTS) show that *A. subulata* migrates south during summer to breed in the warm shallow water of the southern North Sea and it migrates north again to winter in the deeper waters of the northern North Sea (Oesterwind *et al*., 2010).

4.7 Marine mammals

Harbour porpoise (*Phocoena phocoena*) is the most common cetacean found in the North Sea, it is considered to be both resident and breeding in the North Sea

(Reijnders & Lankester, 1990). A study conducted by Mærsk Oil and Gas over a three year period (2006-2009) showed that the species occurs within the plan area (Mærsk Olie og Gas, 2011) but the distribution and density of porpoises in the North Sea is not well known.

In the SCAN survey (Small Cetacean Abundance in the North Sea) in 1994 Hammond *et al*. 2002 reported that Harbour porpoises were encountered in large part of the North Sea except in the Channel and southern North Sea. White-beaked dolphin (*Lagenorhynchus albirostris*) and mink whale (*Balaenoptera acutorostrata*) were found mainly in the north-western North Sea. These data was verified in 2005 by the SCANS II project. However the concentration of porpoises had shifted to the southern North Sea where the favoured areas in 1994 were observed off the northern eastern coast of the United Kingdom and waters around Denmark.

Teilmann *et al*., 2008 found high density areas of harbour porpoise in the in Skagerrak, near Skagen, and in the southern part, in the Wadden Sea around the Natura 2000 site 'Sydlig Nordsø', and around Dogger Bank.

Other cetaceans commonly observed in the North Sea are white-beaked and white-sided dolphin (*Lagenorhynchus albirostris and L. acutus*), bottlenose dolphin (*Tursiops truncates*), pilot whale (*Globicephala melaena*), minke whale (*Balaenoptera acutorostrata*) and killer whale (*Orcinus orca*) (Reijnders & Lankester, 1990). Of these species only white-beaked dolphin and minke whale were observed in the plan area during the three year survey performed by Mærsk Oil and Gas (Mærsk olie og Gas, 2011).

Pinnipeds are also common in the North Sea, the most frequently observed species being grey seal (*Halechoerus grypus*) and common/harbour seal (*Phoca vitulina*). Common seals breed along the UK coast and in the Wadden Sea. Grey seals breed in the northern UK and in the Dutch and German Wadden Sea. According to Hammond *et al*., 2001 common seals have been found to forage up to 60 km from their haul-out sites, but Tougaard *et al*., 2006 has observed distances up to 250 km. Grey seals travel both long (up to 2,10 km away) and short distances (typically 40 km), returning 2-3 days later (Hammond *et al*., 2001).

The main prey for common seals are sandeels, whitefish, herring, sprat, flatfish, octopus and squid, while grey seals prefer sandeel, gladoids and flatfish in that order (Hammond *et al*., 2001). Both species are observed in the plan area (Mærsk Olie og Gas, 2011).

4.8 Birds

Appointed important bird areas are not found within the plan area itself, but important areas like Skagerrak/ the Norwegian Trench, German Bight, the Wadden Sea and parts of Dogger Bank are located around the plan area.

In the nearby Natura 2000 areas on Dogger Bank significant proportions of the British population of guillemot have been found but it was not a regular occurrence (Kober *et al.* 2010). Similarly increased survey activity in the British and German parts of Dogger Bank show indications of temporal high densities of red-throated diver (Ib Krag Petersen *pers. com.*). There have also been indications of wintering populations of the globally near threatened yellow-billed Diver on Dogger Bank (Bemmelen *et al.* 2011). It cannot be ruled out that these occurrences might spill into the plan area.

The eastern German Bight and part of the Danish Wadden Sea (the Wadden Sea is located approximately 140 km from the plan area's southeastern corner, (**Fejl! Henvisningskilde ikke fundet.**) houses around 22 % of the biogeographic population of red- and black-throated divers (Knust *et al*. 2003). The species use the area for foraging, resting and wintering. Northwest of the area, important tidal fronts are located along the British east coast. This is important to birds because of primary production blooms occurring at the fronts.

The plan area is mainly used by birds from autumn to spring, especially by northern Fulmar, kittiwake, auks and skuars. But none of these occur in numbers of regional importance (Stone *et al.* 1995). Guillemot and kittiwake can, though occur in moderate to high numbers locally within the plan area (Ollason *et al.* 1997). Common for all these species is, that they are widely distributed over the North Sea from autumn to spring, and that the population in the plan area is relatively low compared to other parts of the North Sea. However also summer appearances of post breeding guillemot are likely to occur within the area. In recent years there have been raised concerns about negative population trends in these species (JNCC, 2009) in the North Sea.

More than 10 million land birds migrate every year between breeding grounds in Scandinavia and Russia and wintering areas in south and western Europe and Africa. The migration is generally widespread and neither land nor water birds use concentrated routes which pass through the plan area. This is confirmed by radar surveys performed during the establishing of offshore wind farms in the German Bight (Knust *et al*., 2003).

4.9 Marine archaeology

The plan area was dry land at the end of the last Ice Age. Transgression of the central North Sea area followed shortly after the ice had retreated from the Danish area and flooding of the entire North Sea area occurred around 8000 years BP (before present) (Erbs-Hansen *et al*., 2011). Traces of settlements are therefore unlikely to be found, whereas tools from hunter-gatherer cultures could potentially be found as well as fossils like wood and mammoth teeth.

It has not been possible to find information on wrecks in the plan area.

4.10 Socio-economic aspects

The resources, besides oil and gas, collected from the North Sea are sand, gravel and stones. Dredging is only performed along the coastlines to minimize transport costs and is therefore far from the plan area.

The North Sea is an important area for shipping. Major harbours are located along the coast line of the North Sea and it serves as a transit area to and from the Baltic Sea. It is estimated that at any time there are at least 500 vessels with more than 100 gross register tonnages present in the North Sea (Lange, 1991; Mærsk Olie og Gas, 2011). The most important shipping routes are subject to constant change and it is therefore not possible to get a collective image of the shipping activity in the plan area.

The North Sea in general is an important fisheries area, but the collective amount of fish caught in the plan area in 2008 accounted only for around 10 % of the total catch landed in Denmark. The most common species caught in the plan area and their percentage of total landings in Denmark in 2008 are: sand eel (4 %), sprat (10 %), plaice (4 %), herring (0.4 %), cod (1 %), Norway lobster (6 %). The numbers may vary significantly from year to year (Mærsk Olie og Gas, 2011).

Tourism is important along the coastline of the North Sea especially in Denmark, Norway and south of the Wadden Sea.

5 ENVIRONMENTAL PROTECTION OBJECTIVES

5.1 International and national objectives

The relevant international and national protection objectives in relation to this plan are included in:

- The Convention for the Protection of the Environment of the North-East Atlantic (OSPAR Convention)
- The European Union's Marine Strategy Framework Directive
- The Environmental offshore action plans
- The NEC-directive
- The marine Environment Protection Act
- Natura 2000

The Convention for the Protection of the Environment of the North-East Atlantic (OSPAR Convention) entered into force in 1998 to replace the Oslo (1972) and Paris (1974) Conventions. The European Community is a Contracting

Party to the Convention for the protection of the marine environment of the North-East Atlantic, which was signed in Paris in 1992. The Parties must undertake all possible steps to prevent and eliminate pollution and to protect the maritime area using two principles: the precautionary principle and the polluter pays principle. The Contracting Parties must take account of the latest technological developments and best environmental practice.

The North-East Atlantic Environment Strategy addresses the main threats identified, concerning issues within OSPAR competence, in six strategies including an Offshore Industry Strategy. The objectives for the Offshore Industry strategy are: to achieve by 2020 a reduction of oil in produced water discharged into the sea to a level which will adequately ensure that each of the discharges will present no harm to the marine environment; to have phased out, by 1 January 2017, the discharge of offshore chemicals that are, or contain substances that are, identified as candidates for substitution, except for those chemicals where, despite considerable efforts, it can be demonstrated that this is not feasible due to technical or safety reasons (OSPAR Recommendation 2006/3).

The European Union's Marine Strategy Framework Directive aims to protect more effectively the marine environment across Europe. The Marine Directive was adopted and came into force in 2008. It was transposed into Danish national legislation in 2010 (Law nr. 522 af 26/05/2010). The Marine Directive aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020. In order to achieve GES by 2020, each Member State is required to develop a strategy for its marine waters, which must be reviewed every 6 years.

The Environmental offshore action plans have been developed by the Danish Environmental Protection Agency, since 2005, in cooperation with the Danish Offshore Operators for the protection of the marine environment in the Danish part of the North Sea. According to the plans the impacts on the environment from the offshore activities should be within the limits that are set through both national and international regulation.

The NEC-directive aims to limit emissions of acidifying and eutrophying pollutants and ozone precursors in order to improve the protection in the Community of the environment and human health. Member States of the European Union must report information annually concerning emissions and projections for four main air pollutants: SO_2, NO_X, non-methane volatile organic compounds (nmVOCs) and NH_3. The NEC-directive sets pollutant-specific and legally binding emission ceilings for each of these pollutants and for each country.

The marine Environment Protection Act (LBK nr 929 of 24/09/2009) aims to prevent and reduce marine pollution from ships and platforms. A number of marine environmental conventions are implemented in this law.

Natura 2000 is an EU wide network of nature protection areas established under the 1992 Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also the Special Protection Areas (SPAs) which they designate under the 1979 EC Birds Directive. The conservation and protection of these areas are given in the provisions of Article 6 of the habitats Directive (92/43/EEC). Plans and project are prohibited to have any significant effects in view of the sites conservation objectives.

5.2 Relationships with other plans and strategies

The objections and environmental considerations mentioned in the list above in section 5.1 have been taken into account when preparing the plan and Environmental Report. The description of activities related to exploration and production and injection of CO_2 are made with reference to the existing conventions and regulations. For example when describing discharges of material and disposal the OSPAR Convention is taken into account.

In connection with the design and implementation of this plan, a number of specific laws will regulate the environmental impact (see also chapter 7) among other legislation on emissions. The legislation relates to the conventions and plans mentioned above.

The only known other plans and projects in the area involve large wind farms on Dogger Bank. Both in the German and, especially, British parts plans of an up to 9 GW wind farm are known (Forewind). Information on these projects is not sufficient to assess if these plans together with this plan can cause cumulative impacts, but it indicates a future higher pressure on the marine environment where increased level of noise from seismic surveys, hammering and noise from vessels can have a potential effects on especially mammals, fish and fish larvae and birds.

6 THE LIKELY SIGNIFICANT EFFECTS ON THE ENVIRONMENT

In this chapter the predicted likely significant effects on the environment are described and assessed.

The environmental effects considered are those which can be expected with a reasonable degree of probability.

The plan includes new rounds of licensing in the area west of 6° 15' E with a view to exploration and production of oil and gas and a separate possible licensing round of permits for injection of CO_2 (to enhance oil recovery) in existing oil fields west of 6° 15' E. and will lead to an (unknown) increase in the current levels of activity but not to the initiation of new types of activity. Intensive exploration and production activities have been carried out over the last 50 years in the area, and there is already a pressure from different sources on the marine environment. Therefore the prediction and assessment of impacts of this plan has been carried out with emphasize on the changes of the likely effects the plan will cause compared to the existing situation in the area today.

The pressures and impacts were identified during the scoping process and include the impact on:

- Impact on marine mammals caused by increased level of noise and disturbance
- Impact on birds caused by increased level of noise and increased attraction effect to platforms, vessels and other structures
- Impact on fish (including eggs and larvae) caused by increased level of noise
- Impact on the Natura 2000 habitat type "reef" caused by increased sediment dispersal. Effects on other Natura 2000 issues are included in the bird and marine mammal sections
- Impact on fisheries caused by increased level of disturbance and prohibition zones

Possible impacts as e.g. impacts on water and air quality and on other fauna groups have not been considered to be significant during the scoping process.

The expected likely impacts of the plan have been predicted based on the identified pressure described in chapter 3, the summary of existing data in chapter 4 and the international and national objectives of plan area summarized in chapter 5. The impacts have been assessed as positive or negative and whether they are expected to be none, minor, moderate or major when compared with the current level of impact. The geographical scale of the effect was scored as local, broad or very broad (transboundary).

6.1 Marine mammals

Sound is very important to many marine mammals. All marine mammals have a highly developed sense of hearing and many communicate using low-frequency sounds, in particular mysticete whales and pinnipeds. Odontocetes (toothed

whales) orientate themselves and locate food sources by emitting high frequency sounds that are reflected from obstacles in the same way as sonar on a ship.

The plan can result in an increase in activities which can imply a general increase in the level of noise emitted from platforms in operation, vessel and helicopter traffic and seismic surveys activity. The level of noise from platforms is estimated low (Mærsk Olie og Gas, 2011). The increase in the load of traffic is expected to be small when compared to the current level, but as the current level may already be high it is difficult to assess the likely future changes to the environmental base line and the magnitude of the impact caused by additional pressure on the mammals.

Increase in level of noise from platforms and vessel traffic etc.			
Positive or negative	Impact	Time scale	Geographical scale
Negative	Minor	Long-term	Small for platforms, broad for vessel traffic

Another type of noise is the noise emitted by hammering of conductors during exploration and production drilling, pile driving during construction of platforms and noise emissions from seismic surveys. The noise emitted by these sources is quite intensive.

It has been recognised that sound generated from seismic sources, conductor hammering and pile driving has the potential to cause injury (e.g. permanent damage to hearing and tissue, postural instability and akinesia (H. Gray and K.V Warebeek, 2011) or possibly even death) and to disturb marine mammals. Injury will likely only be inflicted on individuals close to the source of the noise while disturbance may occur at a distance of up to hundreds of kilometres from the source. Therefor mitigation measures will be required before launching any activity (see also chapter 6.1.1).

Seabed core penetration tests, sidescan sonar, and magnetometer or gradiometer surveys and small-scale retrieval of seabed sediment samples might also be included in certain situations. Such surveys affect a relatively small area of the seabed and are not considered to embody any significant environmental impacts.

During construction of the Horns Rev Offshore Wind Farm in the North Sea, the density of porpoises in the area was monitored before, during and after pile driving activities. The study showed that there was a significant effect on the density of porpoises in the area around Horns Rev. The disappearance of porpoises during pile driving could be measured in reference areas up to 15 km away from the pile driving site (Dong Energy *et al*., 2006).

Marine mammals usually return to the affected areas within hours after the noise emitting activities cease. Because of this, and the fact that there are no indications that the license area is especially important to marine mammals when compared to other areas and that there are no seal breeding areas close to the license area, it is evaluated that the effect of the disturbance caused by increased noise is minor for a single conductor pipe piling, but a seismic survey may keep animals out of a large area for many weeks, if not months. For seismic surveys, the significant impact is not the injury, which may be inflicted on a few animals; it is the behavioural impact, reduced communication distances and possibly increased stress hormone levels in animals over a much larger area, hundreds of square kilometres or more.

The impact is evaluated as moderate at the individual level because of the increased risk of physical injury to marine mammals due to noise. At the population level it is assessed that there is no risk of a significant impact.

Increase in level of noise from pile driving and seismic surveys			
Positive or negative	Impact	Time scale	Geographical scale
Negative	Minor with regard to disturbance, moderate with regard to physical injury	Short-term	Broad with regard to disturbance, small with regard to physical injury

If mitigation measures are implemented adequately the increased level of disturbance and noise that results from the plan will not affect marine mammals included in designations of Natura 2000-sites of the North Sea or protected by Annex IV of the Habitats Directive.

However it shall be mentioned that mitigation, as it is performed now for seismic survey and pile driving, can only reduce the risk of injury, it cannot do anything to mitigate the behavioural and other effects which occur at greater distance.

6.1.1 Mitigation

To eliminate the risk of physical injury to marine mammals, mitigation measures will likely be required in connection with the regulation of the activities (see also chapter 7).

The commonly used mitigation measures when regarding pile driving in connection with exploration of oil and gas are:

- Use of the “soft start” or “ramp up” procedure that ensures that full ramming power is only administered after a period of low-energy blows that are unlikely to cause harmful effects to marine mammals present in the area. The low-energy blows will cause the marine mammals to leave the area.

When regarding seismic surveys, mitigation might include such measures as recommended in JNCC, 2010 and Boertmann *et al.*, 2011:

- The airgun array should not be larger than needed for the specific survey.
- The survey should be delayed if marine mammals are observed within a safety zone of 500 m from the airgun array.
- A soft-start procedure should be implemented.
- In some cases marine mammal observers should be aboard the survey vessel. Operations are only permitted to start when it is certain that no marine mammals are present within 500 meter from the source.

It is evaluated that some level of mitigation will always be necessary when pile driving, conductor hammering or seismic surveys take place in the license area. The level and implementation of mitigation measures should be evaluated in relation to each specific project (see also chapter 7).

6.2 Birds

As there are no important routes of concentrated bird migration through the plan area, it is expected that the effect of permanent installations as "stepping stones" for migratory birds will be minor. Individual birds migrating through the area or making daily migrations inside the area may collide with platforms, vessels or other structures or be attracted by the light on these structures, but it is unlikely that birds will be affected at population level by this.

There are potential areas with higher densities of resting birds (and not only wintering birds) in the plan area as northern fullmar, kittiwake, auks and skuars occur with moderate and high numbers locally and there are indications of resting guillemot, red-throated diver and yellow Billed Diver in the area. But as the population in the area is lower compared to other parts of the North Sea it is assessed unlikely that an increased risk of collisions will have impacts at the population level.

Increase in collisions of migrating and resting birds with structures or use of structures as "stepping stones"			
Positive or negative	Impact	Time scale	Geographical scale
Negative	Minor	Long-term	Local/broad

The areas already in action within the plan area are not very likely to be especially important to feeding, resting, moulting and wintering sea birds and other water birds. Most likely bird species to be affected are auks, divers and kittiwakes. Individual birds, especially auks migrating by swimming in late summer,

may be disturbed by the increased level of noise and vessel activity in the area, but it is unlikely that birds will be affected at population level by this.

Increase in disturbance of resting, feeding, moulting and wintering birds by increased level of noise and vessel activity			
Positive or negative	Impact	Time scale	Geographical scale
Negative	Minor	Long-term	Local/broad

The only known other plans and projects in the area involve large windfarms on Dogger Bank. Both in the German and, especially, British parts plans of up to 9 GW wind farm are known (Forewind). As there might be significant populations of divers and auks in that area, activities might disperse birds to less useful habitats of Dogger Bank. This potentially increases the number of birds in the plan area and could imply that the expected change of impact compared to current level will increase from minor to moderate which means that mitigation measures might be considered.

It should also be mentioned that nothing is known about underwater hearing in birds and effects of underwater noise, but there is a possibility that diving birds could be affected by high levels of noise, this is however not considered in this report.

6.3 Fish, fish egg and larvae and fish spawning areas

The type of noise related to the plan that is likely to affect fish is the intensive noise emitted by conductor hammering during drilling operations, pile driving during construction of platforms and during seismic surveys.

The current knowledge does not provide a clear picture of the reaction of fish to the noise emitted by conductor hammering and pile driving.

Several studies show that fish react to and are affected by noise from pile driving. It has been demonstrated that fish can be physically injured by the noise if they are caged and cannot escape. It has also been demonstrated that adult fish will leave areas with high levels of noise if they are not caged (Dong Energy, 2011).

Strong behavioral reactions to pile driving noise of species commonly found in the license area such as herring and sprat can potentially occur over distances of up to 500 m (Mærsk, 2011).

Seismic surveys will also have an impact on the behaviour of fish, but the reported magnitude of this impact is variable. Norwegian reports indicate an effect at a distance of more than 33 km, whereas studies in Australia indicate that there is no behavioural effect at a distance of 2 km. Research in Scotland showed that the fish studied appeared to have stronger avoidance reactions to the visual

impact of a plume of air and mud than from an airgun sound pulse (Gausland, 2003).

Adult fish are able to move away from areas with high levels of noise. Therefore it is unlikely that adult fish will be affected at population level by increased noise in the license area. However fish recruitment plays an important role. Given that the mortality among eggs and larvae is gigantic, then the statement, that killing or disturbing even a large proportion of the adults will not have any significant effect on population size, does not hold for long lived species which have few offspring. In these species adult mortality can be significant.

Increase in effect of noise on adult fish			
Positive or negative	Impact	Time scale	Geographical scale
Negative	Minor	Short-term	Local

As opposed to adult fish, fish egg and larvae are part of the plankton. Plankton cannot actively move across the water currents and as a result of this plankton organisms cannot "escape" from areas with high levels of noise.

Studies have shown that intensive noise can cause physical injury and induce mortality in fish egg and larvae. However, the noise from pile driving will only be able to cause injury to the small amount of egg and larvae that are likely to be in the vicinity of the pile driving site.

Fish egg and larvae cannot avoid the pressure wave from the airguns and can be killed within a distance of less than 2 m. Sub lethal injuries may occur within 5 m (Boertmann *et al*., 2011). This means that the relative volume of water affected is very small and it is concluded that seismic surveys will only account for a very low mortality rate on fish egg and larvae. This is insignificant compared to the natural mortality rate of most species at the egg and larval life stages (Gausland, 2003) and population effects, if any, are considered to be very limited.

However, spawning areas may in certain periods of the year have very high densities of spawning fish, fish egg and larvae. The effects of seismic surveys and other types of intensive noise might be more serious in these areas. As a result of this some areas in the Lofoten-Barents Sea are closed for seismic activities during the cod and herring spawning period (Boertmann et al., 2011).

A number of different species spawn in the North Sea and in the license area. However, all the species have pelagic eggs and at all times apart from the exact time of spawning the egg and larvae will be spread over large areas. Therefore it is evaluated that detrimental effects to congregations of egg and larvae, because of the increased level of activity in the license area, are very unlikely.

Increase in effect of noise on fish egg and larvae and spawning areas			
Positive or negative	Impact	Time scale	Geographical scale
Negative	Minor	Short-term	Local

6.4 Natura 2000

As a general rule it can be assumed that the plan will not lead to an increase in activities within the Natura 2000-sites of the North Sea.

Inside the license area there will be a number of activities that will result in sediment spill. It is estimated that the area strongly influenced by sediment dispersal in relation to this work is limited to a maximum of 100 m from the working site (Dong Energy, 2011). Further away from the work site the effect will be small.

It is evaluated that exploration activities and construction work within the license area is not of a magnitude that will lead to sediment dispersion or other effects, which can affect the conservation status of habitat types (such as reefs) within the Natura 2000-sites of the North Sea. Therefore it is not likely that the plan will have significant effects on the adjacent Natura 2000 sites.

A possible activity related to the plan that might result in effects in Natura 2000-sites is the construction of pipelines for hydrocarbon export. However, the existing pipelines from the license area to the coast of Jutland do not cross Natura 2000-sites. It is not very likely that it is necessary to construct a new pipeline and if a new pipeline is constructed, it is unlikely that it will have to cross protected areas. If however it turns out to be the case a thorough investigation of the effects must be carried out.

Loud noise from activities in the plan area has the potential to affect adjacent habitat areas within Danish, German and possible United Kingdom waters. But it is not likely that the effects will be of significance for the designated habitats and species in the view of the sites conservation objectives.

6.5 Socio-economic aspects

The main socio-economic aspect of the plan is the impact on fisheries. The plan will further constrain the fishery in the license area due to prohibition zones around platforms, pipelines and during construction work.

The license area is not particularly important to the fishery and that alone limits the effect of the constraints.

Fishing will most likely be prohibited in a 500 m exclusion zone around platforms and in a 200 m safety zone on each side of a pipeline. Some pipelines are strong enough to withstand beam trawl fishery and have no prohibition zones.

It is evident that prohibition zones will affect the possibilities of fishing in the license area. However, the area affected will be less than 1 % of the total area of the license area. The significance of the effect to the fishery will therefore be very small.

Increase in disturbance and area of prohibition zones			
Positive or negative	Impact	Time scale	Geographical scale
Negative	Small	Long-term	Broad

6.6 Likely transboundary effects

It has been concluded that the plan can have minor impacts on marine mammals, birds and fish, but none of the impacts are assessed as significant and with transboundary dimension. The plan will add a pressure on the marine environment that together with other plans can cause cumulative impacts where increased level of noise from seismic surveys, hammering and noise from vessels can have a potential effect on especially mammals, fish and fish larvae and birds. It has been concluded that the plan can have minor impacts on marine mammals, birds and fish, but as mentioned above none of them are assessed as significant.

The main socio-economic aspect of the plan is the impact on fisheries. The plan will further constrain the fishery in the license area due to prohibition zones around platforms, pipelines and during construction work, but this effect will only be local.

7 MITIGATION MEASURES

The mitigation measures, if any shall prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan.

Implementation of the plan requires many steps from pre-investigations to the construction of off shore technical installations, and will include regulations from a number of Acts and Executive orders which set up a number of requirements and limit values to protect the environment. The different mitigation measures listed in chapter 6 are expected to be included in the phases of consent given by the authorities (the Danish Environmental Protection Agency and the Danish Energy Agency). The constructor is furthermore obliged to follow a detailed Environmental Management Plan including risk, health and safety.

In the following is given a short overview of the regulations of the activities included in the plan. It is assumed that the environmental parameters are covered by these regulations and therefore no particular mitigation measures are described for the plan itself.

Before any investigations are carried out in the plan area the constructor has to apply the Danish Energy Agency for approval of the pre-investigation programme. In connection with the approval of programs, the Danish Energy Agency has to ensure that the provisions of the EIA Ordinance concerning conservation areas and some species are observed. The licensee shall perform the investigations in a proper way so that activities performed by other licensees in pursuance of the Danish Subsoil Act, including other holders of pre-investigation permits, fishing activities and other economic activities, are not unreasonably obstructed. The Danish Energy Agency may order the licensee to coordinate the activities with the activities of other licensees.

In cases of application and approval of deep drilling the Energy Agency is obliged to conduct an EIA screening to assess if the project has to go through an EIA.

The environmental requirements to be met on an offshore installation are laid down pursuant to the Subsoil Act (Consolidated Act No. 526 of 11 June 2002 on the Use of the Danish Subsoil), as well as the Marine Environment Protection Act (Consolidated Act No. 925 of 28 September 2005 on the Protection of the Marine Environment).

The Danish Environmental Protection Agency lays down requirements regarding the quantity of substances and materials that may be discharged into the atmosphere and the sea (the external environment), while the Danish Energy Agency draws up design requirements that offshore installations must meet in order to observe the principle of using the Best Available Techniques (BAT) to reduce harmful environmental impacts.

Applications to the Danish Energy Agency for approval of a development plan for oil and gas fields pursuant to the Subsoil Act and the establishment of pipelines pursuant to the Continental Shelf Act (Consolidated Act No. 1101 of 18 November 2005 on the Continental Shelf) must be accompanied by an Environmental Impact Assessment (EIA) and an account of the measures taken to reduce such impact, including by means of BAT. Detailed rules are laid down in Executive Order No. 684 of 23 June 2011 on Environmental Impact Assessment (EIA), impact assessment regarding international natural habitats and conservation of certain species at projects offshore on exploration and extraction of hydrocarbons, storage in the subsoil, pipelines, etc.

The Danish Energy Agency must conduct a EIA screening before approval of deep wells.

The conditions that the Danish Energy Agency imposes for the approval of e.g. seismic surveys are based on the latest data and information concerning marine mammals in the Danish offshore area. Two monitoring programs concerning the presence and behavior of porpoises and other fauna have been carried out by Mærsk Oil and Gas as part of its obligations under the work programs. The data have not been published yet. But the Danish Energy Agency and the Danish Nature Agency are currently evaluating the results with the aim of clarifying whether there is a need for additional measures in order to improve the protection of marine mammals.

Therefore it is assumed that the environmental parameters described in chapter 6 are covered by the above mentioned regulations and therefore no particular mitigation measures are described for the plan itself.

8 0-ALTERNATIVE AND SELECTION OF ALTERNATIVES

The 0-alternative is defined as the situation in the area where activities are carried out at the day to day level with no increase in activity. In this case the current state of environment will be unchanged if the plan is not adopted.

The 0-alternative can also be described as a future predictable situation when the plan is not adopted. It is likely that the activities in the area will decrease in the future because the resources of oil and gas will become sparse. In this case the 0-alternative most probably will have a positive impact on the environment, but concerning material goods and population this alternative can be assessed as having a negative impact because the plan contributes to an income increase to the Danish State (tax on hydrocarbons and creation of new jobs off- and onshore).

No other alternatives of the plan have been selected.

9 MONITORING

The monitoring of a plan will generally be described as an activity of following the development of the parameters of concern in magnitude, time and space.

There is no proposal for specific monitoring of the plan, because investigations etc. will be a part of the EIA and regulations mentioned in chapter 7, but it should be considered that the plan together with future plans for off shore wind farms at

Dogger Bank can add a pressure to the southern west part of the plan area of especially noise, which can increase the impacts on birds and mammals.

In connection with this it could be considered to establish a monitoring program for mammals and birds in a defined area of the south western part of the Plan Area if the English and German plans are going to be carried out.

In addition to this it is a prerequisite that the licensees of licenses granted after the Subsoil Act provides the necessary data to be able to evaluate if planned exploration and production activities have an effect on the environment in the area, including:

1) reject any damage on Natura 2000 sites (also in neighbour countries)

2) ensure that breeding or resting areas for species listed on the Habitats Directive Annex 4 will not be damaged or destroyed

3) ensure that birds are not affected to an extent that will affect the population of the species

The data must be adequate to be able to evaluate the possible impacts over a year.

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ANNEX A,

Summary of the scoping consultation responses.

The scoping report (January 2012) has been consulted by different Danish authoritative responds, and a letter of notification with a summary of the scoping report was submitted to the neighbor countries of Germany, Netherlands, United Kingdom and Norway. The table below gives an overview with a list of the respondent comments and the response to the comment.

Respondent	Comment	Response
Environmental protection Agency, Danish Ministry of Environment	The authority mention to include in the description of the activities: emission of chemicals in produced water and nmVOC in addidtion to emission of NOx and SO2.	The description of the plan (chapter 3) in the environmental report has been revised with addition of the mentioned parameters according to the comment.
Government of Schleswig-Holstein	Landesamt für Bergbau, Energie und Geologie does not expect impact of the planned Danish exploration activities for the German North Sea sector. Scientific Examination would be necessary if a future production is expected to reach the Economic Zone of Germany.	Taken to note
Ministerium für Wissenschaft, Wirtschaft und Verkehr des Landes Schleswig-Holstein, Germany LBEG (Landesamt für Bergbau, Energie und Geologie)	The Landdag of Schleswig-Holstein emphasize that all parties has voted against storage of CO_2 in the subsoil. Therefore they ask for translations of all documents to Landesamt für Bergbau, Energie und Geoloie in Niederscahsen, who is the competent authority and can ensure the public hearing.	The draft environmental report will be submitted in German language for 11 weeks of public participation. The plan for licensing round includes injection of CO_2 in existing oil fields to enhance oil recovery (EOR). This activity can't be compared with the process of capture and storage of CO_2 by pumping it into underground geological formations. This activity is covered by the EU-CCS Directive. To avoid misunderstandings the Environmental report will underline in more detail the process of EOR.
Netherlands	The Netherlands wishes to participate in the SEA procedure as transboundary effects may likely occur.	The draft environmental plan (in English) will be submitted to Netherland for 11 weeks of public participation.

United Kingdom	No reaction	
Norway, Ministry of Environment	Relevant authorities has been consulted, and the response was “No comments”	Taken to note