ENVIRONMENTAL REPORT 2023

OFFSHORE NORGE

Contents

Offshore Norge – Environmental Report 2023

Linguistic Solutions by Angela Balteskard

1. Foreword

Each year, Offshore Norge publishes an environmental report containing a detailed overview of last year's emissions and discharges from the petroleum industry. The purpose is to share data on l emissions and discharges and to inform about the industry´s environmental work and results.

The Norwegian petroleum industry has an ambition to be world leaders in environmental matters and to constantly improve. Detailed reporting on all emissions and discharges is imperative to measure progress and to ascertain how far we have come in terms of reaching our goal.

Data basis and methodology

This environmental report is based upon the annual emission and discharge reports which all field operators are required to submit to the Norwegian Environment Agency (NEA), conforming to the regulatory requirements as detailed in the NEA´s guideline M-107. This applies to all planned and officially approved operational emissions and discharges, as well as to those occurring accidentally. Common frameworks as detailed in Offshore Norge´s guideline 044 ensure consistent emissions/discharge reporting from all production licenses. The data from each field is entered into Collabor8 Footprint, (hereinafter referred to as Footprint), a joint data base for Offshore Norge, the NEA, the Norwegian Radiation and Nuclear Safety Authority, (DSA), and the Norwegian Petroleum Directorate, (NPD). The field-specific emissions and discharge reports submitted to the NEA are available for downloading from Offshore Norge´s website.

Reports from previous years can also be found on Offshore Norge´s website.

Emissions and discharges from the petroleum industry are defined in accordance with the Norwegian Petroleum Tax Act. As such, the following are not included in this report: Emissions and discharges from the construction and installation phase, maritime support services, helicopter traffic and those areas of onshore facilities which cannot be related to offshore production. Carbon capture and storage activities (CCS) are included in this year´s report for the first time. Whilst they are not defined as petroleum activities, there are striking similarities between "normal" drilling activities and CCS drilling activities. The NEA and the operators have therefore agreed to include reports on CCS drilling activities in Footprint.

Emissions and discharges will vary according to the operations on the NCS. The environmental report therefore contains a brief description of the operation in question before presenting the facts and figures summarizing the emissions/discharges from the entire operation. A summary of the projects linked to the marine environment and climate is also provided at the end of the report.

2. Summary

War and the energy crises characterized the year 2022. Going forward, it is crucial that Norwegian supplies of natural gas to Europe remain at a stable high level.

In 2022, 97.8 million Sm^3 of oil were produced on the NCS. This is a slight decrease compared to the level for 2021. 122 billion Sm^3 of natural gas (bcm) were sold and supplied, which is an 8 % increase compared to 2021.

The temporary adjustments to the petroleum tax legislation passed in the summer of 2020 have had the desired effect, and the activity level on the NCS is stable. Plans for development were submitted to the authorities for a total of 18 new field developments and for the further development of 13 fields in production under the temporary tax adjustments.

In 2022, 34 wells were completed (30 wildcat wells and 4 appraisal wells), down from 40 wells in 2021. Two CO_2 storage wells were also drilled for the Northern Lights license. A total of 12 oil and gas discoveries were made, yielding a gross resource increase of 52 million Sm^3 o.e.

Total greenhouse gas emissions from the NCS and onshore facilities stood at 11.6 million CO_2 equivalents in 2022 under the petroleum tax legislation, which is approximately the same as in 2021. Emissions remain stable, despite production start-up at Melkøya in 2022. CO_2 emissions per produced unit were unchanged from 2021 to 2022 (7.6 kg. per barrel o.e.).

Methane emissions on the NCS are low by international standards, with total methane emissions dropping further from 14,682 tons in 2021 to 13,152 tons in 2022. This decrease has been achieved despite increased gas production.

Total NOx emissions from petroleum activities were reduced by 6% from 2021 to 2022, for both turbines and engines. The Melkøya production start-up has contributed to the low NOx emissions figures, as the facility is equipped for NOx abatement.

A decrease in drilling activities resulted in a parallel decrease in the discharge of drill cuttings using water-based fluids, whilst the use of oil-based fluids was reduced by 5%. There was an increase in the injection of drill cuttings from oil-based fluids, leading to a drop in the quantities of hazardous waste being sent ashore in 2022 compared to 2021.

Discharges from produced water stood at 116 million m^3 in 2022, down from 127 million m^3 in 2021. These discharges have been reduced by over 30 million m^3 since 2015. Injected produced water remains at the same level as for the previous year (27 per cent). Many of the fields on the NCS are mature and in need of increased water injection to maintain reservoir pressure, thereby also increasing the volumes of produced water from these fields.

The average oil content in produced water for the entire NCS has shown a downward trend in recent years but increased from 11.1 mg/l in 2021 to 11.8 mg/l in 2022. The regulatory threshold for oil content is 30 mg/l. Research results, environmental monitoring, and companies´ own risk-based analyses of the discharges have concluded that the environmental impact of these discharges is low and limited to the vicinity of their source.

Extensive chemical substitution has reduced the release of the most environmentally hazardous chemicals to a fraction of what it was ten years ago. The reason for this development is a risk-based approach to and substitution of those chemicals identified as environmentally hazardous.

The industry is working proactively on chemical substitution to lower the risks associated with discharges. Total chemical discharges decreased from 189,000 tons in 2021 to 171,000 tons in 2022, with approximately 90% of the discharges falling into the category classified as green, denoting zero or very little environmental impact. The most environmentally hazardous chemicals which are found in the red and black categories now account for 0.25% and 0.002% respectively of discharges.

The industry has implemented a comprehensive preventive action plan to avoid unplanned acute oil spills, leading to a downward trend in the number of oil spills over many years. The total volume of spills varies considerably from year to year and is dominated by isolated incidents. In 2022 there were 43 acute oil spills in total, 20 of which exceeded 50 litres in volume. There were 25 crude oil spills in 2022, five of which were categorized as greater than 1 m^3. The total volume of acute oil spills in 2022 reached 61 m^3, compared to 31 m^3 in 2021.

The number of unplanned chemical spills rose from 160 in 2021 to 194 in 2022. Over 50% of the spills were small (under 50 litres), but the total discharge volume increased from 124 m^3 in 2021 to 388 m^3 in 2022. The increase is due to a couple of isolated incidents, where the largest one resulted in a 160 m^3 spill, as a result of a hose leak during the loading of drill fluids. The vast majority of the discharges (99.7%) are from chemicals classified as yellow and green, causing little or zero environmental impact.

Environmental monitoring is carried out by independent consultants pursuant to government recommendations. The industry uses significant resources annually to determine which types of discharge may have an impact on the environment. Environmental monitoring of the seabed and the water column is carried out in addition to visual monitoring, particularly in areas where vulnerable fauna is present.

The results of seabed analyses show that the impact is related to particle discharges and wellbore instability, generally located between tens and some hundred meters from the spill. Water column monitoring shows that acute effects on organisms in the water column are limited to the vicinity of the discharge.

3. Activity level on the Norwegian Continental Shelf

War and the energy crises characterized the year 2022. The Russian export of pipeline gas through Nord Stream 1 and Yamal was shut down completely in 2022, and exports via Ukraine were reduced significantly. This development has also had consequences for the global LNG market, since most of Russia´s pipeline gas has been replaced by increased imports of liquefied natural gas. It will be crucial that Norwegian natural gas supplies to Europe to remain at a high and stable level going forwards.

The temporary adjustments to the petroleum tax system, passed in the summer of 2020, have had the desired effect and the activity level on the NCS is stable. Development plans for 18 new developments and 13 plans for the further development of fields in production were submitted under the temporary adjustments. New calculations carried out by Menon Economics for the Ministry of Petroleum and Energy show that the projects sanctioned under the temporary adjustments will yield investments of 440 billion kroner. These investments are expected in turn to provide employment equating to approximately 158,000 man-labour years from 2020 to 2029.
Relatively low levels of new oil and gas investments globally in recent years, economic recovery following the pandemic and international value chain bottlenecks, coupled with war and the energy crisis have led to increased costs and inflation across several countries. These effects are also felt by the operators on the NCS, causing activity levels to be constantly assessed and adapted to suit the prevailing circumstances.

Oil production development and global demand
In 2022, 97.8 million Sm^3 of oil were produced on the NCS, as illustrated in Fig. 1. This is a slight decrease compared to the 2021 level. The decrease must be seen in relation to production delays from newer fields, as well as a focus on increased gas production due to the European energy situation.

Global oil demand in 2022 stood at approximately 99.8 million barrels per day, according to the IEA. Global demand in 2023 is expected to rise by 2.2 million barrels per day to a total of 102 million barrels per day. This growth is driven primarily by increased demand in China as a result of restarting its economy following the pandemic. Global demand is now higher than it was prior to the pandemic.

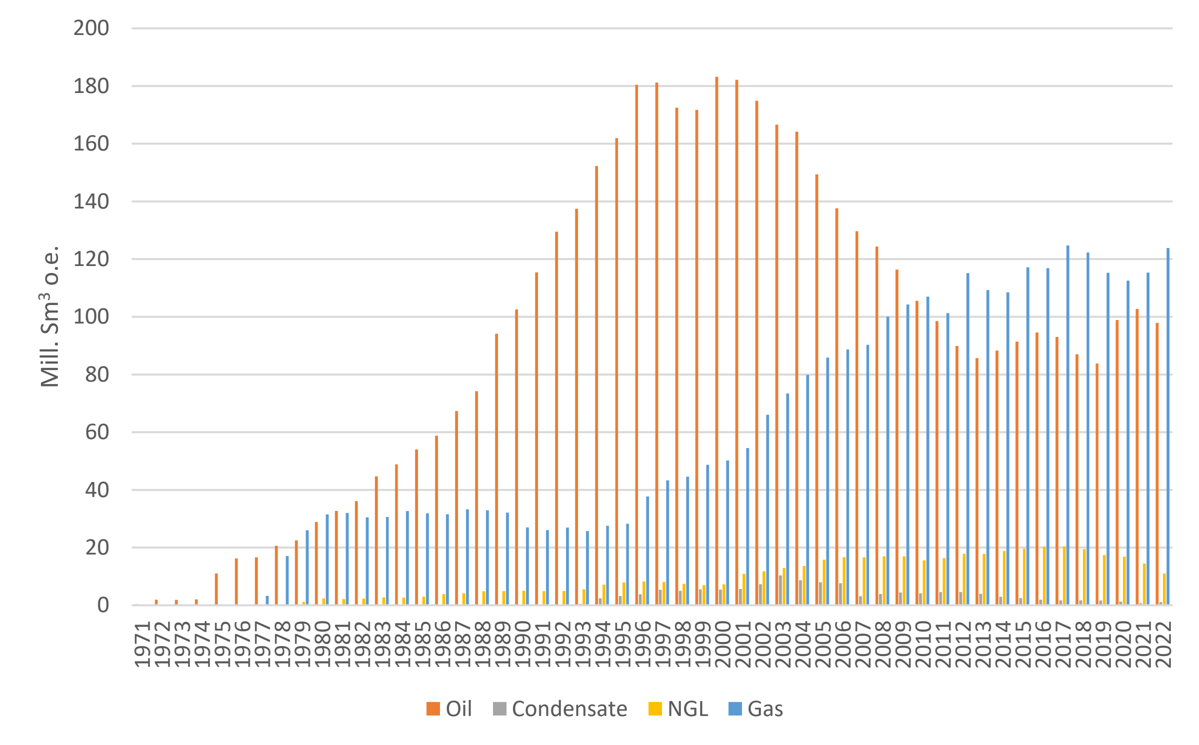


Fig. 1: Historic petroleum production on the NCS (Mill. Sm^3 o.e.)

Gas production development and European demand

In 2022, 124 billion Sm^3 of natural gas were sold and supplied from the NCS. This is an 8% increase from 2021. Demand for natural gas in Europe from the NCS has been high due to the reduced supply of Russian pipeline gas and the desire to become independent of Russian energy. Norway is now Europe´s largest single supplier of gas.

According to the IEA, OECD European gas demand dropped by 13% (over 70 bcm) in 2022. Extremely high prices coupled with subsequently lower demand in the energy and industry sectors, temporary crisis measures, and mild winter temperatures contributed to the decrease. The IEA anticipates a further drop in demand of approximately 5% in 2023, but this development is uncertain.

Exploration activity, APA 2022, APA 2023

In 2022, 34 exploration wells were started (29 wildcat wells and five appraisal wells), as illustrated in Fig. 2. A total of 12 oil and gas discoveries were made, yielding a gross resource growth of 52 million Sm^3 o.e. Approximately 35 exploration wells are expected to be drilled in 2023.

In the Awards in Pre-defined Areas (APA) for 2022, 25 companies were awarded shares in 47 new production licenses. These were broken down into 29 blocks in the North Sea, 16 blocks in the Norwegian Sea and two blocks in the Barents Sea.

In May, the Ministry of Petroleum and Energy announced APA 2023. The APA areas were extended since APA 2022 with 78 blocks in the Barents Sea and 14 blocks in the North Sea.

As a result of the budgetary agreement between the Socialist Left Party (SV) and the Norwegian government, there will not be a 26th. Licensing Round in this Parliamentary term.

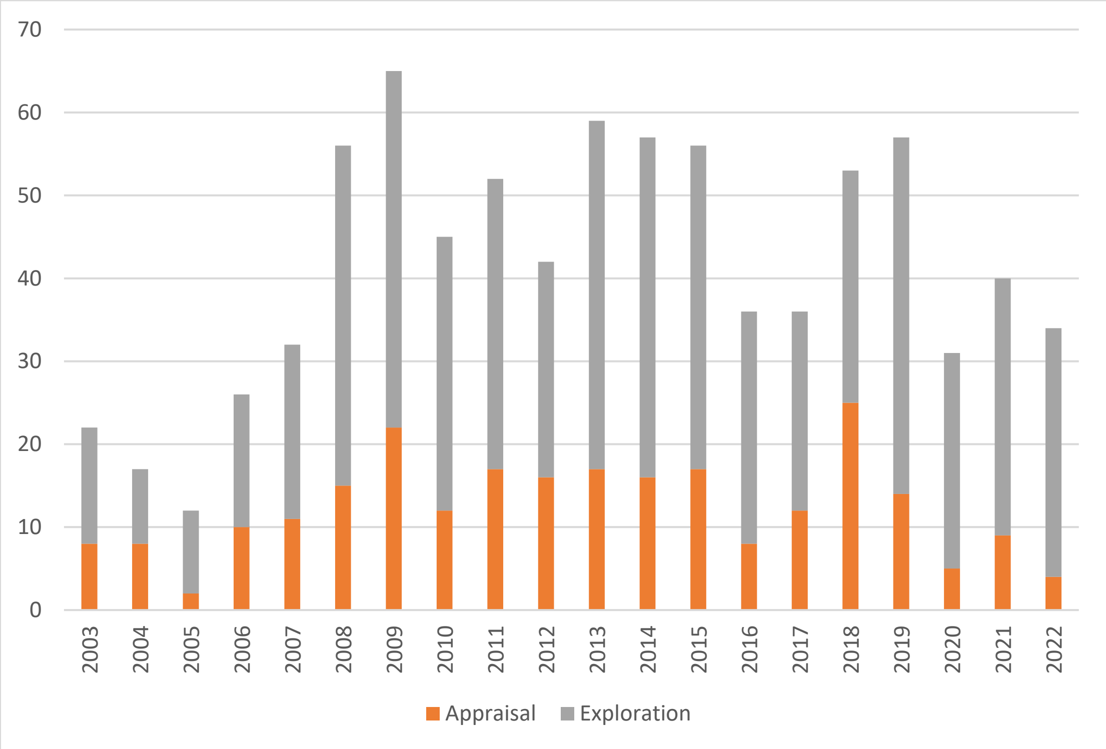


Fig. 2: Exploration wells started on the NCS (Source: NPD)

Investments

Offshore Norge presented its investment analysis for the NCS in December 2022. The analysis includes estimates for investment levels on the NCS over the next five years. In 2023, investments are expected to stand at 187.1 billion kroner. This is an increase of approximately 6% compared to investment levels for 2022 and calculated at current rates.

The increase is seen in relation to several new projects starting up over the coming years, with a large proportion of the investments set to take place between 2023 and 2026. The estimated investment level in the coming years is higher than that indicated a year ago. Tight national and international markets, along with continued disruptions to international value chains amplified by the war in Ukraine, point to pressure in numerous sectors. A weakened Norwegian krone also means an increase for investments made in foreign currencies.

4. Discharges to sea

Discharges to sea consist primarily of discharges associated with well drilling and produced water. Produced water is water which follows the oil from the reservoirs. Drilling discharges are mainly comprised of rock particles (drill cuttings) from the borehole and drilling fluid. Discharges are only permitted from wells drilled using water-based fluid. Oil-based fluids can be permitted by NEA if contamination from oil-based fluids stands at less than ten grams of base oil per kilogram of cuttings.

Fig. 3 illustrates that drilling activity in 2022 was significantly lower than in the peak year of 2019, with a total of 182 wells drilled. Thirty-four of these were exploration wells. Discharges from produced water were at their highest in 2007, totaling approximately 160 million Sm^3. In 2022 total discharges stood at 116 million Sm^3.

4.1 Discharges from drilling

Drilling activity showed a slight decrease in 2022. The number of new production wells drilled in 2022 was 148. The number of exploration wells stood at 34, compared to 40 in 2021.

The fluid used for drilling wells has multiple functions. It transports the drill cuttings up to the platform and is also used to lubricate and cool the drill bit. In addition, it prevents the borehole from collapsing. Last, but not least, it keeps the well pressure stable, preventing uncontrolled oil and gas blowouts.

The industry primarily uses two types of drilling fluid: oil-based and water-based. Synthetic drilling fluids were also used previously, and these were either ether-based, ester-based or olefin-based. In recent years, synthetic-based fluids are rarely used.

The discharge of oil-based or synthetic-based drilling fluids, or cuttings contaminated with these, is prohibited if the oil concentration exceeds one per cent by weight. One per cent by weight equates to 10 grams of oil per kilogram of cuttings. Drill cuttings discharge contaminated with oil-based or synthetic-based drilling fluids containing less than one per cent by weight of oil is only permitted if authorized by the NEA. Used oil-based drilling fluids and contaminated cuttings are either transported onshore as hazardous waste for carefully controlled treatment or injected into specially designated wells beneath the seabed.

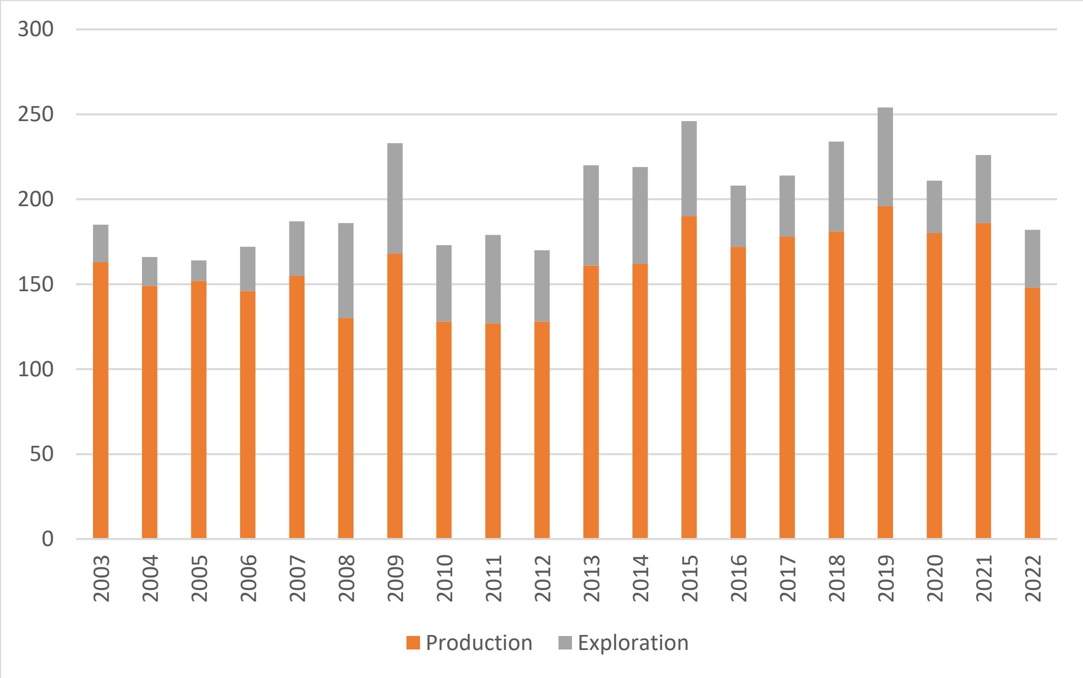


Fig. 3: Number of wells drilled on the NCS (Source: Norwegian Petroleum Directorate)

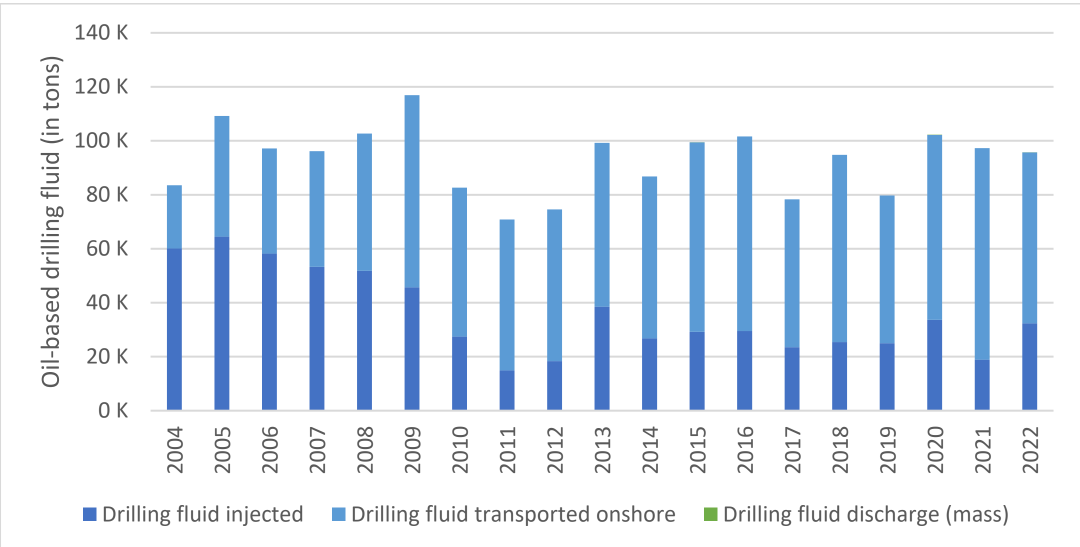


Fig. 4: Disposal of oil-based drilling fluid

Field operators use water-based drilling fluids as far as possible, also to reduce the quantities of waste requiring treatment. Oil-based fluids are more effective from a technical drilling perspective than water-based fluids, and more complex wells will have a greater need to use oil-based fluids.

The use of oil-based drilling fluids dropped by almost 5% in 2022 compared to 2021, as illustrated in Fig. 4. The quantity of oil-based cuttings contaminated by drilling fluids and injected sub-surface shows a downward trend, with the ratio falling from 9% to 7%.

The quantities of drill cuttings presented in Fig. 5 are based on calculations of the rock which has been drilled out. However, the quantities of drill cuttings registered as hazardous waste transported onshore (see Chapter 8) are considerably larger. Cuttings from many fields are slurrified by adding water so that they can be handled more easily from platform to ship to shore. This nonconformity is therefore largely due to water being added to the drill cuttings before they are received onshore.

The quantity of oil-contaminated drill cuttings sent onshore as waste has decreased from 2020 to 2022. This quantity stood at just below 88,000 tons in 2020, compared to 70,000 tons in 2022. The water and drill cuttings are separated onshore. Whilst the water is treated and discharged to sea, the drill cuttings are further treated in compliance with current regulations.

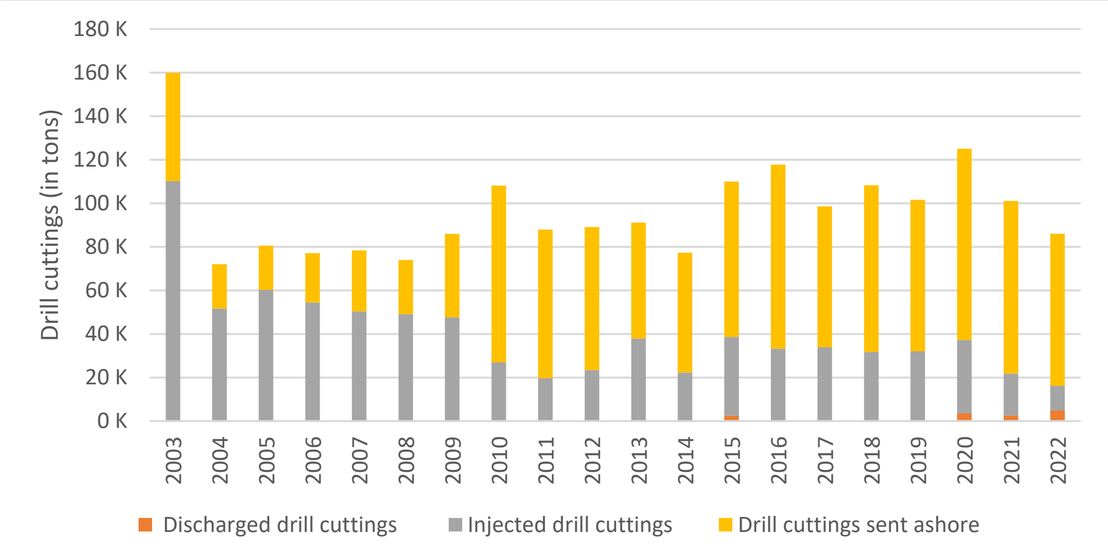


Fig. 5: Disposal of drill cuttings contaminated with oil-based drilling fluids

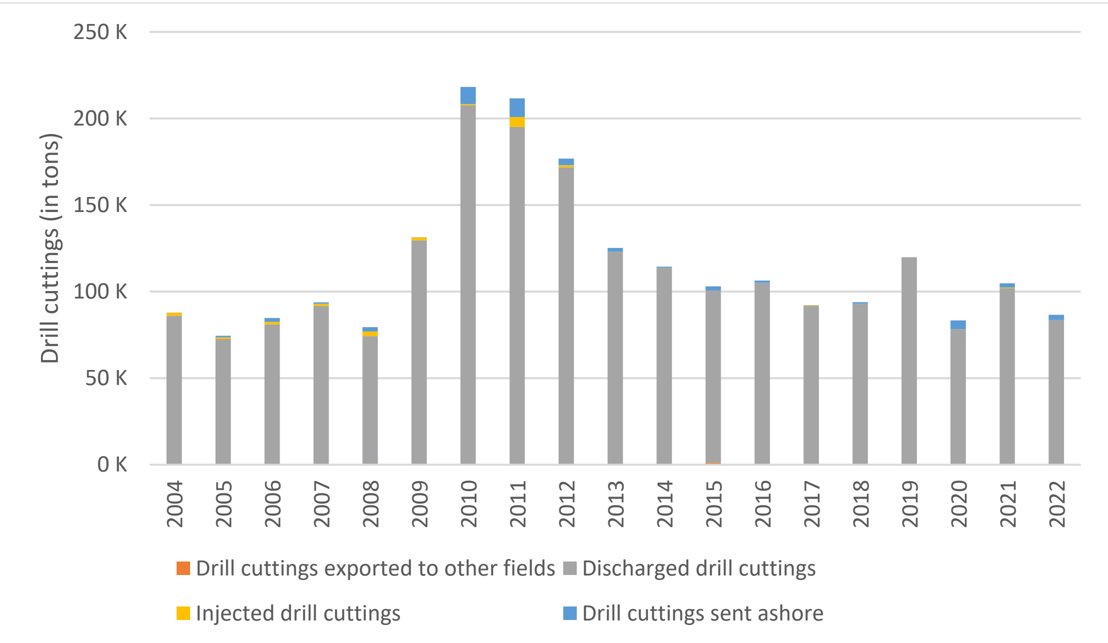


Fig. 6: Disposal of drill cuttings from wells drilled using water-based drilling fluids

Discharges from drill cuttings drilled with water-based fluids stood at approximately 85,000 tons in 2022, representing a decrease of 17% from the previous year, as illustrated in Fig. 6.

Water-based fluids contain largely natural components such as clay or salts. These substances are classified as green in the NEA´s classification system. In accordance with OSPAR, these substances pose little or no risk to the marine environment when discharged.

The potential impact of these discharges is followed closely by extensive environmental monitoring (see Chapter 5.3).

Discharges from oily water

Oily water discharges from petroleum operations on the NCS derive from three main sources, with produced water accounting for the largest contribution.

1. <u>Produced water</u>
   This is water which comes up from the reservoir along with oil and gas. Produced water is complex and can contain several thousand individual components. Routine analyses are therefore carried out. When produced water is injected to enhance production, the water will mix with formation water. The produced water will also contain various chemical additives in order, for example, to inhibit bacterial growth, corrosion, and emulsion. The water is treated on the offshore installations using various technologies prior to being discharged to sea. These technologies help to keep the oil content as low as possible. The regulatory threshold for the oil concentration in produced water discharged to sea is 30 milligrams per litre (mg/l).

2. <u>Displacement water</u>
   Seawater is used as ballast in the storage cells on some platforms. If oil is to be stored in these cells, the water must be treated prior to discharge. The seawater has a limited contact area with the crude, so the quantity of dispersed oil is normally small. The discharged volume depends on the level of oil production.

3. <u>Drainage water</u>
   Water falling as rain and water used to hose down the decks may contain chemical residues and oil. Drain water discharges make up only a small proportion of the total volume of water discharged.

   Particles and sand contaminated with oil are collected in separators and must be hosed periodically, known as “jetting”, which also may contribute to discharges to sea. Particles may still be contaminated with oil following treatment in accordance with regulatory requirements, but the volume of oily water discharged to sea is marginal.

   Oily water can also occur from hosing down processing equipment, from an incident, or from droplets forming when burning oil for well-testing purposes or when carrying out well maintenance work.

Produced water discharges

Fig. 7 shows the historic development of produced water volumes discharged to sea and volumes reinjected into the bedrock. For many years, produced water discharges from the NCS were predicted to increase and were expected to exceed 200 million Sm^3 from 2012 to 2014. However, discharges peaked at 160 million Sm^3 in 2007 and declined substantially in the years that followed. From 2012 to 2015, annual discharges rose to almost 150 million Sm^3. Since 2015 they have dipped again, and in 2022, they stood at 116,127 million Sm^3, which is a decrease from 127 million Sm^3 in 2021. The quantity of dispersed oil to sea stood at 1,490 tons, distributed across all types of discharge. The greatest discharges are found on mature fields with large volumes of produced water, where produced water accounts for 97% of the oil discharged to sea.

On certain fields where conditions allow, all or parts of the produced water is injected back into the bedrock. Water injection increased substantially from 2002 and has been at around 20% in recent years. In 2022, approximately 23% of the water, or roughly 43 million Sm^3 was injected, which is approximately the same as in the previous year.

On new fields, produced water consists solely of water already present in the reservoirs. Water injection, however, leads to an increase in produced water volumes as the field matures. The water is injected to maintain the reservoir pressure and to improve the recovery factor from the reservoir. This is primarily treated seawater. The recovery factor from fields on the NCS is generally significantly higher than in the rest of the world. However, produced water discharges are comparable to international figures.

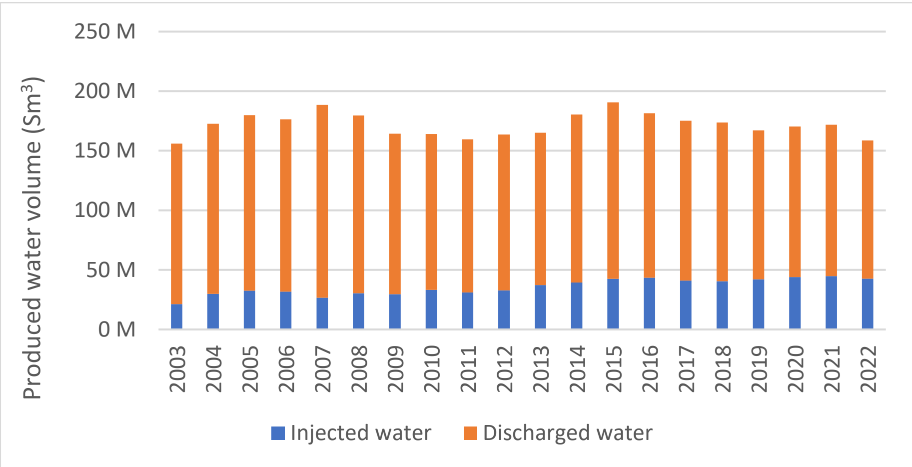


Fig.7: Produced water volumes discharged to sea and injected into bedrock

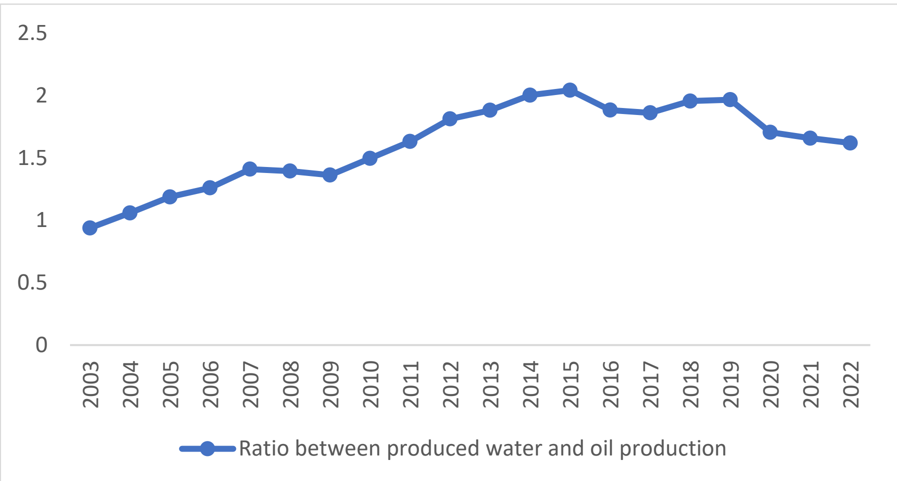


Fig. 8: Ratio between produced water and oil

The ratio between the volumes of produced water and produced oil on the NCS, as illustrated in Fig. 8, has generally shown a tendency to rise, although it dipped in 2016. This is probably due to production starting up on several new fields. The start-up of the Johan Sverdrup field contributed to increased oil production whilst water production did not increase at the same rate.

The results from risk-based modelling and from environmental monitoring have not yet indicated any significant environmental impact caused by discharging produced water (see Chapter 5.3). An article by Beyer et al (2020) indicates mild acute environmental impact associated with produced water in the water column and is limited to the vicinity of the discharge.

Discharges of other water types

Fig. 9 illustrates that displacement water dominates discharges of other water types. Discharge volumes decreased steadily up to 2009-2011. Post-2011, volumes hovered at approximately 30 million Sm^3. In 2022, displacement water discharges totalled approximately 32 million Sm^3.

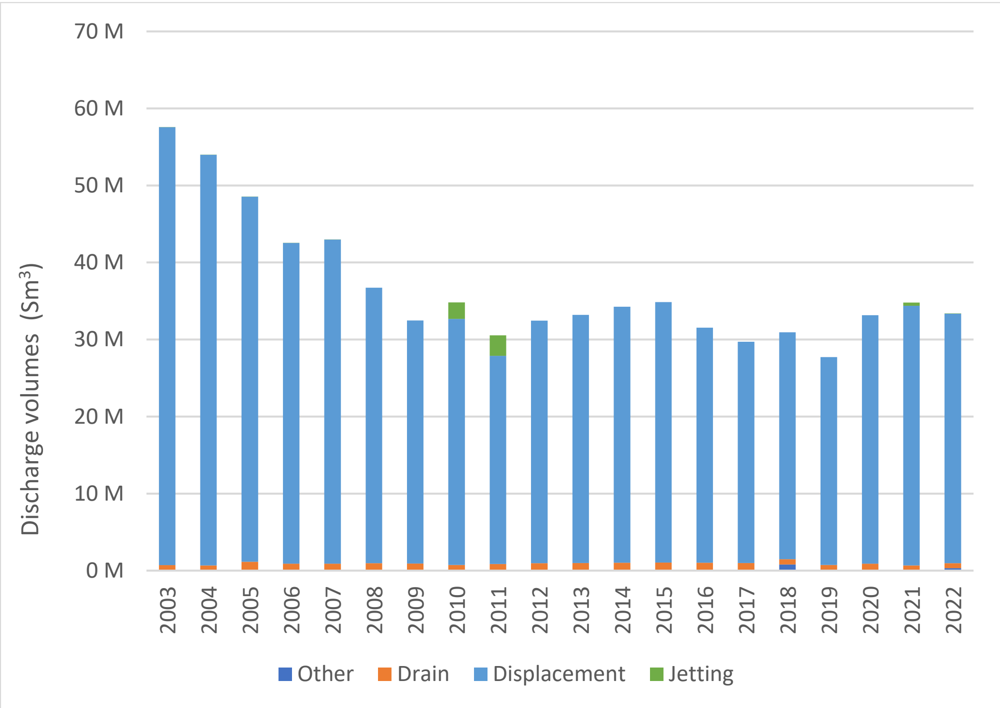


Fig. 9: Discharges to sea of other water types

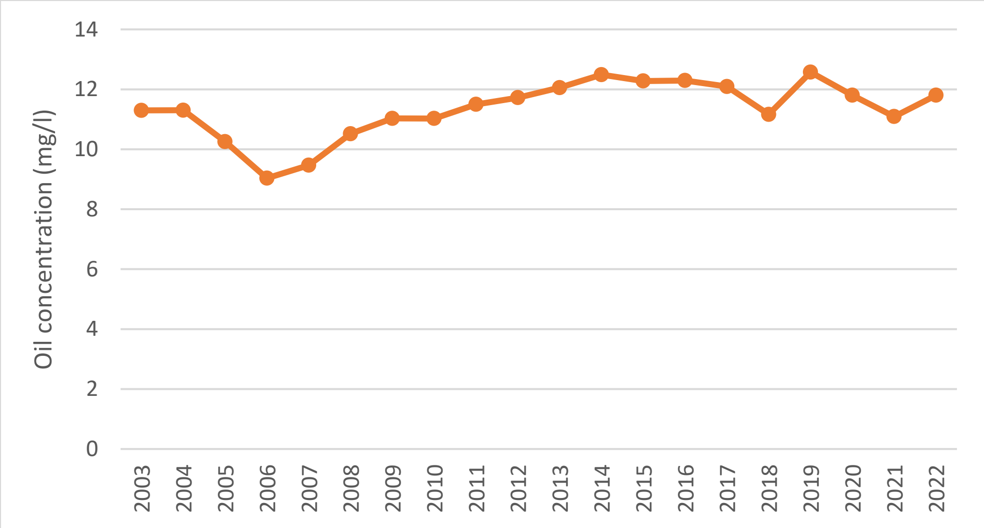


Fig. 10:
Oil Concentration in produced water discharged to sea

Discharge of oil with water

Oily water is treated prior to being discharged to sea. Different types of technology are used on different fields. The average oil content in produced water for the entire NCS in 2022 was 11.8 mg/l, with the government threshold standing at 30 mg/l. The water volume decreased by 11 million m^3, whilst the concentration of dispersed oil rose marginally compared to 11.1 mg/l in 2021, as illustrated in Fig. 10. If we look at total water discharges, the average oil content stood at 9.5 mg/l in 2022.

The amount of oil discharged to the sea with produced water went down from 1,409 tons in 2021 to 1,370 tons in 2022, as illustrated in Fig. 11. A total of 1,445 tons of oil were discharged with water from drainage, displacement, produced water and jetting. In 2021, this figure stood at 1,531 tons.

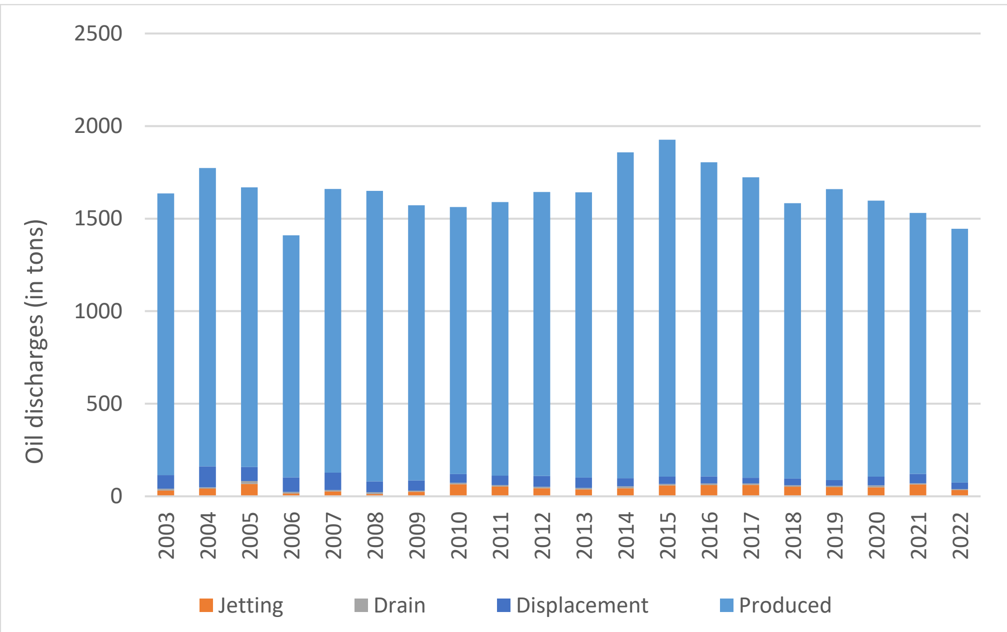


Fig. 11: Oil discharges accompanying water discharges from the NCS

Discharge of other substances accompanying produced water

Produced water has been in contact with the bedrock over a long period of time and therefore contains a number of naturally occurring substances. In addition to oil, a typical composition will include mono- and polycyclic aromatic hydrocarbons (PAH), alkylphenols, heavy metals, naturally radioactive materials, organic substances, organic acids, inorganic salts, mineral particles, sulphur, and sulphides. The composition will vary from field to field, depending on the properties of the bedrock. Generally, the content of environmentally harmful substances is low and similar to the normal base level for these substances in seawater.

An article which describes the potential modelled effects of PAH on cod roe and spawn in the North Sea was published by Nepstad and his colleagues in the 2021 Marine Pollution Bulletin.

"North Sea produced water PAH exposure and uptake in early life stages of Atlantic Cod."

The article concludes, inter alia, that "In all simulations we find the predicted total internal PAH concentration (26 components) to be below 1.2 nmol/g, a factor of 1,000 less than concentrations commonly associated with acute narcotic effects."

Experiments and tests were also carried out as part of the water column monitoring on the Ekofisk field in 2021, with the results thereof being presented in the autumn of 2022 during the Forum for Offshore Environmental Monitoring (see Chapter 5.5).

4.2 Chemical discharges

Chemicals are assessed according to their environmental properties, including persistence, potential for bioaccumulation and toxicity (PBT). The Norwegian government has also specified criteria in the Activities regulations and guidelines for reporting from offshore petroleum operations.

Chemical additives which are controlled by discharge permit requirements are divided into four categories in accordance with the classification system in the Activities regulations:

Green Zero or minimal environmental impact. May be discharged without special conditions.

Yellow Normally acceptable environmental impact. Discharge permit is required, but usually approved.

Red These chemicals must be prioritized for substitution with chemicals in green or yellow categories.

Black Discharge is not permitted. Exceptions may be made under extenuating circumstances, such as if crucial for safety reasons.

A more detailed description of the classification system may be found in the NEA´s M-107 Guidelines on reporting from offshore petroleum operations.

Discharges of chemical additives from Norwegian petroleum operations in 2022 totaled approximately 172,000 tons. This is a decrease of around 9% since 2021. Green chemicals accounted for 90% of the total, whilst red and black chemicals accounted for approximately 0.2% of the total, as illustrated in Fig. 12.

Replacing chemicals with less environmentally harmful alternatives is an important part of the environmental initiative to reduce the potentially harmful effects from offshore discharges. Operators carry out regular assessments on the chemicals used to determine whether they can be substituted. The extensive substitution of chemicals has reduced the release of the most environmentally harmful chemicals to a fraction of its level just ten years ago.

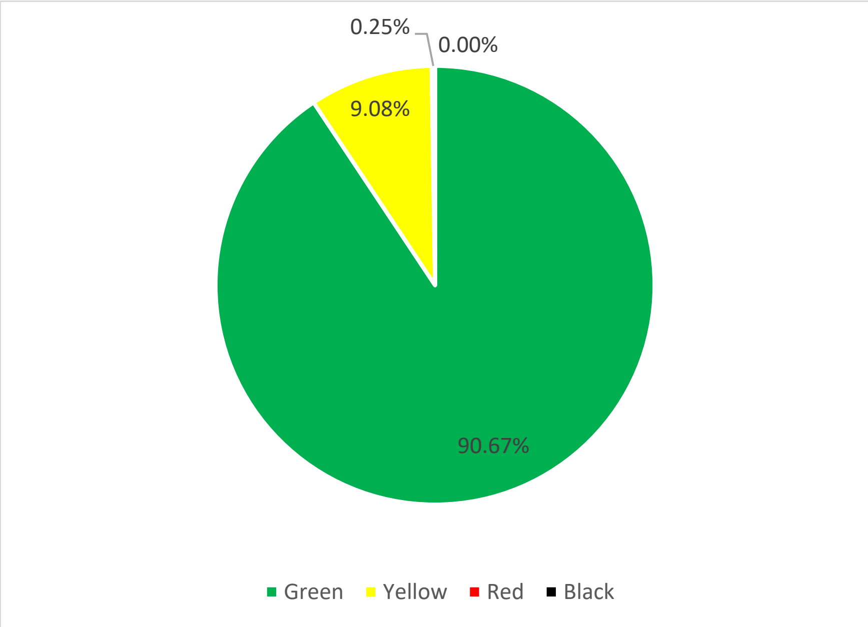


Fig. 12: Breakdown of discharges of chemical additives from the NCS by the NEA´s colour categories

Between 2011 and 2014 there was a substantial increase in the reported discharges of black chemicals. This is primarily because firefighting foam discharges were not previously reported, as fire foam was classified as a contingency chemical. Alternatives with less environmentally harmful properties are now available, meaning that firefighting foam falls into the category of chemicals for substitution. The new alternatives are now implemented on all NCS fields.

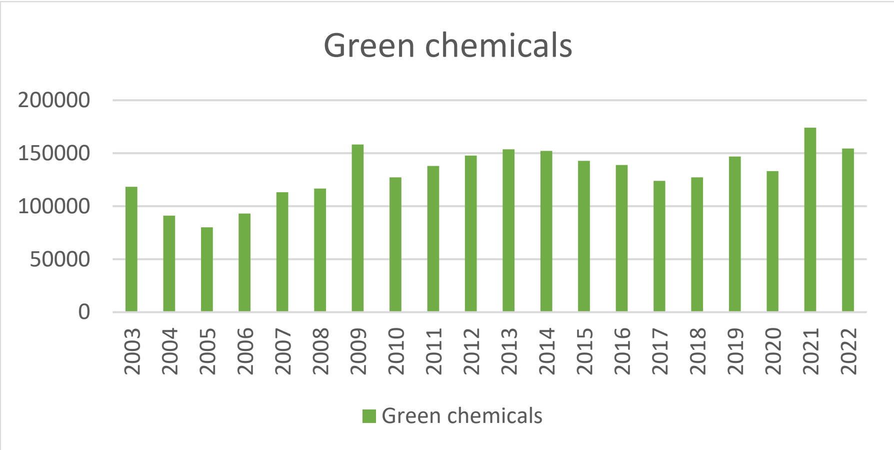
The increase observed in 2020 is partly because lubricants leaking from submerged seawater pumps had to be reported as black category discharges. Discharges from black category substances are expected to be reduced further in the coming years, due to the ongoing substitution work. There are now alternatives available to the lubricants used in submerged water pumps.

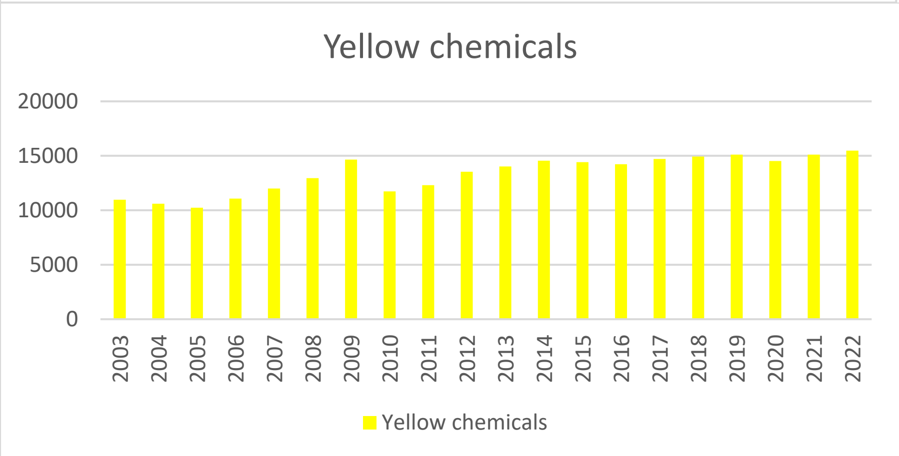
Black chemical discharges stood at 3.7 tons in 2022, compared to 5.5 tons in 2021, as illustrated in Fig. 13. Several of the chemicals used in the production of freshwater offshore lack Harmonized Offshore Chemical Notification Format (HOCNF) and are therefore categorized as black.

Fig. 13 shows that red category chemicals experienced a steady increase in reported discharges from 2013, when they were down to approximately 8 tons. In 2022, 419 tons of red chemicals were discharged, down from 450 tons in 2021.

The reason for the apparent increase in recent years is the change in reporting requirements. This also applies to the antifouling agent sodium hypochlorite, used in the treatment of drinking water and in indoor swimming pools onshore, which has been reclassified from yellow to red.

2020 also saw the introduction of a new reporting requirement for chemicals used in the production of freshwater. Several fields use their own hypochlorite, which must now be reported and has been classified as red.





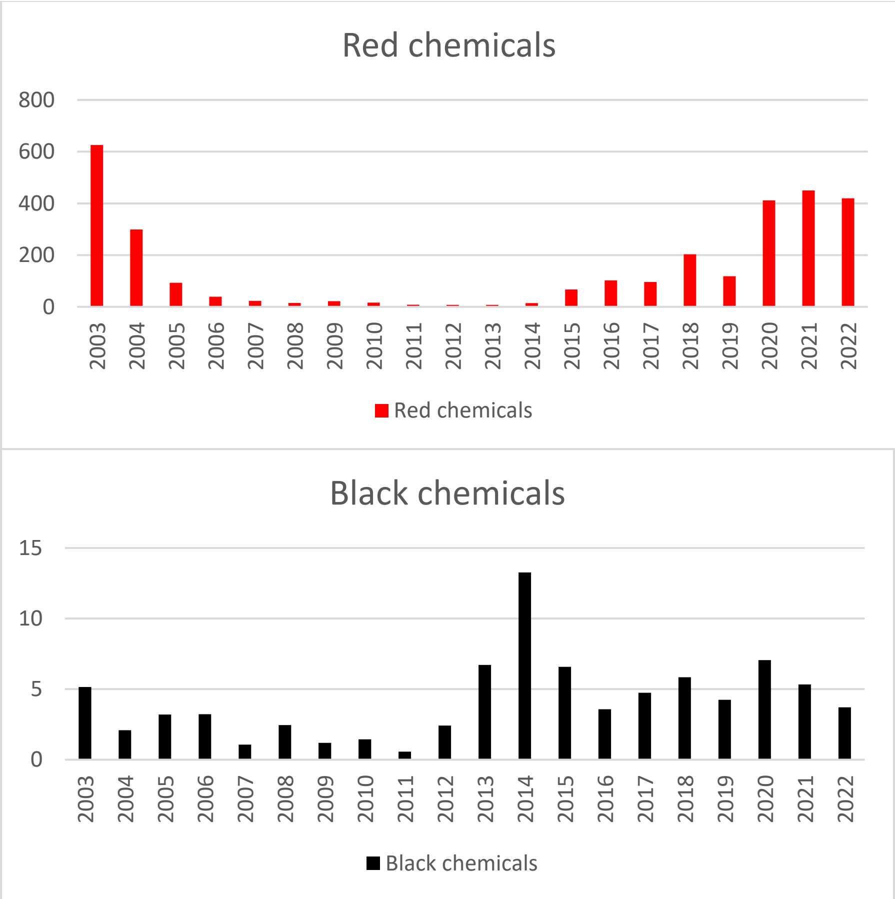


Fig 13: Discharges of chemical additives from the NCS by the NEA´s categories

4.3 Zero emissions target initiative

The zero-emissions target initiative started as a collaboration between the industry and the Norwegian government in the Zero Emissions Project in 1998 and was further developed in 2002 and 2003. The term "zero emissions" has been the subject of debate and interpretation. The Zero Emissions Group – an advisory collaborative body consisting of representatives from the NEA, (formerly the Norwegian Pollution Control Authority), the Norwegian Petroleum Directorate (NPD) and the Norwegian Oil Industry Association (OLF) – clarified in 2003 that a literal interpretation of the zero emissions target for all types of emissions is neither environmentally advisable nor achievable. In many cases, the term "minimization" may also suffice.

The zero-emissions target initiative is anchored in a Risk Based Approach (RBA) from OSPAR, whereby risk assessments are used to implement measures where a) it is most environmentally advantageous to do so and b) a sensible cost/benefit balance can be achieved. The zero emissions initiative has led to a significant reduction in oil and chemical discharges to sea. Oil discharges to sea are reduced by reinjection on many fields and significant investments have been made in water treatment prior to discharge. The most environmentally hazardous chemical additives were reduced by over 99%, - a target which was achieved prior to 2010. Operators continue, however, to work on assessing and phasing out environmentally hazardous chemicals. The discharge of those chemicals categorized as red and black usually accounts for less than 1% of discharges.

The potential environmental impact associated with produced water discharges is assessed for each individual field through analyses and modelling calculations and is referred to as the EIF (Environmental Impact Factor). The oil in produced water accounts for a very small proportion of the risk factor associated with the discharge, whilst chemical additives may play a larger role. The EIF refers to each specific discharge and the purpose is to assess which components in the produced water pose a risk, thus warranting the substitution of chemicals containing these components.

Certain chemical additives and natural components from the bedrock discharged with produced water may potentially have harmful effects on aquatic organisms. This is supported by research and EIF calculations. This applies primarily in concentrations located close to the point of discharge, typically within a hundred to a thousand metres. Chemical additives which contribute to environmental hazards are regularly assessed and substituted. Offshore Norge´s guideline 084 for EIF modelling and calculation was updated and published in the autumn of 2022.

The results obtained from water column monitoring on the NCS in 2021 indicate that significant acute biological effects from the discharges can not be proven beyond the immediate vicinity of the point of discharge. Research and modelling have also been carried out and have not indicated any significant effects from produced water discharges to date. Research was continued in 2022.

Significant investments in treatment technology and injection have been made to reduce oil discharges from produced water. The discharges from most fields are far lower than the regulatory threshold of 30 mg/l. For various reasons, however, certain fields have stability issues with their injection plants and treatment processes, and therefore have a higher level of discharges, particularly when phasing in new well streams.

The Risk Based Approach under OSPAR started with the Offshore Industry Committee (OIC) Decision in 2008. A holistic approach and a set of guidelines for the initiative were developed in 2012. The guidelines recommended that the risk should be characterized by:

- Whole Effluent Testing (WET)
- Substance-based approach applying EIF – SB HC50
- A combination of both

The RBA campaign was approved for introduction to the NCS between 2013 and 2019. Final guidelines were issued in March 2020 by the (OIC) under OSPAR, which discussed the RBA in its Intersessional Correspondence Group (ICG), concluding, inter alia, that;

- A report should be prepared summarizing the findings of RBA
- “Recommendation” 2012/5 and its proposals should potentially be revised according to RBA (OIC19/2/1 Ass.1 & OIC19/2/1 Add.2.

The International Association of Oil and Gas Producers (IOGP) published a guide for RBA in autumn 2020. It describes the RBA approach and the recommended implementation of its principles, where the results determine whether the risk level is acceptable, or whether further measures ought to be implemented.

The NEA tasked its Expert Group with providing an overview of the greater environmental impact from produced water discharges to be expected in the Barents Sea and in arctic conditions, as opposed to on the NCS, and in the Norwegian Sea and North Sea.

The Expert Group concluded towards the end of 2019 that, based on the information gathered, there was no reason to believe that there is a systematic pattern indicating that organisms and ecosystems in the Barents Sea are significantly more sensitive towards chemical pollution and ecotoxicological effects than in other parts of the NCS. This accords with findings made in the PROOFNY study during the Marine and Coastal Program from 2005 to 2015, as well as with environmental monitoring.

Chemicals which contribute towards environmental impact are subject to regular assessment and substitution.

4.4 Unintentional spills

Unintentional spills are defined as unplanned emissions/discharges, occurring suddenly and without a permit. The potential environmental impact of such releases will depend upon the properties and the volume of the substance spilled, and upon the time and place of the spill.

Unintentional spills are classified according to three main categories:

- Oil: diesel, heating, crude, spill oil and others
- Chemicals and drilling fluids
- Emissions to air

The oil and gas industry prioritizes preventive measures very highly. These are measures (barriers) which prevent unwanted incidents from occurring, thereby reducing the number of unintentional spills. All unintentional spills are reported to the NEA in the annual emission/discharge reports.

Unintentional oil spills

The total number of unintentional spills of all oil types has generally declined over the past twenty years. The marked drop in the number of spills from 2013 to 2014 is due to a clarification of the regulations, leading to less spills smaller than 50 litres, whilst the number of unintentional chemical releases in the same volume category increased correspondingly.

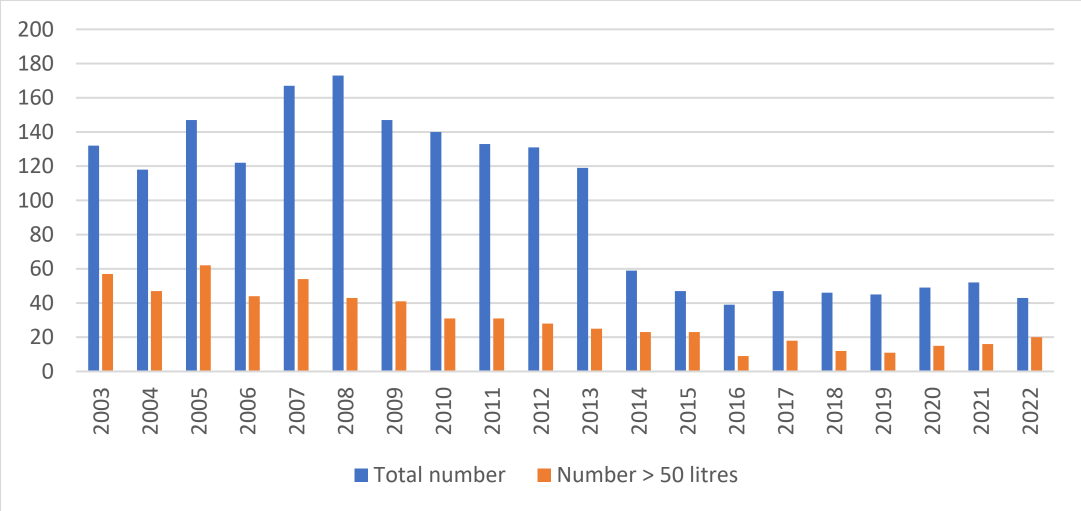


Fig. 14: Number of unintentional oil spills to sea on the NCS

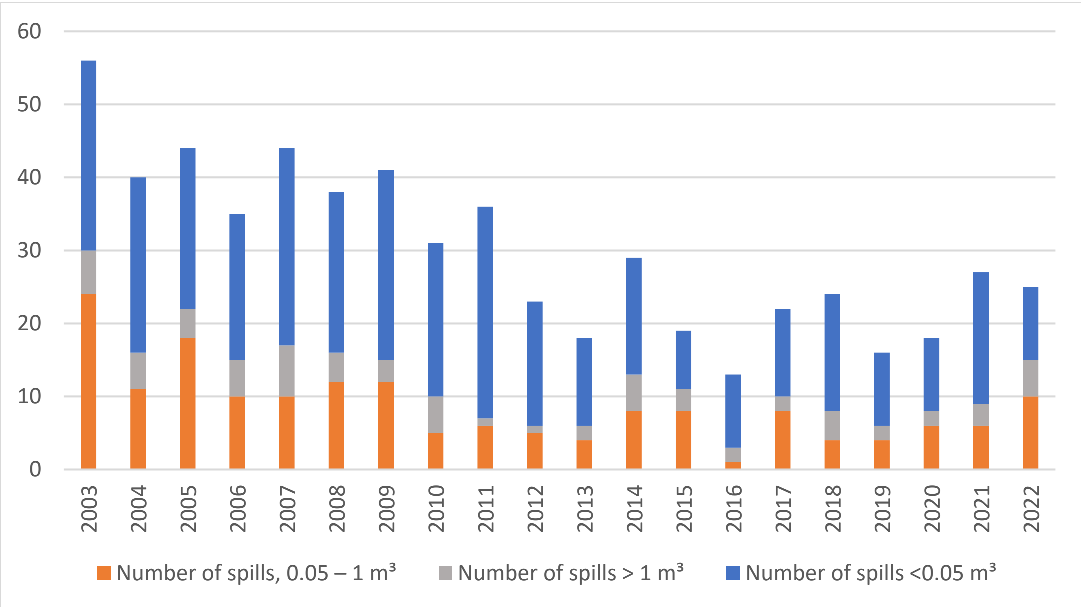


Fig. 15: Number of unintentional crude oil spills to sea on the NCS

In 2022 there were 43 incidents involving oil spills, compared to 52 in 2021, as illustrated in Fig. 14. There have been approximately 10 – 15 incidents per year in recent years involving spills of over 50 litres. In 2022 there were a total of 20 spills exceeding 50 litres of oil, 8 of which were larger than 1 m^3. The two largest isolated spills in 2022 measured 18 m^3 and 16 m^3.

There has been a marked decline in crude oil spills over the past 10 – 15 years, as illustrated in Fig. 15. In 2022 there were 25 spills in this category, 5 of which measured over 1 m^3.

The total volume of oil unintentionally spilled varies substantially from year to year, as illustrated in Fig. 16. Statistics tend to be characterized by large, isolated incidents. 2007 saw the second-largest spill on the NCS, measuring approximately 4,000 m^3, whilst total spills since then have ranged from 10 m^3 to 200 m^3. In 2022 the total volume stood at 61 m^3.

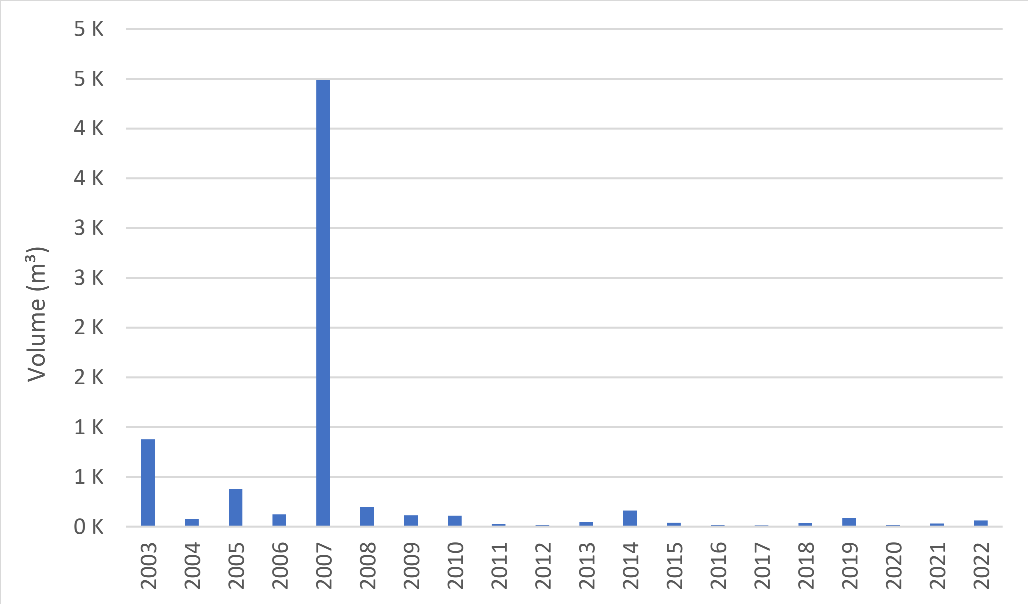


Fig. 16: Discharge volumes from unintentional oil spills on the NCS

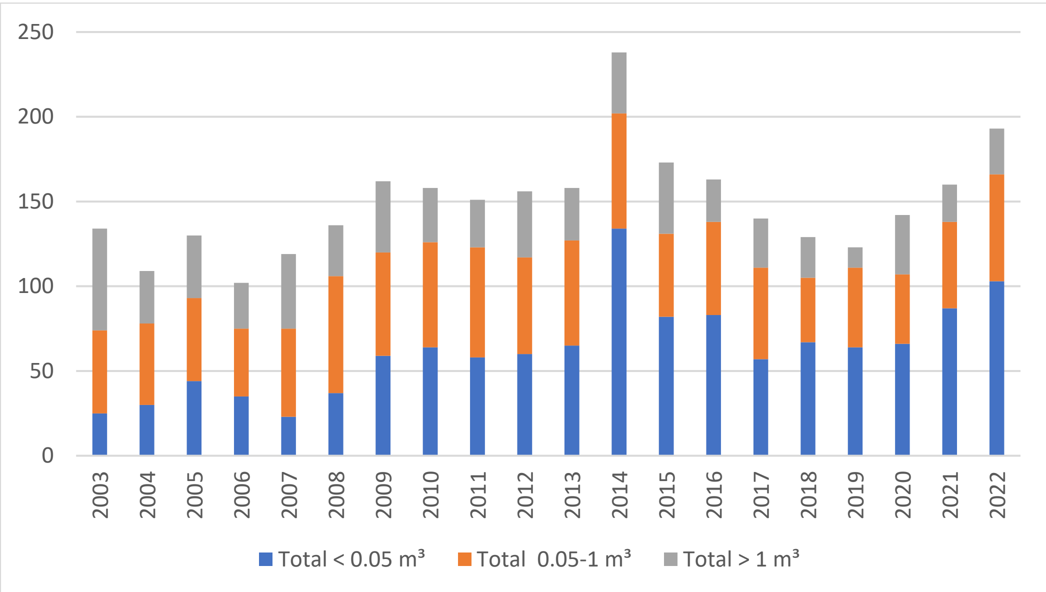


Fig. 17: Total unintentional chemical spills on the NCS distributed across three sizes of spill

Unintentional chemical spills

The number of unintentional chemical spills does not show the same downward trend as for unintentional oil spills. The marked increase in 2014 to 237 spills can be attributed to a clarification of the regulations, leading to fewer oil spills being reported and more chemical spills being reported. The number of spills in 2022 totalled 194, of which 27 were larger than 1 m^3. Their distribution is illustrated in Fig. 17.

The overall volume of unintentional chemical spills in 2022 was 388 m^3, denoting a marked increase from 2021 when they totalled 124 m^3. Fig. 18 illustrates a number of larger, isolated incidents which explain the increase in volume; one spill of 160 m^3

during the loading of drill water and two spills of over 20 m^3 from water-based drilling fluids (56 m^3 and 29 m^3). The unintentional spills were broken down as follows: 93% green chemicals, 6.6% yellow chemicals, 0.3% red chemicals and 0.2% black chemicals.

Discharged volumes were dominated from 2007 to 2010 by individual years when leaks from injection wells were detected. These wells have now been shut in.

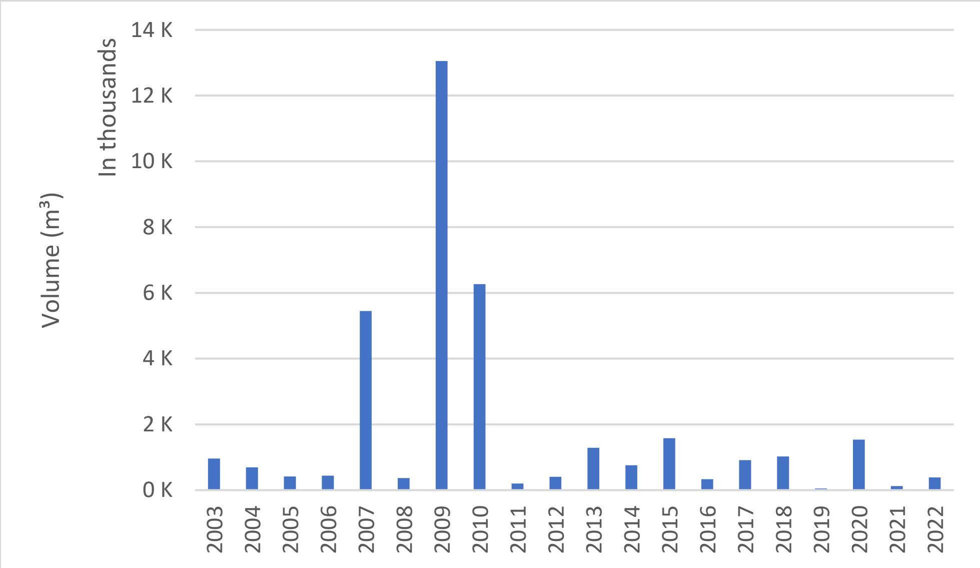


Fig. 18: Total volume of unintentional chemical spills

Subsea leak detection

A detection system is an important barrier used to detect leaks and other unintentional spills as swiftly as possible. The system is designed to provide essential information so that the relevant measures can be implemented as quickly as possible, also ensuring the notification and reporting of the spill in compliance with regulatory requirements. All installations on the NCS today have one or several leak detection technologies installed.

The number of incidents involving unintentional spills from subsea installations is low, and is highlighted annually in the Norwegian Petroleum Authority´s RNNP (Trends in Risk Level) report.

Large spills can be detected immediately by, for example, process monitoring, as well as by daily satellite monitoring and daily radar monitoring of the sea surface. The detection of smaller spills from subsea installations can, however, prove more challenging. Modern subsea installations are equipped with a local system for leakage detection, but this is not always the case for older installations built before this type of technology was available.

The NEA and the PSA (Petroleum Safety Authority) carried out a joint audit initiative in 2020/early 2021 to inspect the operators´ routines and equipment for detecting leaks of oil, gas, and chemicals from subsea installations on the NCS. Common deviations were observed amongst all operators, including routines for the detection of minor leaks and performance requirement procedures. A work group was therefore established under the directive of Offshore Norway to investigate this jointly.

The findings from these audits are largely due to insufficient risk assessments of potential spills from individual installations, as well as insufficient documentation and assessment of the systems´ capabilities. The industry is currently working to resolve these issues, and assessments are ongoing to identify the gaps and how best to close them. Technological limitations must also be considered, as most leak detection systems can only cover a limited area and cannot always detect small spills from a distance. For this reason, inspections may be the only means of detecting the smallest spills. Inspections are carried out regularly on all fields.

There are also several subsea installations on the NCS having low or negative pressure relative to the surrounding water mass. These fields are more likely to experience water leaking into the system than oil and gas discharges to sea.

5. The marine environment, offshore operations and management plans

As a coastal and marine nation, Norway aims for an integrated, ecosystem-based management of its marine resources and ecosystems. The first integrated ocean management plan for the Barents Sea and the areas outside of Lofoten came about in 2006. This plan has since been extended to include the Norwegian Sea and the North Sea and Skagerrak. The most recent plan update appeared in the Norwegian Parliament´s White Paper (2019 – 2020). The white paper brings together all management plans for the first time.

The next revision of the integrated ocean management plans will take place in 2024, and the scientific grounds for the revision were submitted to the Norwegian government on 16th. May.

In addition to the integrated ocean management plans, other overlapping processes within ocean management are also taking place, such as marine conservation and the following up of international commitments (the Kunming-Montreal Global Biodiversity Framework), as well the development of industry plans. Offshore Norge believes it is important for ocean management to continue to be integrated and sees the ocean management plan as the primary tool to ensure this.

5.1 Integrated ocean management plans for the Norwegian sea areas

The purpose of the plans is "to create value through the sustainable use of resources and ecosystem services whilst maintaining the structure, function, productivity, and diversity of the ecosystems."

The petroleum industry has always supported this approach and wishes to assist in ensuring an optimum foundation for the management plans. The integrated ocean management plan must, in our opinion, be based on the following:

- Value creation through sustainable practices as an important factor
- Equal treatment of industries in the sea areas
- Practice of the precautionary principle regarding the Act for the management of biological, geological and landscape diversity
- Involvement of interest groups

There are three main marine industries in Norway today which are assessed in the management plans, namely fishing, shipping and the petroleum industry. There are also new industries coming into play, such as offshore wind, carbon capture and storage (CCS), mineral extraction and aquaculture (outside of 12 nm).

The Norwegian Parliament´s white paper confirms the current balance between sustainable use and conservation. Environmental conditions in the Norwegian sea areas are good in many respects, but are increasingly impacted by climate change, which is having a very clear effect on the state of the ecosystems both in the North Sea and in the northern Barents Sea. The impact of discharges from the petroleum industry during normal operations is insignificant, whilst the fishing industry has the largest impact. The fish species are generally sustainably managed, meaning that sustainable use and conservation are currently in balance.

The next revision of the integrated ocean management plan is underway, and information and updates on the scientific basis can be found on the Havforum website. The scientific basis was submitted to the Minister of Climate and Environment on 16th. May 2023. The basis consists of a primary report and several supplementary reports, including:

- Particularly valuable and vulnerable areas (SVO) in Norwegian sea areas – environmental value
- Environmental values´ vulnerability in Norwegian sea areas
- Environmental status in Norwegian sea areas

The participation of interest groups is an important part of ecosystem-based management. In the upcoming update, less resources have been labelled for such participation compared to the current management plan. The petroleum industry has been a significant contributor for many years towards building expertise on environmental values and on the potentially environmentally harmful effects of activities from operations on the NCS. It is important that this expertise also forms a part of the scientific basis and is included in the ocean management plan.

Offshore Norge works actively with our members to highlight this expertise, regularly sharing information and providing feedback. In this update round, we have participated in input meetings and submitted our written input to the SVO report on environmental values, as well as responses to the consultation on factual errors/inadequacies of the scientific basis.

5.2 Particularly valuable and vulnerable areas (SVO)

Particularly valuable and vulnerable areas are identified by the integrated ocean management plan for the sea areas. As per today, 7 SVOs have been identified in the Barents Sea – Lofoten region, 12 in the Norwegian Sea and 11 in the North Sea. Within the marine areas are sub-areas which stand out as particularly valuable and vulnerable from an environmental and resource perspective. These areas have been identified by scientific assessments as being of great importance for biodiversity and biological production, and where potential harmful effects may have long-term or irreversible consequences. The areas are identified based on specific criteria, with significance for biodiversity and productivity being the most important. Criteria such as uniqueness, pristine condition, representativity, and scientific and pedagogical value are supporting criteria.

The designation of an area as a SVO does not have any direct effect in the form of restrictions on commercial activities, but indicates that these are areas in which it is important to show special caution.

As a part of the scientific basis for this white paper, all assessments across all sea areas have been merged, and all SVOs have been thoroughly reviewed in order to highlight the grounds for their value and vulnerability. In June 2021, the Institute of Marine Research (HI) presented the report “Particularly valuable and vulnerable areas in Norwegian sea areas – Environmental value”. The report delineates, describes, and states the reason for identifying areas of environmental value which meet the necessary criteria. These areas are referred to as proposed SVOs. A vulnerability assessment was published in the autumn of 2022, containing information about the environmental values´ inherent vulnerability towards various impacts in the areas. A new methodology was implemented to assess vulnerability in the report. The scientific forum believes that further work needs to be carried out on vulnerability and has therefore used the environmental values for this further work as a basis. Offshore Norge believes that vulnerability is a part of the SVO definition and must be taken into account when defining the areas.

The proposed SVO areas are a merger of several previously defined areas, an adjustment of previous areas and an introduction of new areas. The number of SVOs is fewer, but the total area is significantly larger (approximately 60% of the Norwegian economic zone). Offshore Norge believes that the size alone of the proposed areas will pose a challenge to optimal management of the entire area, since the presence of natural resources will necessarily vary from one SVO to another. A qualitative assessment of many topics/factors per area will lead to large areas being defined as valuable, which may weaken the intention of SVOs to be viewed as particularly valuable areas.

5.3 Marine conservation/international agreements associated with biodiversity

Measures for conservation, sustainable use and expertise are key components in an integrated ocean management plan. Area conservation can be achieved through marine conservation as well as other effective area-based conservation measures, as discussed in the Storting White Paper 29 (2020 – 2021), Comprehensive National Plan for the Conservation of Important Areas for Marine Nature. Marine conservation areas may be established pursuant to the Nature Diversity Act. This law has a limited reach on the NCS and the regulations for defining marine conservation areas do not apply outside of 12 nm. Area-based measures can be implemented in accordance with sector legislation, and this has been carried out, for example, within fishery management plans, where several coral reef areas are protected against any harmful impact from fishing activities.

Norway has also signed a number of international conventions and agreements on nature diversity and has participated actively in implementing them. The United Nations Convention on Biological Diversity (CBD), informally known as the Biodiversity Convention, was passed in 1992, and in December 2022 a new nature agreement, named the “Kunming-Montreal Global Biodiversity Framework”, was passed in Montreal.

The Norwegian government has started follow-up work of the new global framework, and a part of this work will be to put in place a new marine environment law allowing areas outside of 12 nm also to be protected.

5.4 Environmental risk and the precautionary principle

Knowledge of vulnerable environmental resources which can be impacted by the petroleum industry´s operations is important, and large-scale resources are invested in mapping, environmental monitoring, impact studies and risk analyses in all phases of petroleum-based operations.

Knowledge of the factual vulnerability of the environmental values is important in order to make informed decisions on any operational limitations placed on industrial activities. Both the government and the responsible body may be better equipped to avoid costly activity limitations during those periods when the vulnerable resources are not present and/or when operations do not impact the resource in question. Offshore Norge has previously commented that the vulnerability assessments made in the scientific basis for the integrated ocean management plans have not been sufficiently precise. Before making any large-scale changes and ensuing limitations on the existing SVOs, there must be complete clarity on what the valuable component of the ecosystem is actually vulnerable towards.

The Nature Diversity Act and supporting documents (including Ot.prp. No. 52, 2008 – 2009) makes it clear that the precautionary principle should only be applied if there is a risk of “serious or irreversible” damage to biological, geological or landscape diversity. It is clear from the Nature Diversity Act and from supporting material that the precautionary principle should be made at a decision-making level. It should not be applied “for safety´s sake”, nor in cases of general or hypothetical uncertainty. The principle ensures a risk-based decision based on professional input, data, and science. It is not advisable for the precautionary principle to be drawn into the scientific decision-making criteria, nor for it to be presented to the decision-making body as an increased potential for damage, as a widening of potential outcomes or as an increased uncertainty. The role of science and its institutions is to present the best factual understanding and the most accurate estimates, highlighting the actual uncertainty range as well as the uncertainty indicated by the material.

The precautionary principle does not imply zero risk. In administrative areas where the principle has been well incorporated into decision-making processes, the decisions made are also based on a risk acceptance, and the precautionary principle is seen relative to cost/benefit assessments.

Historical data from the NCS indicates that over the course of fifty years of oil and gas operations, no unintentional spills have caused a significant environmental impact. This includes offshore operations, associated transport, and associated onshore facilities. The industry does not, however, claim that a serious incident cannot occur from its operations. The petroleum industry has therefore prioritized further learning about actual potentials for damage, as well as developing methods to convey this knowledge, to give a complete picture of possible outcomes and uncertainties.

Expertise is essential regarding when environmental resources are at their most vulnerable, when they are present and which activities pose the greatest environmental risk. Examples of this work include the mapping and monitoring of seabirds, (e.g. SEAPOP and SEATRACK), research on the effects upon fish and other resources in the water masses (e.g. PROOFNY and SYMBIOSES), and the research and development of models to predict the presence of seabirds and sea mammals (e.g. MARAMBS).

5.5 Environmental monitoring

The industry has invested significant resources to understand which discharges could cause an impact, so that the most effective measures can be implemented. This commitment includes environmental mapping and monitoring to assess conditions, continuously improved methods of monitoring, and research. It involves preventive measures as well as measures designed to reduce consequences, such as the substitution of chemicals (see chapter 4.4) and oil spill preparedness.

An important element of this work is the comprehensive annual environmental monitoring on the NCS. The aim is to document the condition of the environment and its development as a result of both human impacts and naturally occurring variations. Substantial research work is also being carried out by individual companies. This includes the development of monitoring methods and an increased understanding of the impact of petroleum industry discharges on the marine environment.

The Norwegian Pollution Control Authority (SFT, now the Environment Agency) already demanded in 1973 that operators prepare annual environmental reports, and environmental monitoring on the Norwegian continental shelf has therefore been ongoing for almost 50 years. SFT's first guideline for environmental monitoring came into effect in 1990. Today, monitoring is carried out in accordance with the Environment Agency's guide M-300 (M-408 English version). The extent of monitoring should be related to offshore petroleum activities in the respective regions, and the monitoring program is planned by the operators. Environmental monitoring is conducted by independent consultants according to guidelines and requirements from environmental authorities. The scope, methods used, and results are reviewed and quality-assured by an expert group on behalf of the Environment Agency.

Monitoring includes investigations of the water column, seabed sediments and benthic animals. Visual inspection of the seabed is also carried out in areas containing particularly vulnerable species such as corals and sea sponges. Data collected from the environmental monitoring, which is not protected by confidentiality or competitive significance, is shared and uploaded to Mareano. Mareano is an interdisciplinary program for the mapping of the seabed in Norwegian marine areas, and is led by the NEA, whilst the Institute of Marine Research, the Geological Survey of Norway (NGU) and the Norwegian Mapping Authority are responsible for daily scientific operations.

Water column monitoring

Water column monitoring consists of field examinations and methodology development. The examinations are carried out every third year and must, as a minimum, contain hydrographic measurements, chemical measurements, and examinations of caged organisms (primarily mussels), as well as freely living organisms (primarily fish). The time period between any two field examinations is used for the further development and qualifying of methodologies for future water column monitoring.

In 2021 a comprehensive program was carried out in the Ekofisk region. This work is referenced in more detail in Offshore Norge´s 2022 Climate and Environmental Report.

Several attempts were carried out in 2021 and 2022 to develop methodologies for future field surveys, but no major surveys were carried out in the field. Several of the findings were presented during the Forum for Offshore Environmental Monitoring in the autumn of 2022.

Seabed surveys

Monitoring of the benthic habitats consists of taking seabed samples, usually with the aid of a grab, and analyzing the physical, chemical and biological condition of the sediment. Certain stations have been surveyed regularly for over thirty years and these data are therefore very valuable to both researchers and to the government in assessing naturally occurring and anthropogenic changes to the environment over time. There is a keen interest in applying this material to the government´s ocean management plan.

A regional approach to the monitoring of each region once every three years was introduced in 1996. The NCS is divided into a total of eleven geographical regions for the purpose of seabed monitoring. In addition, all fields must complete a basic survey prior to start-up to document the natural environmental condition of the field.

The environmental monitoring program is extremely comprehensive, covering approximately 1,000 stations on the NCS. Field work and surveying are usually carried out in May and June. All the data are stored in the MOD database, which can be accessed provided one is registered on DNV´s Veracity Data Platform.

Once the production phase has ceased, two further monitoring surveys are carried out at three-year intervals to observe the development of the field once all discharges have come to an end. The NEA put out a proposal for consultation on 18th April 2023, proposing revised guidelines for petroleum monitoring and more specifically, a new chapter on surveys associated with decommissioning.

Several major research programs have been carried out by independent researchers to analyse the potential impact of oil and gas industry discharges to sea. These include The Research Council of Norway´s “Marinforsk” program, launched in 2015, and the former Oceans and Coastal Areas (PROOF/PROOFNY, from 2004 to 2015). The results of the environmental monitoring have also been used in several scientific papers.

In summary, PROOFNY concludes that the potential for harmful environmental impact from discharges to sea is generally moderate. The consequences of drilling operation discharges are only detectable in the immediate vicinity of the drilling location, and usually limited to 150 – 200 meters from the discharge source. The impact is often related to particle discharges and to the filter-eating bottom fauna such as brittle-stars.

The Offshore Environmental Monitoring Forum takes place every autumn, where the annual results from the monitoring programs are presented. Torgeir Bakke from NIVA gave a presentation in autumn 2021 on seabed monitoring on the NCS seen as a timeline from the 1970s until the present.

In autumn 2022, Jonny Beyer and Torgeir Bakke from NIVA initiated work on a new review, financed by Offshore Norge and the NEA. The article will provide an updated overview of the knowledge which has been gained over many years of environmental research and monitoring within the Norwegian offshore oil and gas industry. Based on the findings, the article will provide recommendations for future offshore environmental monitoring. The result of this initiative will be presented at the Offshore Environmental Monitoring Forum 2023, with the published version expected to be completed by the end of 2023.

Surveys and assessment of vulnerable seabed areas

The petroleum industry is present on the NCS in the North Sea, the Norwegian Sea and the Barents Sea. The industry is required to survey the seabed and bottom fauna prior to commencing activities. This provides a basis from which to explain the potential environmental impact of such activities and ensures a minimal footprint from the petroleum industry´s activities. The impact is primarily related to drill cutting discharges. The environmental monitoring is essentially carried out by collecting seabed samples with the aid of a grab, followed by analyses of the physical properties (particle size), chemical properties (hydrocarbons and metals), and biological properties (description of species diversity). In hard bottom areas, or where vulnerable benthic habitats are present, visual and acoustic surveys are carried out, either instead of or in addition to grab surveys of the seabed. This applies particularly to areas in which sponges and corals are present, as they are considered vulnerable to particle discharges from drilling activities. The purpose of visual surveys is to map the presence and scope of species and natural habitats which are red-listed in Norway. Coral reefs, hard bottom coral forests and sponge spike bottoms are considered to be near threatened. The visual monitoring is an effective tool for mapping incidents and avoiding damage to the natural environment.

Offshore Norge has commissioned DNV to update the guidelines for vulnerable benthic habitats, and the work is expected to be completed during 2023. The handbook will be revised pursuant to the report on red-listed species in Norway from 2021, as well as to OSPAR´s status report from 2022. The aim of this guideline is to avoid physical damage to coral reefs and sponge areas, inter alia.

6. Greenhouse gas emissions and other emissions to the air

Emissions to the air from the oil and gas industry consist primarily of CO_2, NO_x, SO_x, CH_4 and nmVOC mainly from various types of combustion equipment. Emissions to the air are usually calculated according to the quantities of fuel gas and diesel oil used on the installations. The emission factors are based on measurements from suppliers, standard factors produced by industry or field-specific measurements and calculations.

Reducing emissions to the air to a minimum has been a key objective for both the industry and the government since the oil and gas industry first began in Norway over fifty years ago. This is significant from both an environmental and a financial perspective. It has also been a pillar of Norwegian petroleum management ever since "the ten oil commandments" were established in 1971. Several of the gases emitted are defined as greenhouse gases (GHG), and it is the reduction of these gases specifically in order to protect the climate which now dominates the debate.

6.1 The climate road map for the NCS

The Norwegian oil and gas industry launched ambitious climate objectives in January 2020, pledging to reduce emissions to almost zero by 2050 along with its KonKraft partners. KonKraft has adopted the goal of 50% absolute emissions reduction in 2030 with reference to the Norwegian Parliament resolution to make temporary changes to the petroleum tax law in 2020. The climate strategy of Konkraft also includes ambitious goals to build up new value chains for low and zero-emission technologies such as offshore wind, blue hydrogen, and CO_2 capture and storage on the NCS. In addition, the Norwegian oil and gas industry will collaborate with shipping companies and rig owners to ensure that the vessels used for offshore maritime operations contribute actively towards the government´s goal for a 50% emissions reduction by 2030 in domestic sea transport and fishing. KonKraft prepares annual status reports measuring progression towards the climate targets. This year´s status report was available in June 2023.

The primary sources of emissions to the air from the oil and gas industry are:

- Combustion of fuel gas in turbines, engines and boilers
- Combustion of diesel in turbines, engines and boilers
- Gas flaring
- Combustion of oil and gas for well testing and well maintenance

Other sources of emissions to the air are:

- Gas venting, minor leaks, and fugitive emissions
- Evaporation from storage and loading of crude oil offshore

Power generation using natural gas and diesel oil as fuel is the main source of CO_2 and NO_X emissions. Their level is primarily determined by the energy consumption on the installations and by the energy efficiency of the power generation. The second-largest source of these emission types is gas flaring. The use of flaring is limited on the NCS pursuant to the provisions of the Petroleum Act but is permitted during operations for safety reasons and in connection with certain operational problems.

Fifty per cent of methane emissions (CH_4) from offshore oil and gas installations come directly from production processes, such as from compressors and from the handling of produced water. For volatile organic compounds not containing methane (nmVOC), the primary offshore sources are crude oil loading and storage. Emissions of nmVOC occur, for instance, when gaseous air is displaced by crude oil during the loading of crude tankers.

Emissions of SO_x are derived primarily from the combustion of sulphur-containing natural gas and diesel. As Norwegian gas contains little sulphur, diesel oil is the primary source of SO_x emissions. Low-sulphur diesel is used to minimize these emissions.

Fig. 19 illustrates emissions to the air on the NCS compared with the international average per barrel of produced oil equivalent. All figures are from 2021, since the international figures for 2022 are not available as per June 2023.

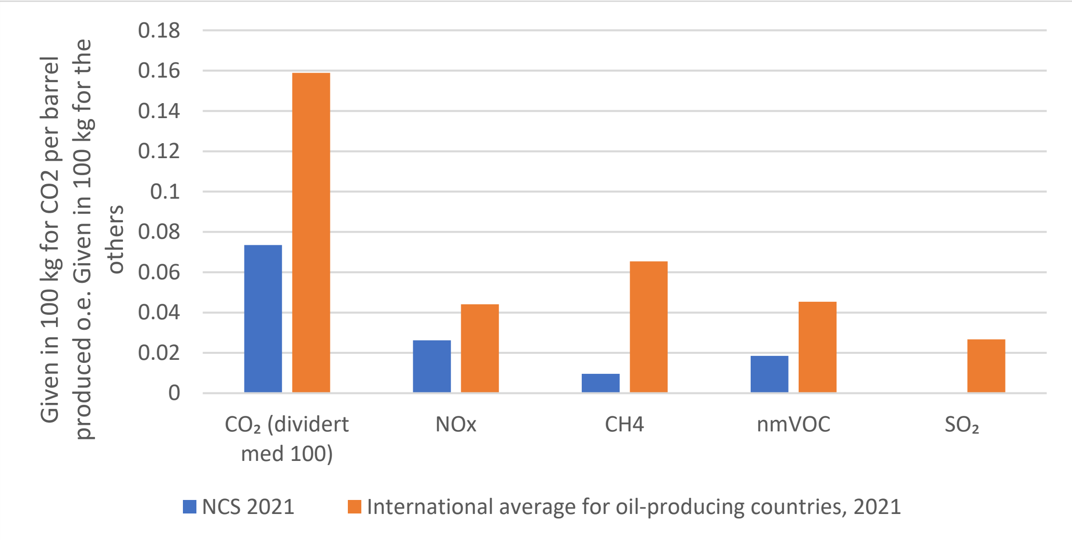


Fig. 19: Emissions to the air on the NCS compared with the international average

6.2 Greenhouse gas emissions

Global warming is one of the greatest challenges of our time and extensive reductions in anthropogenic GHG emissions are critical. Through the Paris Agreement, the member countries have committed to reducing GHG emissions by ensuring that the average rise in global temperatures is kept to well below 2°C compared to pre-industrial levels and to further strive to contain this increase to 1.5°C.

As a part of the Paris Agreement, Norway has committed to reducing its GHG emissions by 55% by 2030, compared with 1990 levels. This will be achieved in collaboration with the EU through already signed bilateral agreements for sectors both inside and outside of the EU´s ETS (Emissions Trading System). For the sector inside of the ETS, of which the petroleum industry is a part, the EU ETS is the most important measure.

The Norwegian government intensified climate goals as defined by the Hurdal governmental platform, calling for a 55% reduction in GHG gases by 2030, compared to 1990. This commitment applies to the entire economy, including the sector subject to the EU ETS. In June 2021, the Solberg government presented the White Paper “Energi til Arbeid” (“Energy to Work"), relating to long-term value creation from Norwegian energy resources. The Norwegian Parliament has requested that the petroleum industry reduces its GHG emissions on the NCS by at least 50% before 2030. This is supported by the temporary changes to the petroleum tax system.

In order to encourage further reductions of GHG emissions in the petroleum sector, the Norwegian Parliament passed a "Climate Plan" in Spring 2021, proposing inter alia a CO_2 tax increase on emissions from oil and gas operations subject to the ETS in line with the tax increase on those emissions outside of the ETS, meaning that the total carbon cost (CO_2 tax + quota cost) in 2030 equates to roughly NOK 2,000 per ton of CO_2 (estimated in 2020 currency). The Climate Plan further stipulates that the total carbon cost should not exceed NOK 2,000 from 2021 to 2030.

Through the European Green Deal, the EU has committed to an emissions reduction of at least 55% by 2030, as well as to being climate-neutral by 2050. The EU´s Green Deal and "Fit-for-55" package will lead to changes in laws and regulations enabling these climate goals to be reached. In addition, the EU launched several measures through RePowerEU in March 2022 to become independent of Russian gas due to the war in Ukraine. These measures are designed to reduce Russian gas imports whilst safeguarding the current climate objectives.

GREENHOUSE GAS EMISSIONS FROM THE NCS

- Emissions to air from Norwegian oil and gas production are reported by several sources. However, both the numbers reported and the development trends from year to year can vary significantly depending on the source. There are several reasons for this, the main one being differing definitions of which activities are included in the Norwegian oil and gas industry.

- The Offshore Norge Environmental Report is published annually at the beginning of June and contains all emissions data from the industry. Which emissions to include are based on the definitions in the Petroleum Tax Act. These cover all exploration and production activities on the NCS, including emissions associated with pipeline transport of oil and gas, even if these may occur at land-based plants such as Kårstø and Kollnes. All activities at Melkøya are also included. The data is collected from the Collabor8 Footprint database, which has been developed to simplify both the reporting of emissions figures and the submission of annual emissions reports from the operators to the government.

- Statistics Norway (SSB) publishes preliminary figures for the entire industry in May, followed by emissions broken down by various sources in oil and gas production in December. The figures are reported to the UN under the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Long-Range Transboundary Air Pollution (CLRTAP). The emissions figures differ from those reported via Footprint to the NEA by including more land-based activities. The inclusion of the Kårstø plant is an example of this. The emissions figures from the SSB will consequently normally be higher than the corresponding Footprint figures, whilst the figures from the majority of sources will generally be comparable. The SSB figures also form the basis for the Miljøstatus.no website.

- The NEA has its own database for Norwegian emissions, (norskeutslipp.no), which is accessible to the public and contains emissions data from all Norwegian sources, including oil and gas production. These are generally the same data as those found in Footprint. The top-level category, "Offshore Petroleum Operations", does not, however, include land-based installations nor exploration activities. Totals for the industry will therefore be lower than the corresponding figures reported in the Environmental Report and by the SSB.

- In addition, emissions figures come from those operations on the NCS subject to the ETS and from the portion of oil and gas production liable to CO_2 taxes. These categories are defined differently both from each other and in relation to the three sources described above, and their figures will therefore vary not only in total but also from different sources.

Greenhouse gas emissions from petroleum operations

Fig. 20 illustrates that total GHG emissions from the NCS and land-based installations subject to the Petroleum Tax Act stood at 11.6 million tons of CO_2 equivalent in 2022, which is the same as the 2021 figure. Emissions remained stable in spite of the 2022 Melkøya re-start. Many fields reduced their emissions associated with energy production and flaring in 2022, whilst emissions due to flaring from existing fields on the NCS showed a slight increase in 2022 due to the re-start of Melkøya. Methane emissions also showed a slight decrease from 2021 to 2022.

In Norway, all oil and gas companies are required to report their emissions in accordance with stringent and detailed regulatory requirements. This is not the case in many other oil-producing countries.

The data in Fig. 21 has been collated from the annual report published by the International Organization for Oil and Gas Producers (IOGP). The international figures for 2022 are not available as per June 2023. This report presents its figures on a regional, not national, level. Other studies including those carried out by Rystad Energy confirm this picture.

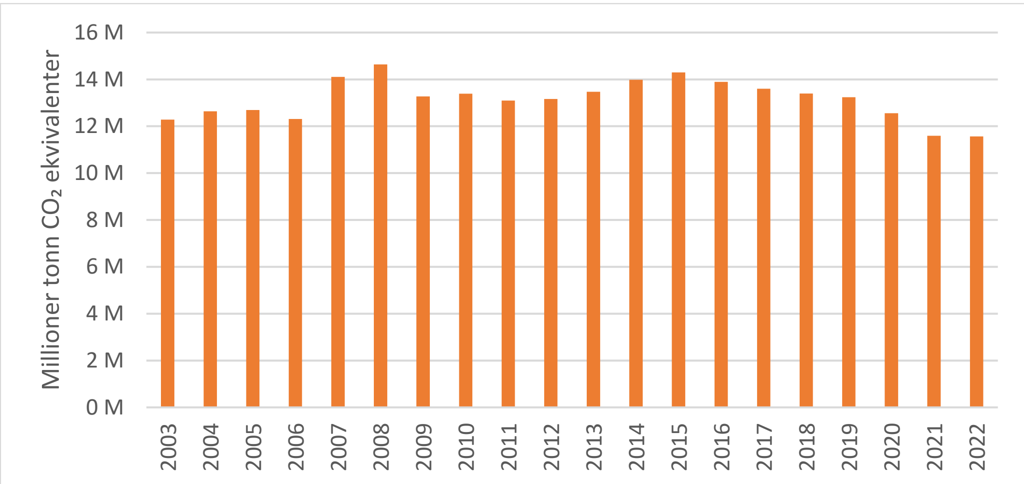


Fig. 20: Emissions of CO_2 equivalent on the NCS

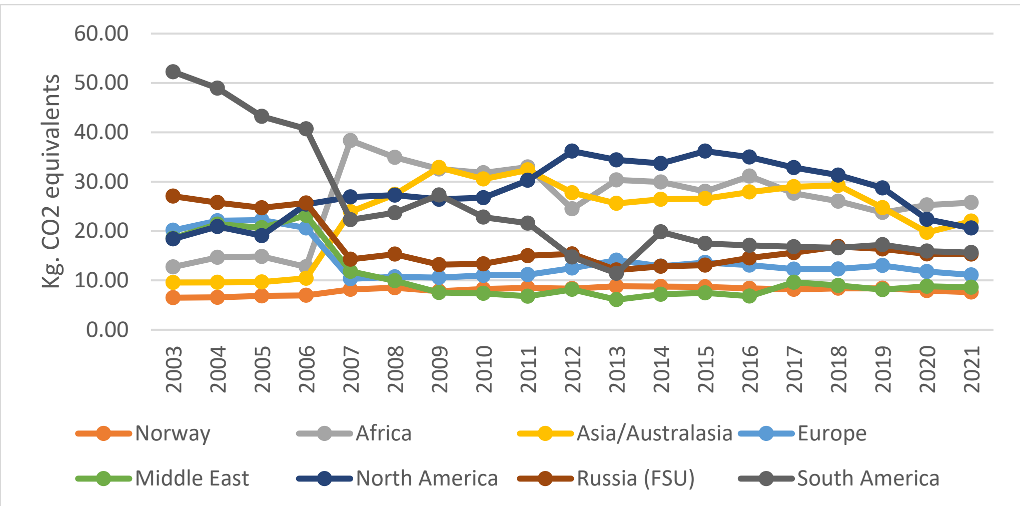


Fig. 21: GHG emissions per unit produced in various petroleum provinces, 2003 – 2021

(Source: IOGP)

CO_2 emissions

In 2022, direct CO_2 emissions from operations on the NCS and onshore installations subject to the Petroleum Tax Law stood at 11.2 million tons, which equates to the 2021 level.

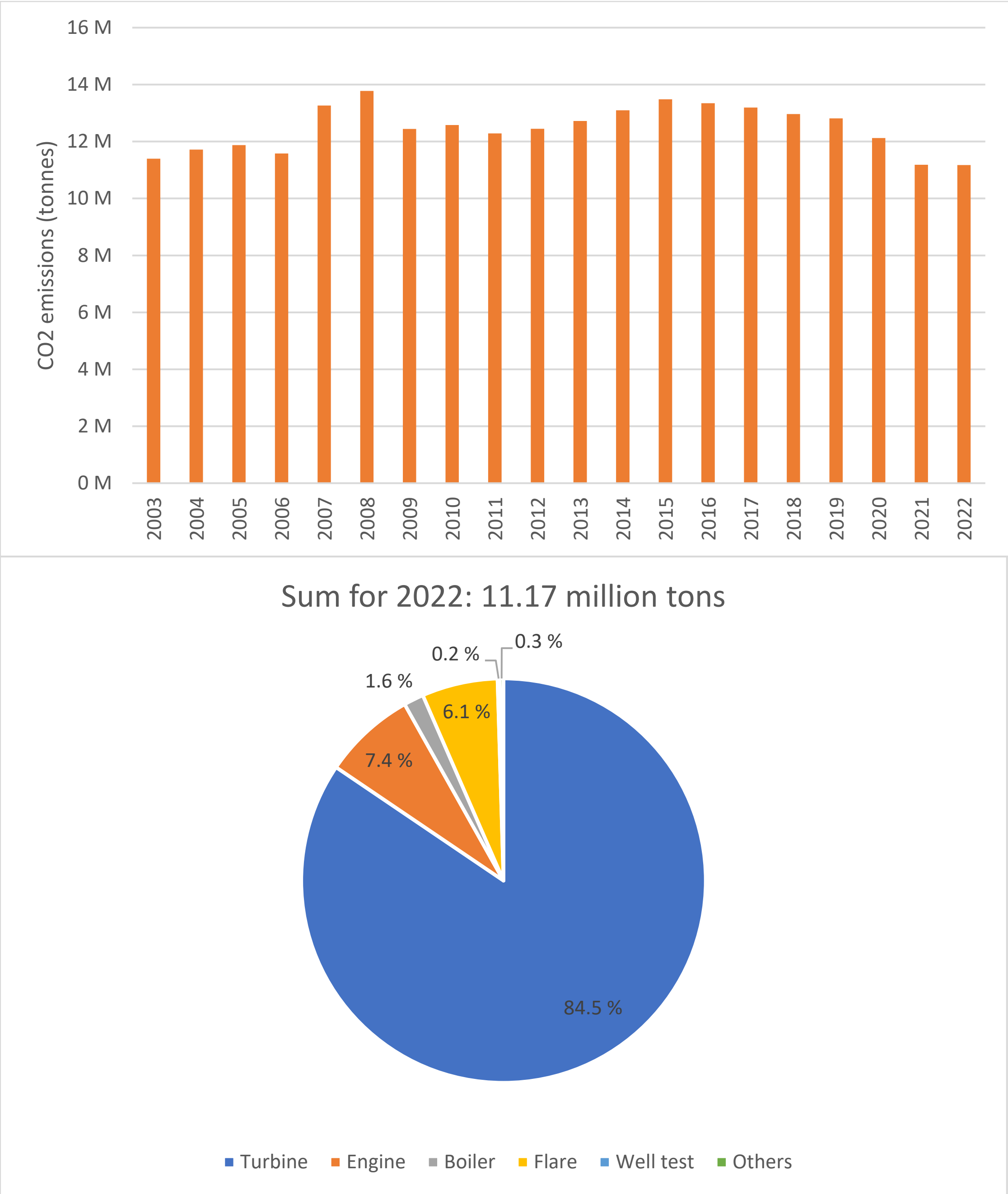


Fig. 22: Historical development of direct CO_2 emissions (millions of tons and distribution according to source)

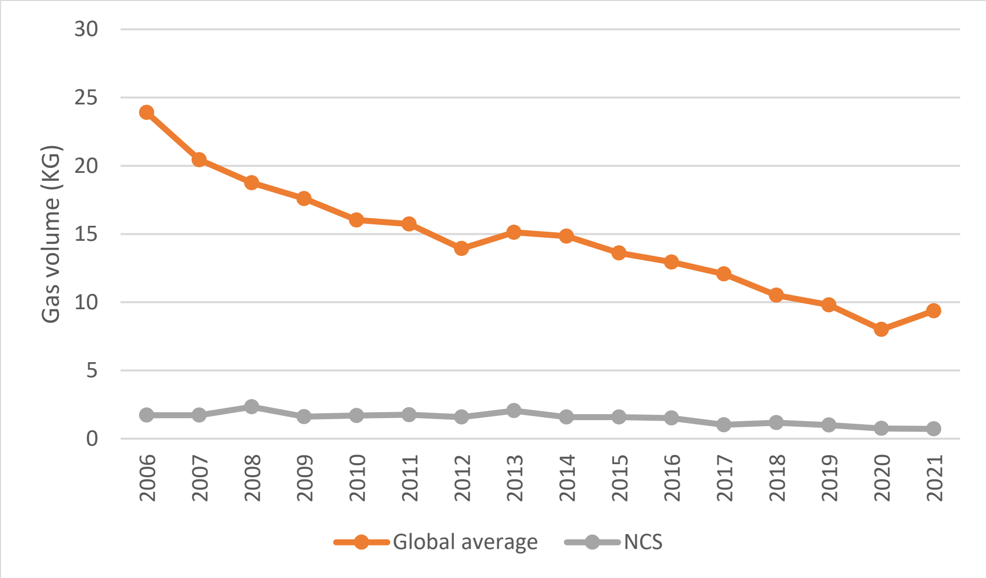


Fig. 23: Volumes of flared gas per produced ton o. e. on the NCS compared to international average

Fig. 23 illustrates the historical development of flared gas volumes per produced unit of oil equivalent in Norway compared to the international average (IOGP) from 2006 to 2021. International figures for 2022 are not available as per June 2023. Low emissions from flaring are a primary reason for significantly lower CO_2 emissions from the NCS than from other countries. In 2021 volumes of flare gas were ten times higher globally than in Norway. Whilst it may appear from Fig. 23 that no developments took place between 2006 and 2022, flare gas volumes in Norway during this period dropped by 58%. During the same period, the reported volumes of global flare gas dropped by 60%.

Fig. 24 shows the historical development of direct CO_2 emissions from the three primary sources, where flaring has been the smallest of the three since 2019.

Total Norwegian GHG emissions in 2022 stood at 48.9 million tons CO_2e, according to SSB, with petroleum industry operations accounting for approximately 25% of the total.

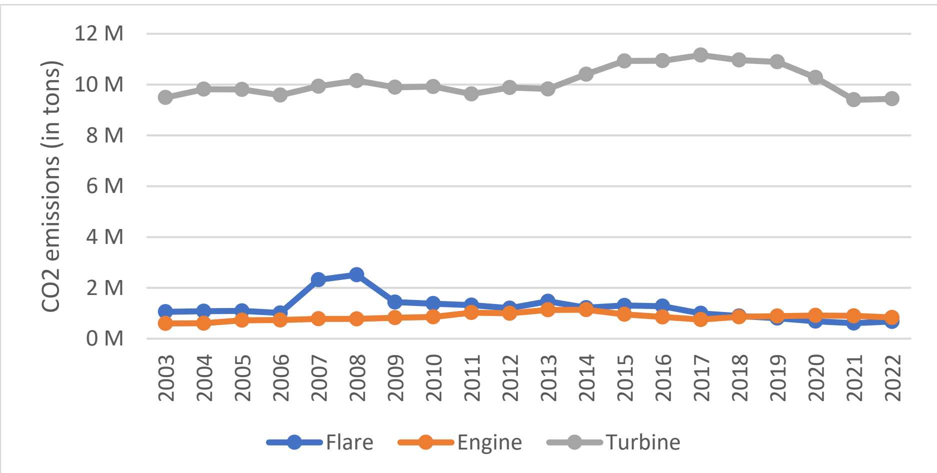


Fig. 24: Historical development of direct CO_2 emissions (in tons) from the three primary sources

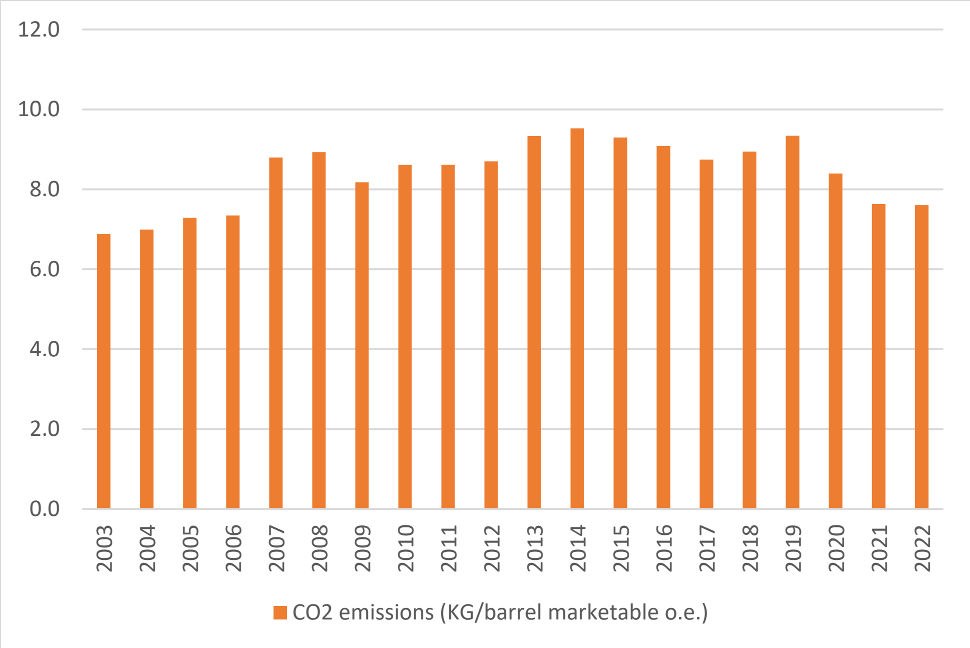


Fig. 25: Specific CO_2 emissions

Norwegian oil production has been world-leading for many years in terms of low GHG emissions. The average emission per produced unit is less than half of the global average. The sector is subject to several measures such as CO_2 tax, EU ETS, NOx tax/fund, flaring restrictions in production licenses, emissions permits with conditions covering energy management, and the use of best available technology (BAT). There is also a requirement to consider onshore power in new developments. Along with a robust resource and recovery policy, these regulatory measures have triggered and will continue to trigger reduced emissions on the NCS.

Prolonged and increased production on existing fields will normally lead to increased energy consumption per produced unit. It is therefore particularly noteworthy that the NCS has succeeded in maintaining low emissions per produced unit whilst significantly increasing oil production.

The result is a Norwegian offshore industry at the top of the international ladder in terms of low CO_2 emissions per produced unit (see Fig. 24). At the same time, we note that certain other countries are beginning to show improvements in emissions by implementing practices like those on the NCS, such as reduced flaring. This is an extremely positive development. Reduced flaring not only lowers CO_2 emissions but also boosts energy supplies for the market, since the gas can be consumed rather than flared.

Short-lived climate forcers

Short-lived climate forcers are comprised of gases and particles which have a short lifespan in the atmosphere, and which are characterized by their negative effects on climate and health. Reducing these emissions will therefore provide both climate and health benefits. In the offshore oil industry, methane (CH_4) and nmVOC emissions from cold venting and diffuse emissions are the primary short-lived climate forcers. Due to the increased focus on these emissions, it has been necessary to update and acquire further knowledge on the various sources of direct methane and nmVOC emissions.

Short-lived climate forcer emissions released from production on the NCS are already low by international standards. Results from a joint project with the NEA showed that the emissions factors applied to date on the NCS have been conservative, and that the actual emissions are lower than previously estimated.

Methane emissions

The primary sources of methane emissions from offshore oil and gas production are 1) planned or unplanned emissions to direct air, 2) incomplete combustion in flares and turbines, and 3) emissions associated with the storage and loading of crude oil. Annual methane emissions are reported pursuant to the methods and emissions factors determined jointly by the NEA and the industry. The oil industry works continuously to improve the methods and emissions factors used for methane and nmVOC. The use of equipment for the direct measurement of methane emissions plays an important role in improving the quality of the reporting methods. A separate leak detection program (Leak Detection and Repair, LDAR), is used to detect leaks from process equipment, involving the use of hand-held infrared cameras. The use of cameras (Optical Gas Imaging) enables measures to be implemented swiftly to reduce/eliminate any emissions associated with minor leaks.

Fig. 26 illustrates methane emissions (CH_4) from activities on the NCS in 2022, broken down by source. Total methane emissions in 2022 stood at 13, 152 tons, compared to 14, 682 tons in 2021. This reduction has been achieved in spite of increased gas production. Compared to 2014, this is a reduction of over 50%. The significant reduction from 2014/2015 to 2016 is mainly due to a far more detailed follow-up of the individual sources and a revision of the emissions factors.

Methane emissions associated with gas exports to Europe

Natural gas produced on the NCS is exported primarily to Europe for domestic consumption, for industrial use and for gas-fired power stations. Natural gas is composed mainly of methane, which is an extremely potent greenhouse gas.

Since CO_2 emissions from gas-fired power stations are approximately 50% lower than those from coal-fired power stations per produced power unit, a switch from coal-fired to gas-fired electricity generation would be a sound climate measure. To do this, the industry first needs to ensure that methane emissions from production and from the gas pipeline system out to the consumer are not so high that they outweigh the advantages. Methane concentration on the NCS in 2022 measured 0.02% (emissions per unit of gas sold), which is approximately 1/10 of the global average for upstream oil and gas production. This shows that Norwegian natural gas has a clear advantage over coal from a climate perspective.

The reasons for the low methane concentration in Norwegian natural gas are, inter alia, subsea gas pipelines, a ban on routine flaring, and high tax levels, as well as a keen focus in minimizing gas leaks for climate and safety reasons.

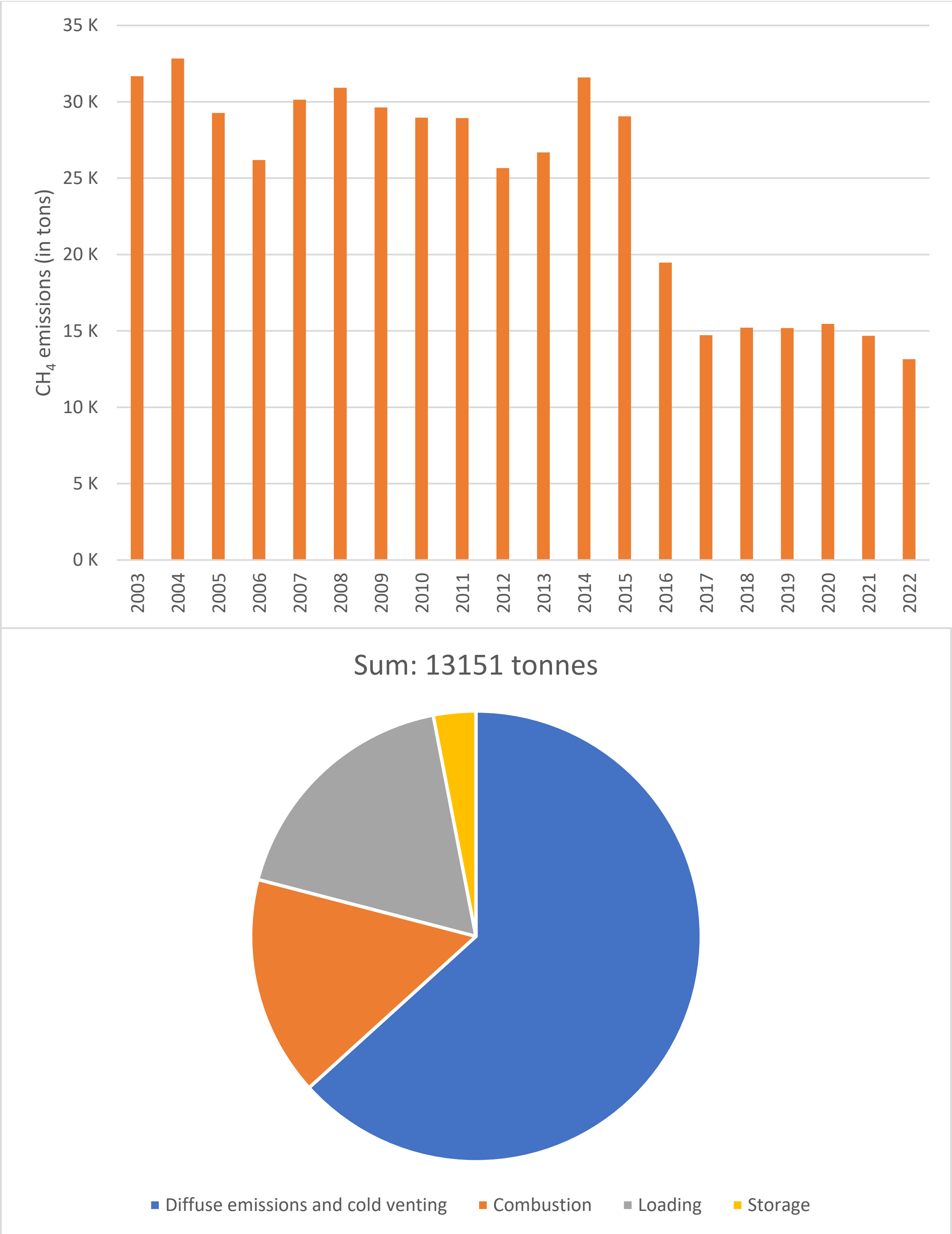


Fig. 26: Historical development of total emissions of CH_4 (in tons) and distribution by source

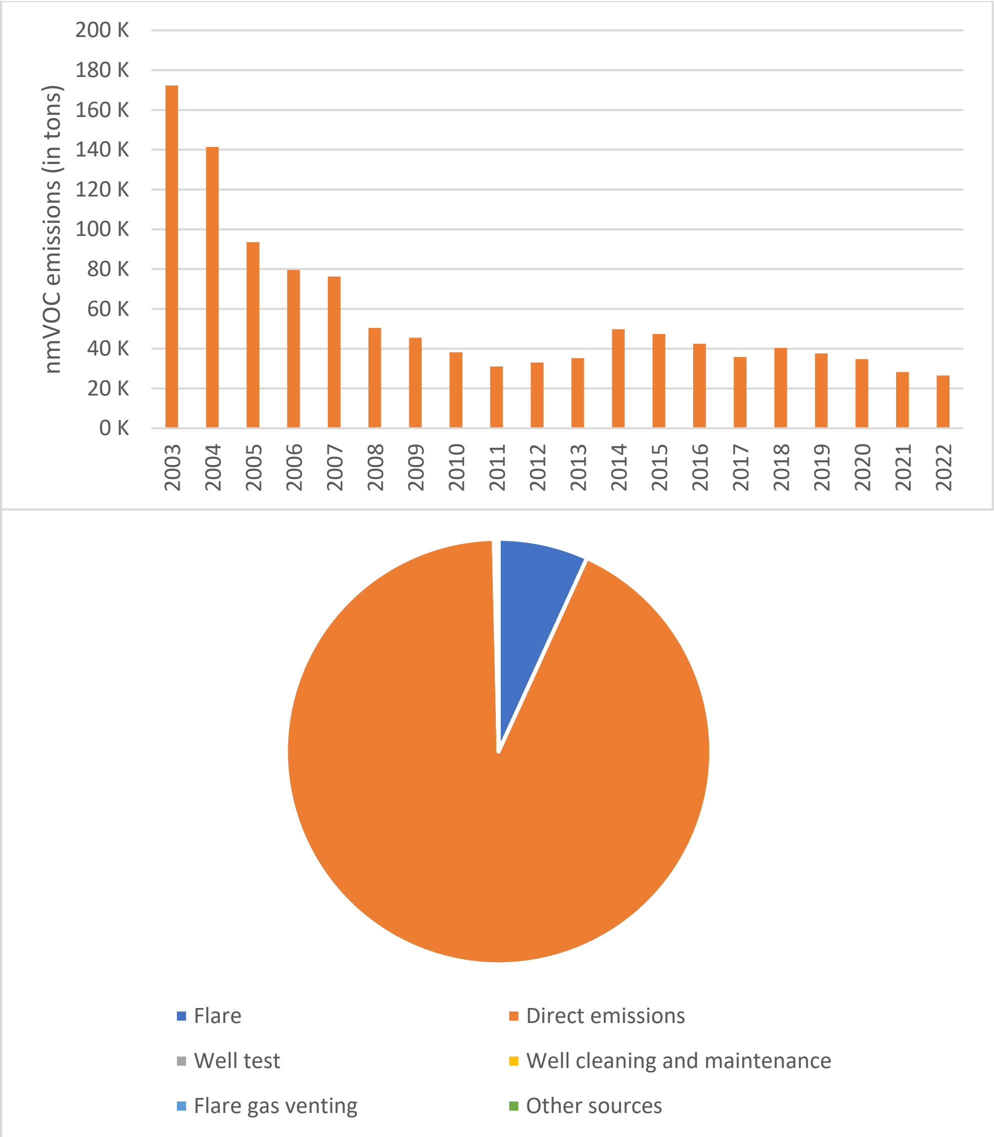


Fig. 27: Historical development of total nmVOC emissions (in tons) and distribution by source

6.3 Emissions of nmVOC

In 2022, total nmVOC emissions from the NCS stood at 26, 543 tons. This is a decrease compared to 2021, when they totalled 28, 233 tons, as illustrated in Fig. 27.

Since 2001, total nmVOC emissions have been reduced by almost 90%. This has been achieved by investing in new facilities for the removal and recovery of oil vapor on storage ships and shuttle tankers. In recent years, the collaboration between the NEA and the industry on methane and nmVOC emissions has also resulted in significant reductions.

6.4 Emissions of NOx

The primary source of NOx emissions on the NCS is from the burning of natural gas and diesel for energy generation on the installations. The diesel-fueled engines on mobile rigs are also a significant source. The mobile rigs are used for both exploration drilling and production drilling.

The environmental agreement on NOx regulates the commitments made to the government by Norway´s industry associations on reducing their overall NOx emissions. Norway met its NOx obligations in the Gothenburg Protocol well before 2020. Efforts to reduce NOx emissions through the NOx fund have been crucial in terms of reaching this goal. The NOx fund gives investment grants to those companies which implement measures to reduce their NOx emissions. The money from the fund is paid out once the measure has been implemented and documented.

NOx emissions have been significantly reduced thanks to the NOx fund initiative. The NOx agreement for 2018 – 2025 was approved by the ESA in 2018, and has now been extended until 2027.

Total NOx emissions from the petroleum industry in 2022 stood at 37, 311 tons, down from 39, 872 tons in 2021. The decrease is due to a general reduction in combustion.

Fig. 28 illustrates NOx emissions from NCS operations and breakdown by source in 2022, whilst Fig. 29 illustrates specific NOx emissions.

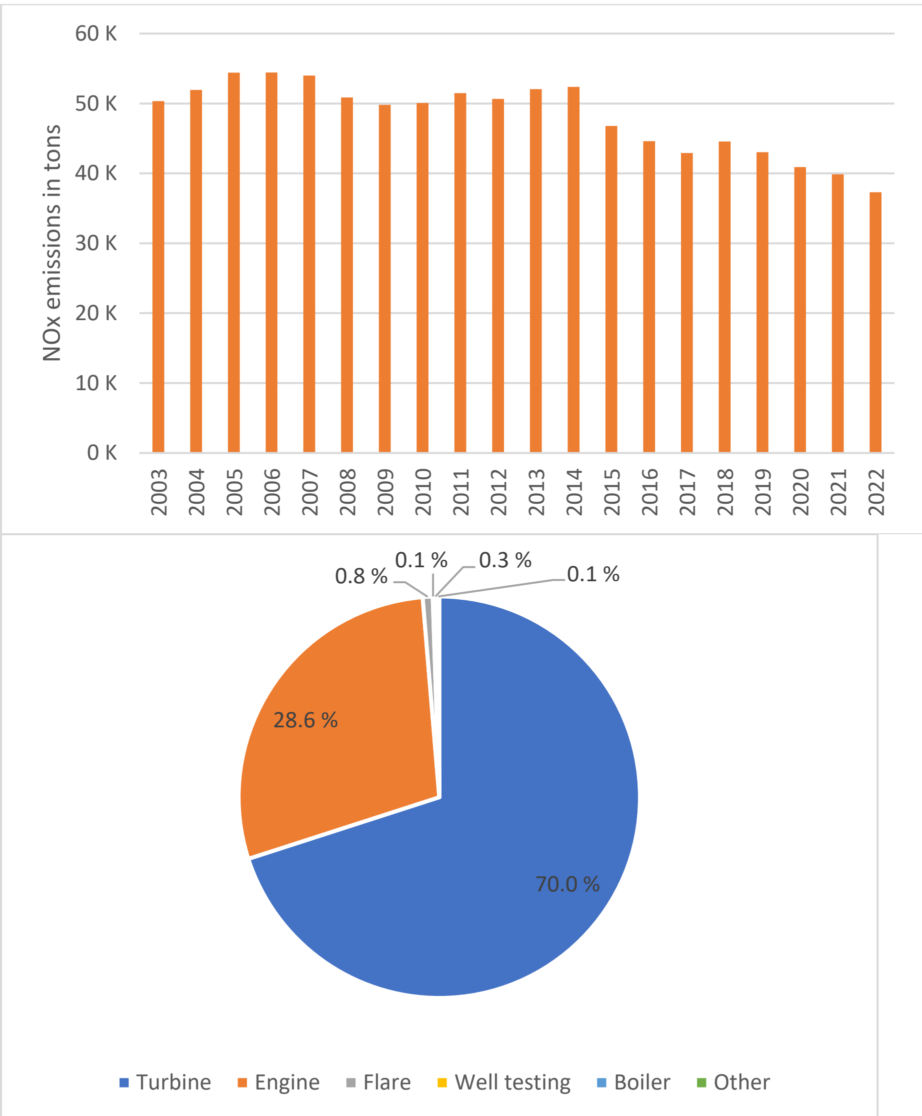


Fig 28: Historical development of total NOx emissions (in tons) and breakdown by source

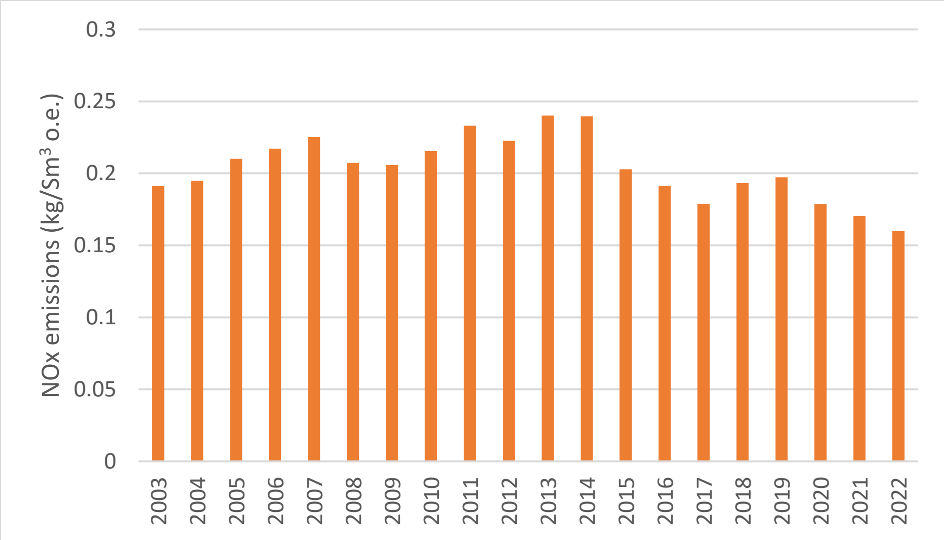
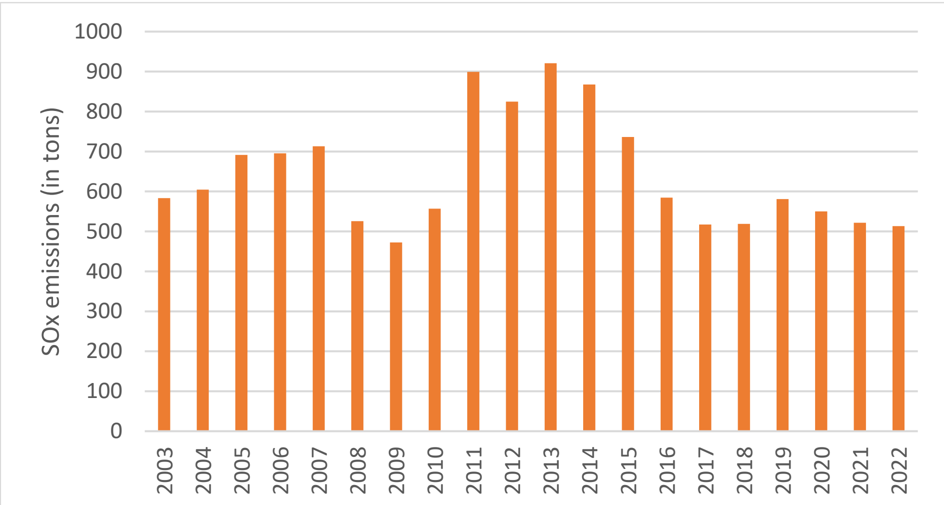


Fig. 29: Specific NOx emissions

6.5 SOx emissions

Fig. 30 shows SOx emissions from operations on the NCS and the break-down of the emissions in 2022 according to source. Total SOx emissions for 2022 stood at 513 tons, down from 522 tons in 2021.



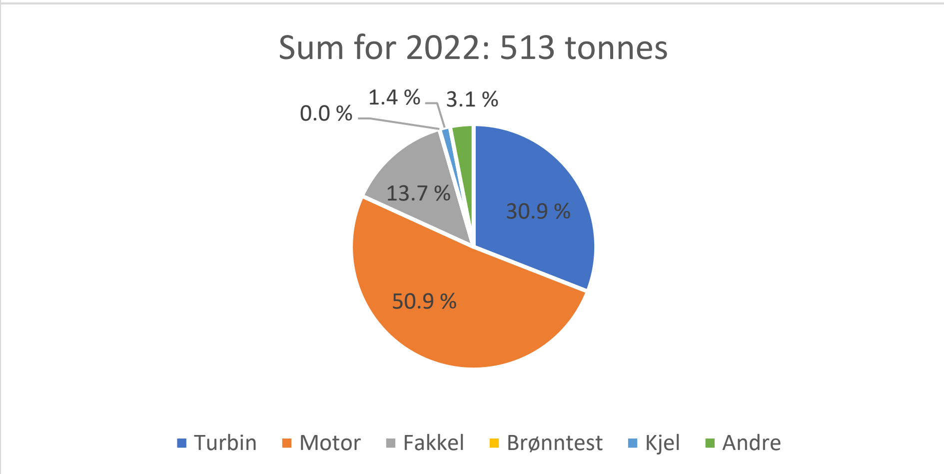


Fig. 30: Historical SOx emissions from the NCS, broken down according to source

7. Waste

The petroleum industry is one of the largest producers of waste in Norway. The industry places great importance on correct waste management. The principal goals of the operators are to generate minimum waste and to establish systems enabling maximum recycling.

Offshore Norge has developed its own guideline 093 for waste management in the offshore industry. These guidelines are applied when declaring and subsequently treating waste. All waste is sent ashore in accordance with industry guidelines.

7.1 Non-hazardous waste

Waste is generally divided into hazardous and non-hazardous waste in accordance with current regulations and must be declared pursuant to national regulations and international guidelines.

In 2022, 20, 090 tons of non-hazardous waste were produced, which is a decrease from 21, 858 tons in 2021. Fig. 31 illustrates the breakdown of non-hazardous waste by various categories.

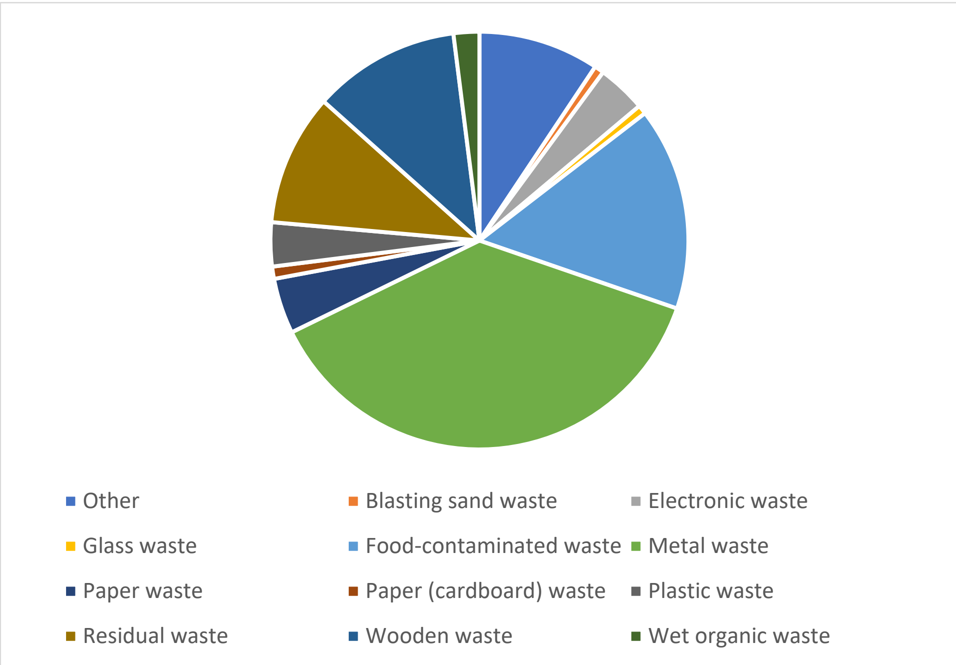


Fig. 31: Breakdown of non-hazardous waste from the offshore industry by various categories (in tons)

7.2 Hazardous waste

Offshore Norge and the NEA jointly introduced new codes in 2014 for hazardous waste from the industry. The aim of the update was to ensure correct waste treatment and declaration.

This update does however make it difficult to compare the various waste types with earlier statistics. A number of the categories have been split into several sub-categories, whilst others have been merged.

Fig. 32 illustrates that in 2022, 275, 738 tons of hazardous waste were sent ashore for treatment, compared to 309, 876 tons in 2021. 223, 153 tons of waste treated onshore were drilling-related. Vessel cleaning and oily waste accounted for 10, 558 and 11, 054 tons respectively.

The reason for the marked increase in oily waste from 2009 and several years thereafter is that previously, much of this waste would have been reinjected. Up to 2009, leaks from injection wells were detected on several fields and injection was stopped in 2009/2010. The oily waste was instead sent ashore for treatment. Methods for handling cuttings on these installations were based on slurrification to enable injection. Slurrification involves crushing the cuttings and adding water. It is not unusual for the volume of the cuttings to expand by four to ten times during the process. This practice continued and the cuttings were sent ashore as slurry, leading to a significant increase in drilling waste from certain fields.

Injection provides considerable environmental benefits and can be cost-efficient compared with final treatment onshore. The drilling of new injection wells has led to an increase in the volume of oily waste (see Chapter 4.1). For installations and fields not expected to reintroduce injection, an effort is made to reduce slurrification and subsequent waste.

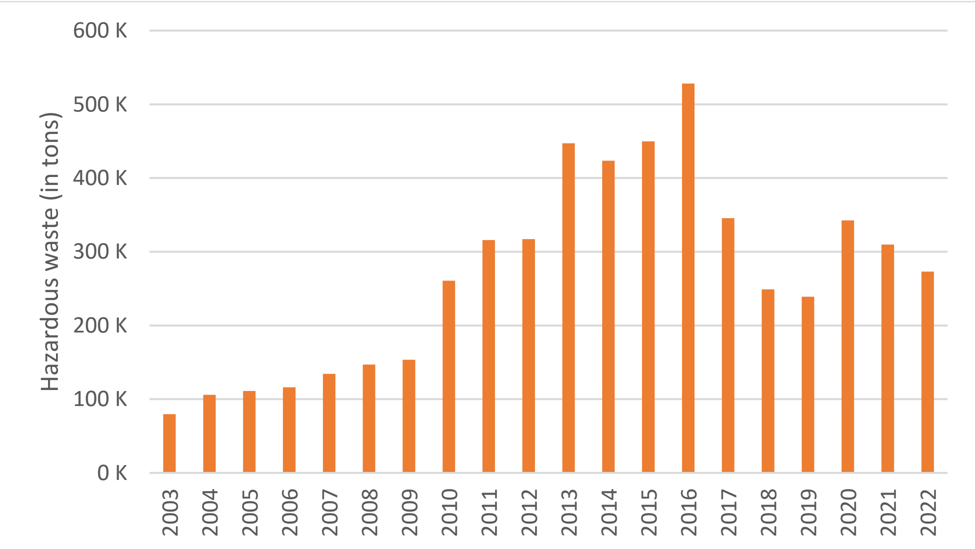


Fig. 32: Volume of hazardous waste from offshore operations sent ashore

7.3 Low-level radioactive waste

Rocks beneath the seabed contain varying amounts of radium and other radioactive isotopes. During oil and gas production, these naturally occurring radioactive substances accompany oil, gas and primarily water to the surface. These substances are often referred to as low-radioactive depositions.

On some fields, the sludge cleaned from oil-water separators can contain varying levels of measurable radioactivity. The concentration of these substances is measured by water and sludge analyses which are carried out by accredited laboratories. The waste is separated into and declared according to three categories; no enhanced concentrations, radioactivity levels lower than 10 becquerels per gram, and radioactivity levels higher than 10 becquerels per gram. Both radioactive categories are treated in accordance with the regulations issued by the Norwegian Radiation Protection Authority. The most radioactive material is sent to a designated landfill site in Gulen.

Fig. 33 illustrates the volumes (in tons) of radioactive waste sent for final disposal in the two categories. The waste containing radioactivity levels lower than 10 Bq/g varies due to fluctuating site capacity.

A total of 394 tons of low-level radioactive waste were sent ashore in 2022, marking a significant decrease from 1, 633 tons in 2021.

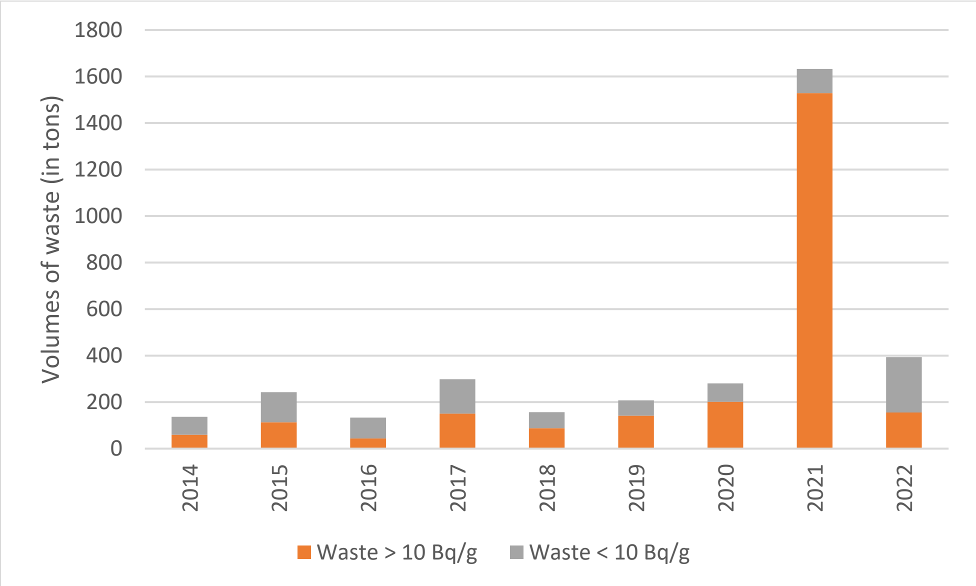


Fig. 33: Volumes of waste with naturally occurring radioactive material

8. CCS activities

As of reporting year 2022, Footprint has been adapted in order to also report on drilling activities from CCS wells. These are not defined as petroleum activities, but there are significant similarities between CCS drilling and “normal” drilling, and the NEA has approved their activities along the same principles. An agreement was therefore reached between the NEA and the operators, stating that these well activities should also be reported into Footprint.

Activities are limited to date but are expected to increase gradually as new storage licenses are awarded. In 2022, three exploration licenses under the CCS storage regulations were awarded on the NCS: one in the North Sea (Equinor ASA), one in the Barents Sea (Equinor ASA/Horisont Energi AS/Vår Energi AS), and another one in the North Sea (Wintershall Dea Norge AS/Altera Infrastructure Group, Stella Maris CCS AS). These licenses are in addition to the Northern Lights license. In 2022, two wells were drilled in the Northern Lights license. Some key figures follow:

Discharges to sea:

- Drainage water – 2, 998 tons
- Oil to sea – 0.03 tons

Chemical discharges:

- Red category – 0.11 tons
- Yellow category – 49 tons
- Green category – 1,294 tons

Emissions to air:

- CO_2 emissions – 8,610 tons
- NOx emissions – 119 tons
- CH_4 emissions – 0.50 tons
- nmVOC – 14 tons

9. Improving the knowledge base

The petroleum industry has contributed actively for many years to building knowledge of the effects on the climate and environment from its activities. Much of this knowledge is made available to the public and forms a basis which the authorities are encouraged to use in their ocean management, for example when updating the integrated ocean management plan (see Chapter 5). This chapter describes some of the activities which the petroleum industry has carried out during 2022.

9.1 SEAPOP/SEATRACK

SEAPOP, derived from the English term, seabird populations, was started in 2005 and is an integrated and long-term monitoring and mapping program for Norwegian seabirds. The program acquires and maintains fundamental knowledge about the seabirds which contributes to a better management of these marine environments.

SEAPOP´s work is organised and carried out by personnel from the Norwegian Institute for Nature Research (NINA) and from the Norwegian Polar Institute (NP). Up to now, the program has been financed jointly by the Norwegian Ministry of Climate and Environment, the Norwegian Ministry of Petroleum and Energy, and Offshore Norge.

SEAPOP carries out detailed mapping of the presence of nesting, resting and overwintering seabirds along the entire Norwegian coastline and in Svalbard, closely monitoring several key locations.
SEATRACK is a project under SEAPOP and was started in 2014. The purpose of the project is to increase knowledge of the presence of seabirds in the North-East Atlantic outside of the nesting season. Many species migrate extensively during the winter season, covering large areas in search of food.

Nest loggers or GPS devices are attached to the birds whilst they are in their nesting colony during the summer. When they return to their nesting colony the following year, the loggers are collected and the data are analyzed. The project is carried out in collaboration with several other countries.

SEATRACK is now in its third phase. Phases 1 and 2 were financed by actively involved research institutions, the Norwegian Ministry of Climate and Environment, the Norwegian Coastal Administration and the industry (Offshore Norge and 6 – 8 operators). In Phase 3, offshore wind operators are also contributing financially, and a total of 17 industry partners are represented (including Offshore Norge).

9.2 Environmental Risk Assessments and ERA Acute

Environmental risk assessments are an important part of the operators´ safety work, helping to identify which activities, time of year and environmental elements contribute to the highest risk for an exploration well or producing field. The results form a basis from which to assess the most effective measures to prevent potential consequences. These can be both preventive measures designed to stop acute spills, and consequence-reducing measures such as oil spill preparedness.

ERA Acute is the recommended methodology for environmental risk assessments for NCS activities. It can also be applied internationally and has the capacity to handle various levels of detail, depending on the data available. The analyses are built up step by step, and guidelines have been developed for best practice so that the analyses use the best possible input data and are carried out comparatively.

Specific software has been developed for ERA Acute, and this is managed on behalf of the operators by Offshore Norge.

Continuous improvements are underway on both the model and the data platform, and include the following initiatives:

- Annual quality control of models and tools applied in the industry´s analyses of environmental risk and need for preparedness in the event of acute spills. The work is carried out by central institutions and encompasses the updating of meteorological and oceanographic tide data. In 2022, it also included updating the data set used to map the presence of seals.

- ERA Acute Marginal Ice Zone Project/dynamic data
  This project is funded by the Research Council of Norway, having started in 2018 and scheduled for completion in Q2 2023. It is a two-part project, firstly paving the way for the use of high-resolution data for selected valued ecosystem components (VEC) in ERA Acute analyses, and secondly developing a methodology to calculate the environmental risk or impact in a simplified way for the ice zone (Marginal Ice Zone) as an independent VEC habitat of ecological importance.
  The industry partners in this project are Equinor, Lundin (now Aker BP), OMW, WintershallDea and Offshore Norge.

- Development project for seabirds
  This project aims for a better understanding of acute oil spill consequences for species and stocks of seabirds in decline. The work is carried out collaboratively with the Norwegian Institute for Nature Research.

9.3 KnowSandeel

The lesser sand eel is considered a key species in the North Sea ecosystem. More extensive knowledge has been found necessary on the lesser sand eel in order to improve environmental risk assessments in the event of various types of spills. KnowSandeel is a collaborative project between the petroleum industry and the Norwegian Institute of Marine Research, aimed at improving the understanding of the lesser sand eel´s vulnerability towards human activities.

9.4 SYMBIOSES

SYMBIOSES is a research project which has been underway for over ten years, in which the first phases were funded by the Research Council and operators on the NCS. The project participants include the Norwegian Institute of Marine Research, SINTEF, the University of Oslo and several research institutions both nationally and internationally. The project is led by the Norwegian Akvaplan-Niva research institution, which is one of the largest marine research institutes in Norway.

Phase III of the project was funded by a group of operators and completed in 2022. The phase modelled the effect of acute oil spills on six different types of fish with differing life cycles and stock varieties. The modelling was carried out on several different spill locations, and with various limits for mortality. The results were presented to various forums working on the integrated ocean management plan, and the report is available at Symbioses.no.

9.5 Methane

The petroleum industry has a keen focus on minimizing methane emissions to air. There are several different technical systems and instruments used to detect methane emissions from the production and transport of oil and gas. Technical systems used to detect subsea methane leaks are, however, limited. Offshore Norge commissioned Carbon Limits to carry out a study entitled "Overview of subsea methane emissions detection and quantification technologies" to highlight the issue.

10. Terms and abbreviations

CH_4	Methane
CO_2	Carbon dioxide
EFTA	European Free Trade Association
EIF	Environmental Impact Factor
HOCNF	Harmonized Offshore Chemical Notification Format
IOGP	International Association of Oil and Gas Producers
KLD	Klima- og Miljødepartementet (Ministry of Climate and Environment)
LRA	Lav radioaktiv avleiring (low radioactive deposition)
MOD	Miljøovervåkingsdatabase (Environmental Monitoring Database)
NGU	Norges Geologiske Undersøkelse (Geological Survey of Norway)
NINA	Norsk institutt for naturforskning (Norwegian Institute for Nature Research)
NIVA	Norsk institutt for vannforskning (Norwegian Institute for Water Research)
NOx	Nitrogen oxide
NP	Norsk polarinstitutt (Norwegian Polar Institute)
nmVOC	non-methane volatile organic compounds
OD	Oljedirektoratet (Norwegian Petroleum Directorate)
OED	Olje- og Energidepartement (Norwegian Ministry of Petroleum and Energy)
o.e.	oil equivalents
OIC	Offshore Industry Committee
OSPAR	Oslo and Paris Convention. This is a legal instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. 15 countries having either a coastline with or rivers flowing into the North-East Atlantic are members.
PLONOR	Pose Little Or No Risk to the Marine Environment is a list from OSPAR detailing chemical compounds thought to have little or no impact on the marine environment if spilled or emitted.
RBA	Risk-based approach
SOx	Sulphur oxides
SO_2	Sulphur dioxide
Sm^3	Standard cubic meter
SFT	Statens Forurensningstilsyn (Norwegian Climate and Pollution Agency, merged into the Norwegian Environment Agency in 2013)
SSB	Statistisk Sentralbyrå (Statistics Norway)

Conversion factors

Based on energy content in hydrocarbons. Calculated according to NPD definitions:

Oil, 1 m^3	=	1 Sm^3 o.e.
Oil, 1 barrel	=	0.159 Sm^3
Condensate, 1 ton	=	1.3 Sm^3 o.e.
Gas, 1,000 Sm^3	=	1 Sm^3 o.e.
NGL, 1 ton	=	1.9 Sm^3 o.e.