Offshore Norge – Climate and Environmental Report 2024

1. Introduction

Each year, Offshore Norge publishes an environmental report with a detailed overview of last year's emissions and discharges from the petroleum industry. The purpose of the report is to share data on all emissions and discharges to the environment from our activities and to provide information about the industry's environmental work and results.

The Norwegian petroleum industry has a clear ambition: We aim to be world leaders in environmental matters and to constantly improve. Detailed reporting on all emissions and discharges is essential to measure progress and the degree of goal achievement.

Data basis and method

The environmental report is based on the annual reports submitted by the operators to the Norwegian Environment Agency (NEA) in accordance with regulatory requirements detailed in NEA's guideline M-107. This applies to all planned, officially approved operational emissions and discharges as well as those occurring accidentally. Common frameworks as detailed in Offshore Norge's guideline 044 ensure consistent emissions/discharge reporting from all production licences. Emission data from each field is recorded in Collabor8 Footprint (hereafter referred to as Footprint), a joint database for Offshore Norge, the Norwegian Environment Agency (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 are also available on Offshore Norge's website.

Emissions and discharges from the petroleum industry are defined in accordance with the definition in the Norwegian Petroleum Tax Act. The following emissions and discharges are therefore not included in the report: Emissions and discharges from the construction and installation phases, maritime support services, helicopter traffic, and those areas of onshore facilities that cannot be related to offshore production. New in this year's report is that carbon capture and storage activities (CCS) are included in a separate chapter. 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 vary according to the operations on the Norwegian continental shelf (NCS). The report therefore includes a brief description of the operation in question before the fact section that summarizes emissions/discharges from the entire operation. A summary of projects related to the marine environment and climate is also provided at the end of the report.

2. Summary

In 2023, approximately 233 million Sm^3 o.e. were produced on the NCS. This is at the same level as in 2022.

The gas price in Europe has dropped significantly from the historically high levels in the autumn of 2022. Since Russia's invasion of Ukraine in February 2022, Russian pipeline gas to the EU has largely disappeared. Much of this loss has been replaced by increased imports of LNG, but increased and stable deliveries of Norwegian pipeline gas have also been crucial.

In 2023, 35 exploration wells were started (23 wildcat wells and 12 appraisal wells), as shown in Figure 2. A total of 15 oil and gas discoveries were made, providing a gross resource growth of 52 million Sm^3 o.e.

Total greenhouse gas emissions from the NCS and onshore facilities under the Petroleum Tax Act in 2023 were 11.1 million CO_2 equivalents, a decrease of just over 4 percent from 2022. The decrease from 2022 to 2023 is partly explained to the electrification of Edvard Grieg and the electrification of Snorre and Gullfaks with wind power from Hywind Tampen. Additionally, Knarr was shut down in 2022. CO_2 emissions per produced unit decreased from 7.6 kg/barrel o.e. in 2022 to 7.3 kg/barrel o.e. in 2023.

Methane emissions on the NCS are low by international standards, and total methane emissions decreased further from 12,997 tonnes in 2022 to 11,579 tonnes in 2023.

Total NOx emissions from petroleum activities were reduced by nearly 10 percent from 2022 to 2023, with reduced NOx emissions from both turbines and engines. Total NOx emissions in 2023 were 33,691 tonnes.

There was higher drilling activity in 2023 than in 2022, yet less drilling fluid was used compared to the previous year. This indicates efficient drilling operations, which is also reflected in the air emissions from mobile rigs. The use of water-based drilling fluids was reduced by 25 percent, and the use of oil-based drilling fluids was reduced by over 3 percent. There was a decrease in the discharge of cuttings drilled with water-based drilling fluids by over 15 percent, injection of cuttings increased by over 50 percent, and the amount of hazardous waste sent to shore increased slightly in 2023 compared to 2022.

Produced water discharges in 2023 amounted to 113 million m^3, a decrease from 116 million m^3 in 2022. Since 2015, emissions have been reduced by over 30 million m^3. The proportion of injected produced water remains at the same level as last year (around 30 percent). Many fields on the NCS are mature, requiring increased water injection to maintain reservoir pressure, which in turn increases the amount of produced water from these fields.

The average oil content in produced water decreased from 11.8 mg/l in 2022 to 11.5 mg/l in 2023. The regulatory threshold for oil content is 30 mg/l. Both research results, environmental monitoring, and companies' own risk-based models of these discharges show that the environmental impact of the 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 they were ten years ago. The reason is a risk-based approach, and the substitution of chemicals identified as environmentally hazardous.

The industry actively works to substitute chemicals to reduce the risks associated with discharges. Total chemical discharges decreased from 172,000 tonnes in 2022 to 162,000 tonnes in 2023, with

approximately 90 percent of the emissions falling into the so-called green category, which has no or very little environmental impact. The most environmentally hazardous chemicals in the red and black categories now account for 0.25 and 0.002 percent of emissions, respectively.

Extensive preventive work in the industry to avoid unplanned acute oil spills has led to a downward trend in the number of oil spills over many years. The total volume of spills varies significantly from year to year and is dominated by isolated incidents. In 2023, there were a total of 41 acute oil spills, of which 12 exceeded 50 litres in volume. When looking only at crude oil spills, there were a total of 18 spills, and in the category greater than 1 m^3, there was 1 spill in 2023. The total volume of acute oil spills in 2023 was 71 m^3, an increase from 61 m^3 in 2022. The largest single spill in 2023 was 64 m^3, an incident at Alvheim in November 2023.

The number of unplanned chemical spills remained roughly unchanged from 2022 to 2023 (194 in 2022 and 199 in 2023). More than half of the spills were small (under 50 litres), and the total discharge volume decreased from 388 m^3 in 2022 to 349 m^3 in 2023. The majority of the discharges (99.3 percent) are chemicals classified as yellow and green, with no or minimal environmental impact.

Environmental monitoring is conducted by independent consultants pursuant to government recommendations. The industry invests significant resources each year to determine which discharges may have an impact on the natural environment. Environmental monitoring of the seabed and the water column is carried out, along with visual monitoring, especially in areas with vulnerable fauna.

Results from seabed surveys indicate that the impact is related to particle discharges and sedimentation, primarily within a few tens to a few hundred meters from the discharge. For water column monitoring, results show 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

3.1 Production of oil and gas

In 2023, total petroleum production from the Norwegian continental shelf amounted to approximately 233 million Sm^3 o.e. , This is roughly at the same level as in 2022 as shown in Figure 1.. Of this, oil accounted for approximately 104 million Sm^3 o.e., gas 117 million Sm^3, and NGL 12 million Sm^3 o.e.

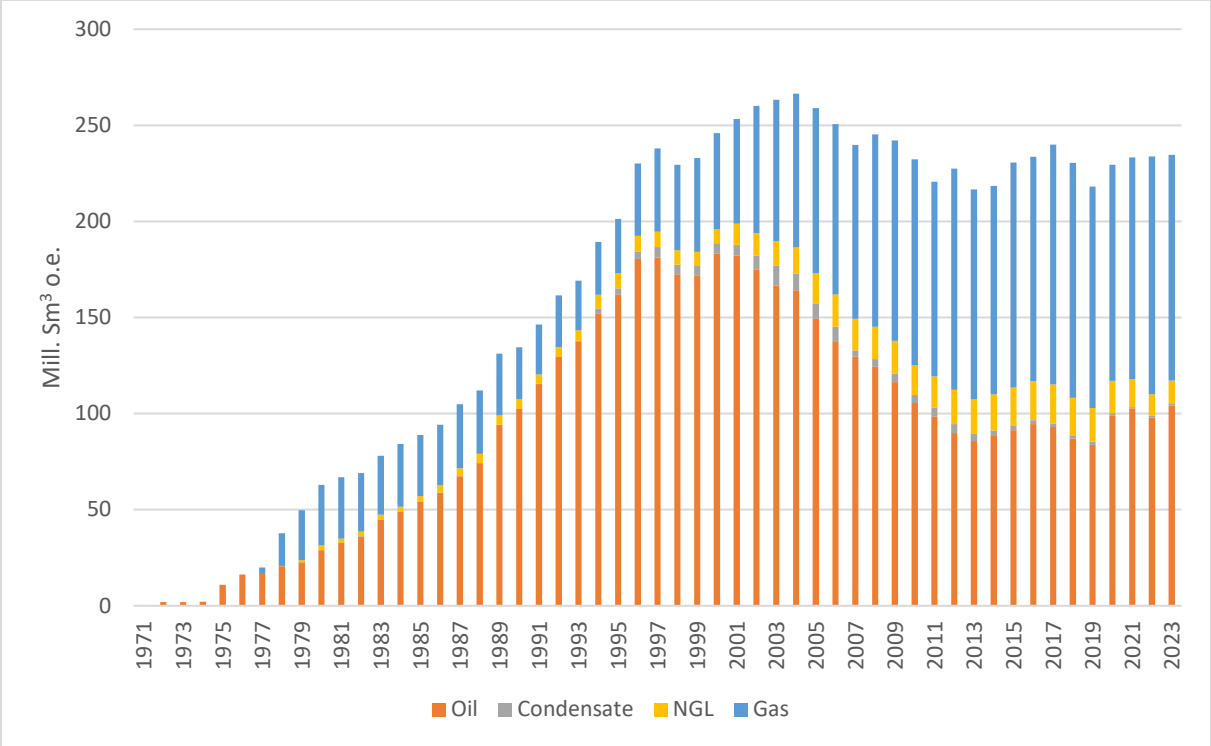


Figure 1: *Historical petroleum production on the NCS*

3.2 Oil and gas market

The gas price in Europe has dropped significantly from the historically high levels in the autumn of 2022. Relatively low gas demand throughout the previous winter, combined with high imports of liquefied natural gas (LNG), has contributed to a stable high level in European gas storage. This has reduced uncertainty in the market. However, Europe remains heavily dependent on importing natural gas, either through pipelines or in the form of LNG. Since Russia's invasion of Ukraine in February 2022, Russian pipeline gas to the EU has largely disappeared. Much of this loss has been replaced by increased imports of LNG, but increased and stable deliveries of Norwegian pipeline gas have also been crucial.

Despite less uncertainty in the market compared to autumn 2022, gas prices remain volatile and tends to react sharply to global events that may threaten supply. This was recently exemplified by increased tensions between Iran and Israel and fears regarding LNG transport through the Strait of Hormuz, combined with increased demand in Asia. Many analysts expect that the global gas market will be tight in the years to come.

Oil prices have fluctuated significantly throughout the year in line with updated expectations for economic prospects, announced production cuts, and geopolitical events. Increased tensions in the Middle East have heightened uncertainty in the market but have not yet caused major disruptions in trade flows. Russian oil exports have remained high in recent years, with a large portion now being exported to China, India, and Turkey. In Europe, increasing import shares are seen from, among others, Norway and the USA.

The International Energy Agency (IEA) estimates a growth in global oil demand of 1.2 million barrels per day (mbbl/d) in 2024 and 1.1 mbbl/d in 2025. This represents a decrease in the growth rate of oil demand compared to 2023. At that time, the growth in oil demand was 2.3 mbbl/d, primarily due to developments in China and strong growth within the petrochemical industry. The declining growth rate is related to the fact that the economic recovery after the pandemic is largely complete, combined with a steadily growing electric vehicle fleet and increased focus on energy efficiency.

3.3 Investments on the Norwegian continental shelf

Global upstream investments in oil and gas fell sharply in 2020 due to the COVID-19 pandemic and the drop in oil prices. Since then, investments have gradually picked up in line with the price developments for oil and gas. On the NCS, the development has been more stable, largely due to the temporary changes in the petroleum tax regime.

Upstream investments in offshore oil and gas, both globally and on the NCS, are expected to remain at a higher level going forward. This contributes to increased order intake in the number of supplier segments.

The development is also reflected in the results from Norges Bank's latest regional network reports, where oil suppliers generally report expectations of increased activity and high-capacity utilization. In NHO's member survey, a clear majority of Offshore Norge's members, both operators and suppliers, assess the market situation and outlook as positive. There is, and may continue to be, strained capacity within several supplier segments in the coming years, but the effect is considered to be temporary.

Offshore Norge presented its updated investment analysis for the NCS in December 2023. The analysis includes estimates for investment levels on the NCS over the next five years. In 2024, investments are estimated to total NOK 240 billion.

Between 2020 and the end of 2022, a number of development projects were sanctioned. During the period, development plans were submitted for 18 new developments and 13 plans for further development of fields in production. In addition to these development projects, decisions were made regarding investments in projects for enhanced recovery, etc., from existing fields. These projects will fall under the temporary changes to the petroleum tax regime introduced in the summer of 2020 and contribute to a high level of activity in the coming years.

The phasing of investments is still somewhat uncertain, but a large portion of investment activity is concentrated in the years 2023–2026. From 2024, investments are expected to gradually decline towards 2028 as these projects are completed. New projects, both standalone development projects and smaller tie-backs, will help maintain the investment level throughout the period.

3.4 Exploration activity, APA 2023, APA 2024

In 2023, 35 exploration wells commenced drilling (23 wildcat wells and 12 appraisal wells), as shown in Figure 2. A total of 15 oil and gas discoveries were made, providing a gross resource growth of 52 million Sm^3 o.e. Between 40 and 50 exploration wells are expected to be drilled in 2024.

In the awards in predefined areas (APA) 2023, 24 companies were awarded shares in 62 production licences. The 62 production licences are distributed as follows: 29 in the North Sea, 25 in the Norwegian Sea, and 8 in the Barents Sea.

The Ministry of Energy submitted a proposal for the announcement of APA 2024 for consultation on January 31. The Ministry stated that APA 2024 will be conducted according to the usual schedule.

As a result of the budget agreement between the Socialist Left Party (SV) and the Norwegian government for the 2023 state budget, a 26th licensing round will not be conducted during this parliamentary term.

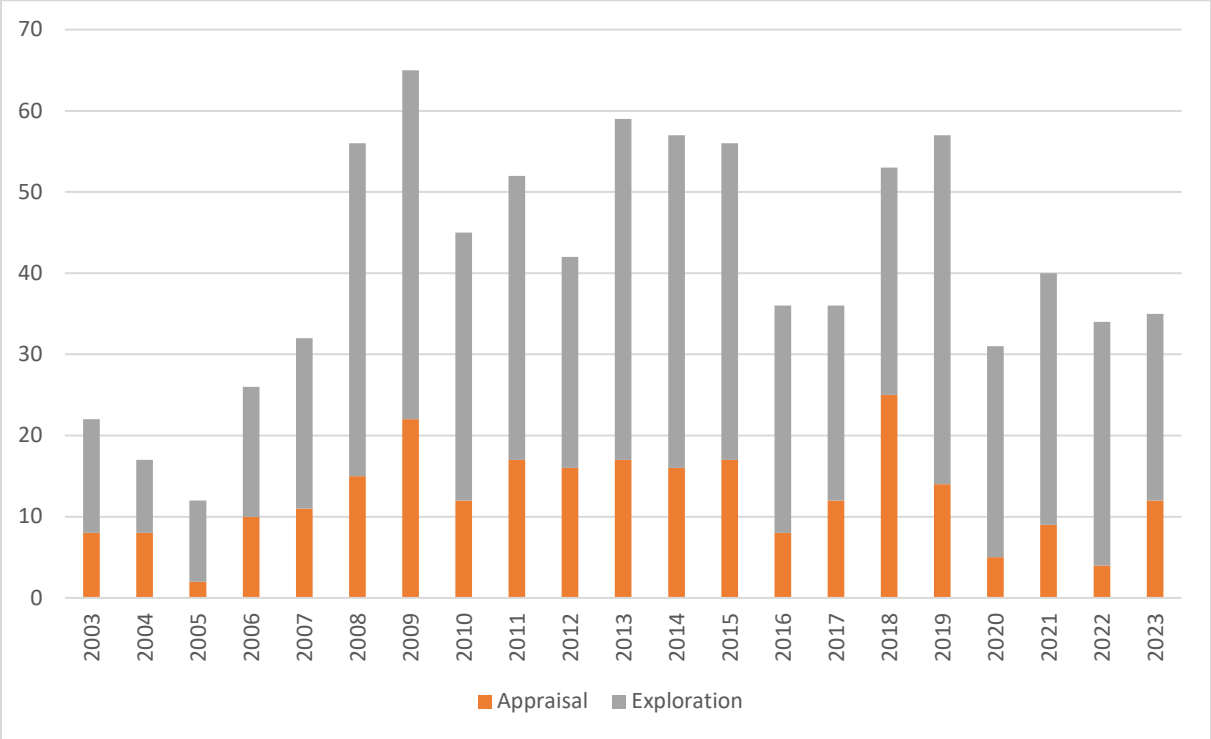


Figure 2: Exploration wells started on the NCS (Source: the Norwegian Offshore Directorate).

4. Discharges to sea

Discharges to sea consist primarily of discharges from well drilling and produced water. Produced water is water that accompanies the oil from the reservoirs. Drilling discharges are mainly comprised of rock particles from the borehole and drilling fluid. Discharges are only permitted from wells drilled using water-based drilling fluid, as well as oil-based drilling fluid with permission from the Norwegian Environment Agency, if contamination from oil-based fluids is less than ten grams of base oil per kilogram of cuttings.

Figure 3 shows that drilling activity in 2023 increased slightly from 2022 to 2023, with a total of 206 wells drilled, of which 35 were started exploration wells. Discharges of produced water reached a peak in 2007 at just over 160 million Sm^3. In 2023, total discharges amounted to 113 million Sm^3.

4.1 Discharges from drilling

Drilling activity increased slightly from 2022 to 2023. The number of new production wells drilled in 2023 was 171. The number of exploration wells was 35, roughly the same level as the previous year (34).

The drilling fluid used in well drilling serves many functions. It transports cuttings to the platform while lubricating and cooling the drill bit. At the same time, the drilling fluid prevents the borehole from collapsing. Last but not least, it keeps the well pressure stable and prevents uncontrolled oil and gas blowouts.

The industry primarily uses two types of drilling fluids: oil-based and water-based.

The discharge of oil-based or synthetic drilling fluids, or cuttings contaminated with these, is prohibited if the oil concentration exceeds one percent by weight. One percent by weight equates to ten grams of oil per kilogram of cuttings. Drill cuttings discharge contaminated with oil-based or synthetic drilling fluids containing less than one percent 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.

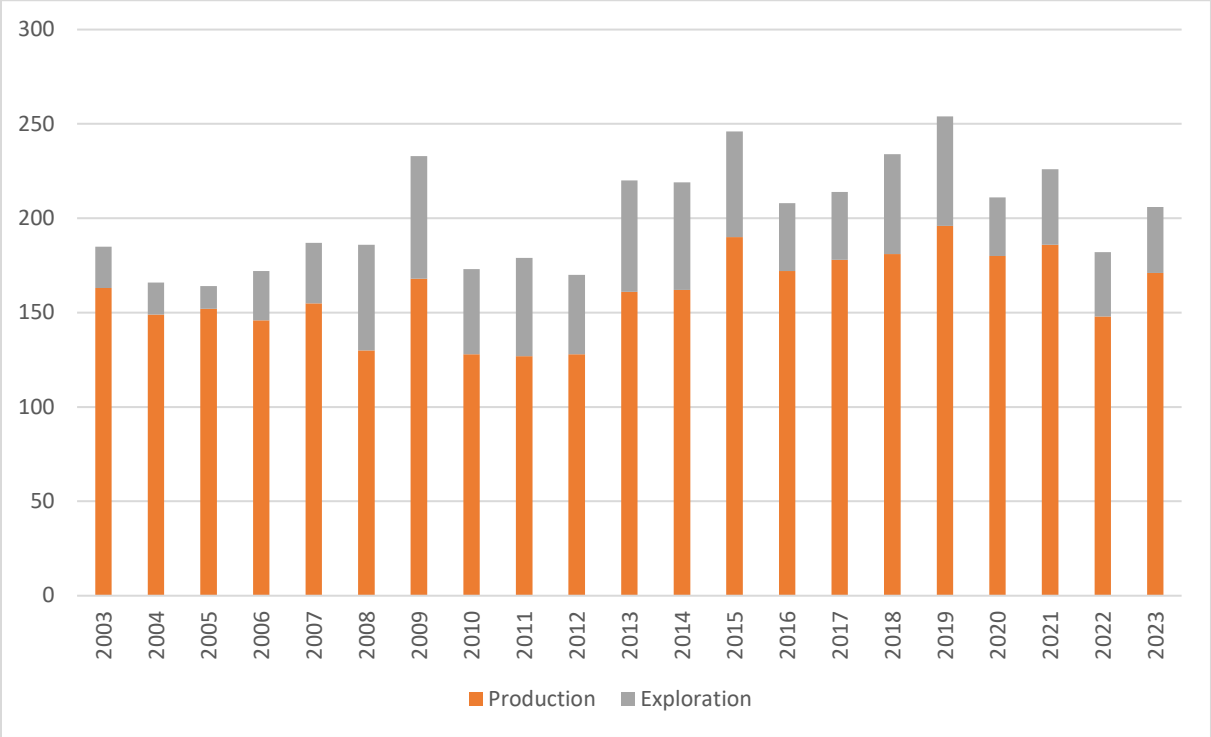


Figure 3: *Number of wells drilled on the NCS (Source: Norwegian Petroleum Directorate).*

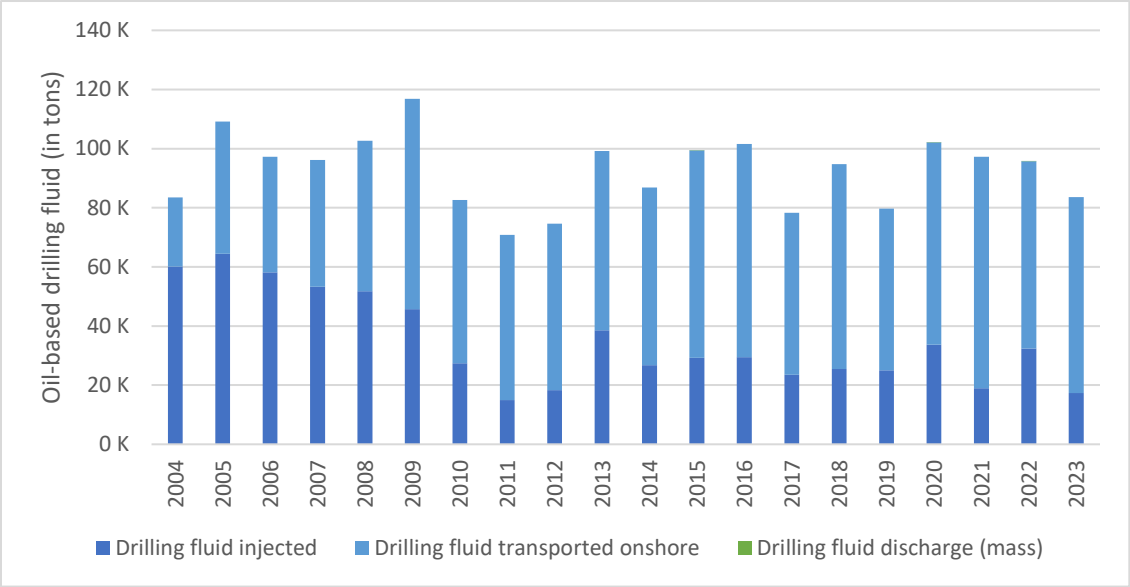


Figure 4: *Disposal of oil-based drilling fluid*

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

The use of oil-based drilling fluid decreased by over 3 percent from 2023 compared to 2022, as shown in Figure 4. The quantity of oil-based cuttings contaminated by drilling fluids and injected sub-surface has shown a downward trend in recent years but increased slightly from 2022 to 2023.

The quantities of drill cuttings presented in Figure 5 are based on calculations of the rock which has been drilled out. The quantities of drill cuttings registered as hazardous waste transported onshore (see Chapter 8) are, however, significantly larger. This is because cuttings from many fields are slurrified by adding water to make them easier to handle from the platform to the vessel and then to shore. This nonconformity is therefore largely due to water being added to the cuttings before they are received onshore.

The quantity of oil-contaminated drill cuttings transported onshore as waste increased from 2022 to 2023. In 2022, the quantity was just under 70,000 tonnes, and in 2023, it was 88,000 tonnes. The water and drill cuttings are separated onshore. Whilst the water is treated and discharged to the sea, the cuttings undergo further treatment in accordance with current regulations.

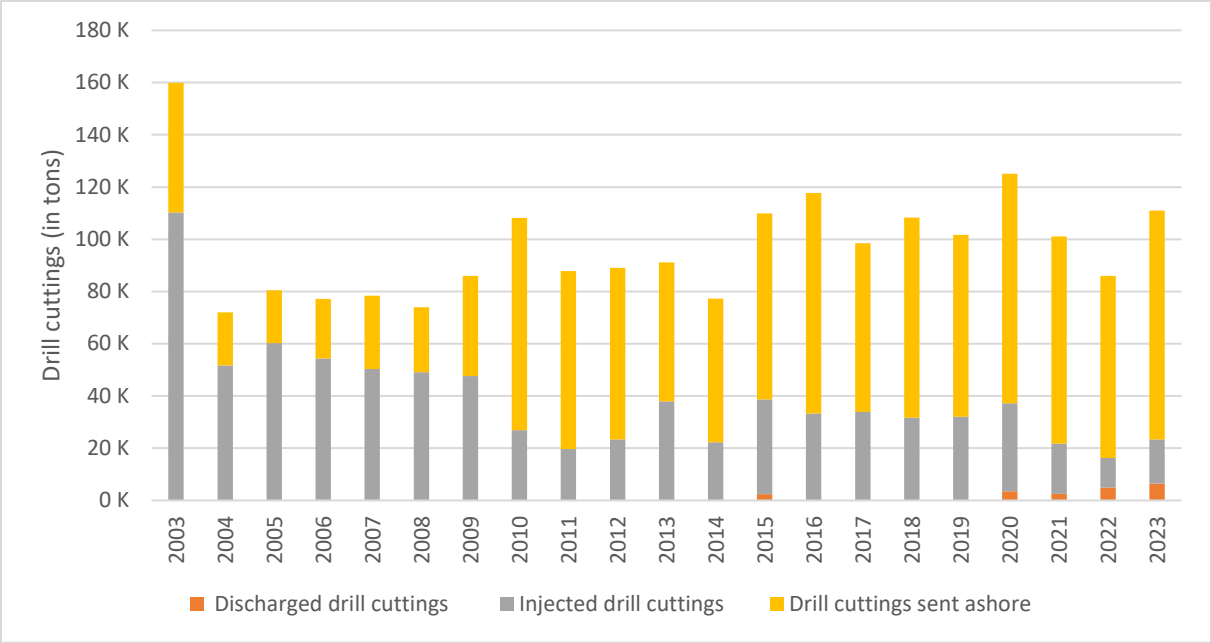


Figure 5: Disposal of drill cuttings contaminated with oil-based drilling fluids

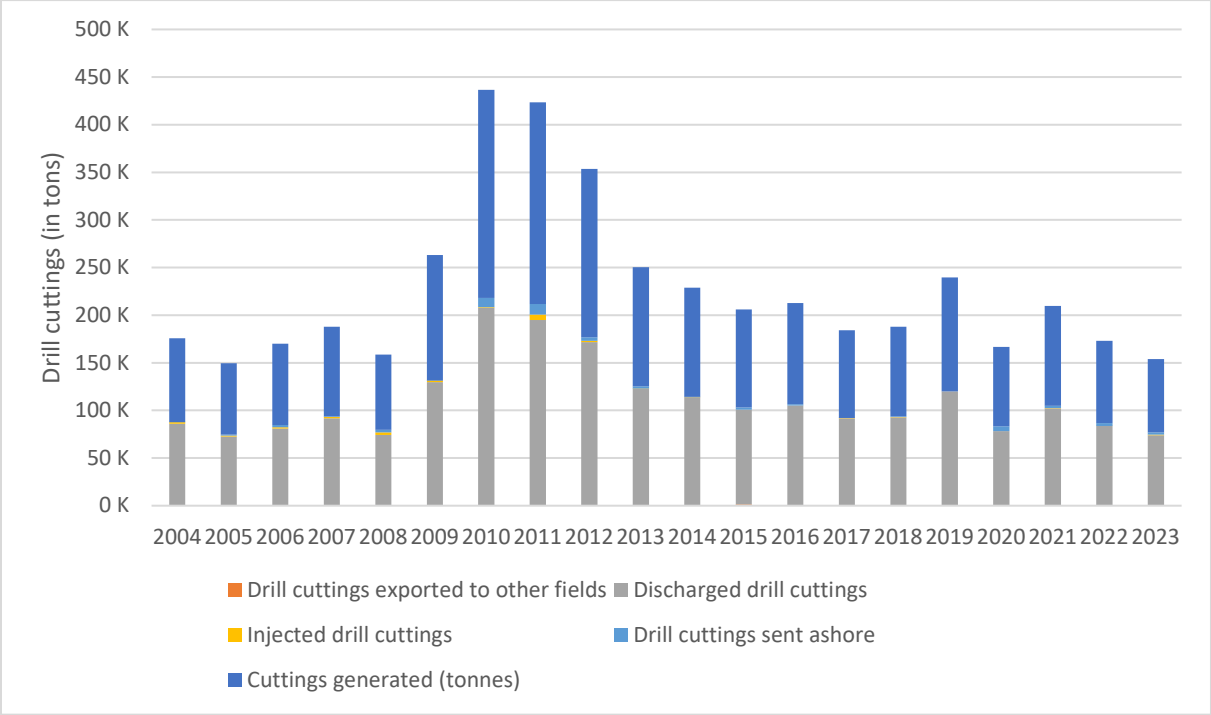


Figure 6: Disposal of drill cuttings from wells drilled with water-based drilling fluids

In 2023, discharges from drill cuttings drilled with water-based drilling fluid were approximately 74,000 tonnes, a decrease of 12 percent from the previous year, as shown in Figure 6. Water-based drilling fluids mainly contain natural components such as clay or salts. These substances are classified as green in the NEA's classification system. According to OSPAR, they pose little or no risk to the marine environment when discharged.

The potential impact of these discharges on the environment is monitored through 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. Produced water
   This is water that accompanies oil and gas from the reservoir. Produced water is complex and can contain several thousand different individual components. Routine analyses of the water are therefore conducted. When produced water is injected to enhance production, it will mix with formation water. The produced water will also contain various chemical additives, for example, to inhibit bacterial growth, corrosion, and emulsion. On the offshore installations, the water is treated using various treatment technologies before being discharged to the sea. Different treatment technologies help to keep the oil content as low as possible. The regulatory threshold for oil concentration in produced water discharged to the sea is 30 mg/l.
2. Displacement water
   Seawater is used as ballast in storage cells on some platforms. When oil is to be stored in the storage 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 usually low. The discharged volume depends on the oil production.
3. Drainage water
   Rainwater and water washed off the decks may contain chemical residues and oil. Drain water discharges make up only a small proportion of the total volume of water discharged.

"Other oily water" is also reported. For example, particles and oil-contaminated sand that are collected in separators must be flushed out from time to time, known as jetting. Some oil adheres to the particles after the water has been treated according to the requirements, but the volume of oily water discharged to sea is marginal. Oily water can also occur from hosing down processing equipment, in connection with incidents, or from the oil droplets forming when burning oil during well testing and well maintenance work.

Discharges of produced water

Figure 7 shows the historical development of produced water volumes discharged to sea and reinjected into the bedrock. Projections for discharges of produced water from the NCS pointed upward for many years 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 significantly in the following years. From 2012 to 2015, discharges increased to nearly 150 million Sm^3. However, after 2015, they were reduced once again, and in 2023, they amounted to 113 million Sm^3, a decrease from 116 million Sm^3 in 2022. The quantity of dispersed oil to sea was 1,309 tonnes, distributed across all types of discharges. The largest discharges occur on mature fields with large volumes of produced water and produced water accounts for 95 percent of the oil discharged to sea.

On certain fields, where conditions allow, all or parts of the produced water is reinjected into the bedrock. Since 2002, injection has increased significantly and has been around 20 percent in recent years. In 2023, nearly 30 percent of the produced water was injected (46 million Sm^3), a slight increase from the previous year (43 million Sm^3).

On new fields, produced water consists solely of water already present in the reservoirs. However, the injection of water leads to an increase in produced water volumes as the field matures. Water is injected to maintain reservoir pressure and increase the oil recovery rate from the reservoir. This is primarily treated seawater. The oil recovery rate from fields on the NCS is generally significantly

higher than the recovery rate worldwide. Despite this, discharges from the NCS are comparable to international figures.

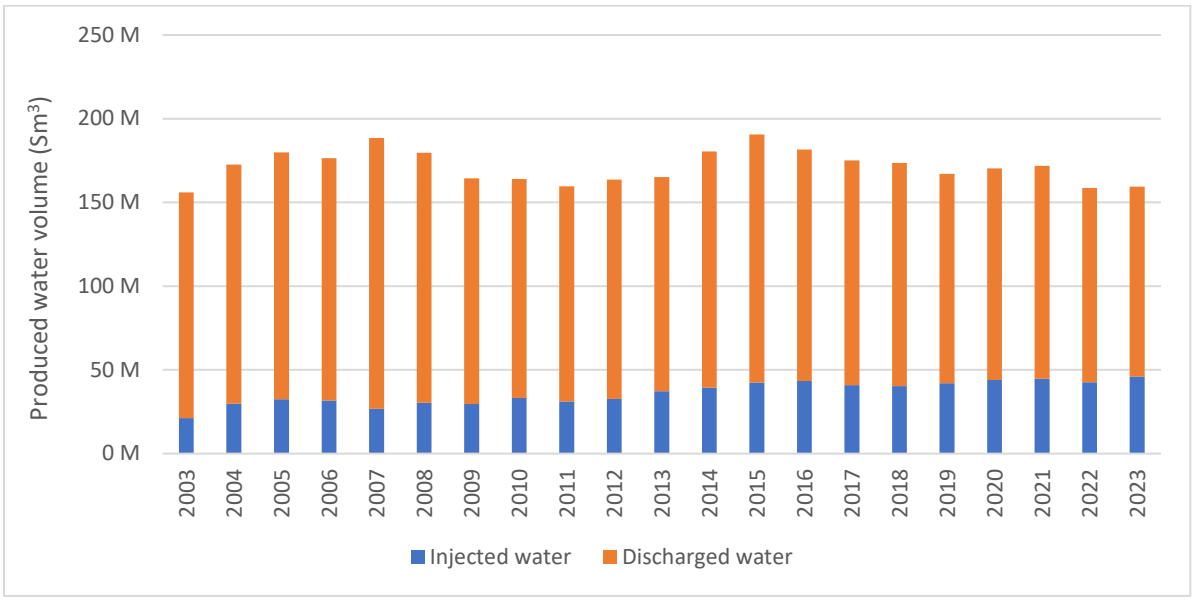


Figure 7: Produced water volumes discharged to sea and reinjected into the bedrock

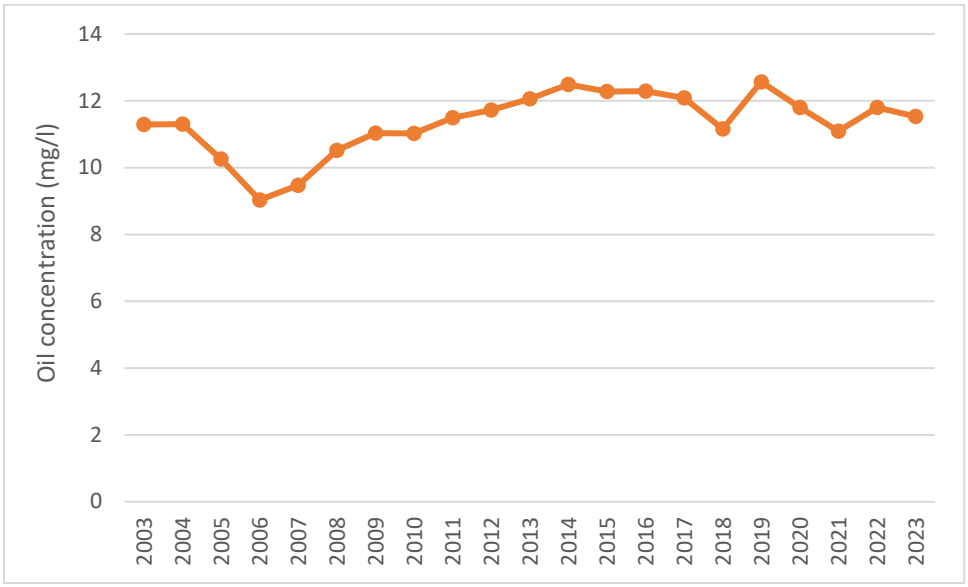


Figure 8: Concentration of oil in the discharge of produced water to the sea

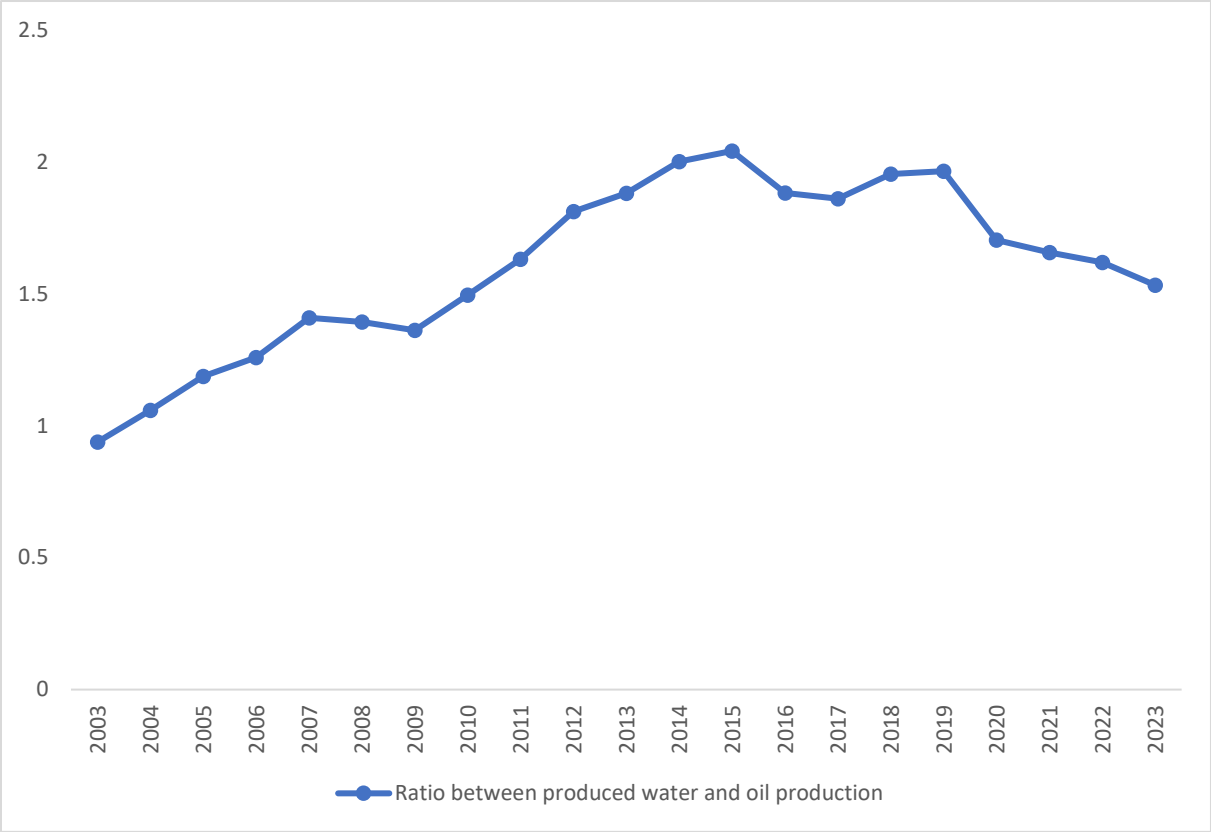


Figure 9: Ratio between produced water and oil

Before oily water is discharged to the sea, it is treated. Different technologies are used on different fields. The average oil content in produced water for the entire shelf in 2023 was 11.5 mg/l, while the regulatory threshold is 30 mg/l. The concentration of dispersed oil decreased from 11.8 mg/l in 2022, as shown in Figure 8.

The ratio between the volumes of produced water and produced oil on the NCS, shown in Figure 9, has slightly declined since 2019. This is likely due to the startup of production on several new fields. The startup of the Johan Sverdrup field, for example, contributed to higher oil production while water production did not increase correspondingly.

Both risk-based modelling and environmental monitoring studies have so far not indicated any significant environmental impact caused by discharges of 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, limited to the vicinity of the discharge.

Discharges of other types of water

Figure 10 shows that discharges of other types of water are dominated by displacement water. Discharge volumes decreased steadily until around 2010. Since 2011, discharge volumes have hovered at around 30 million Sm^3. In 2023, displacement water discharges totalled approximately 32 million Sm^3.

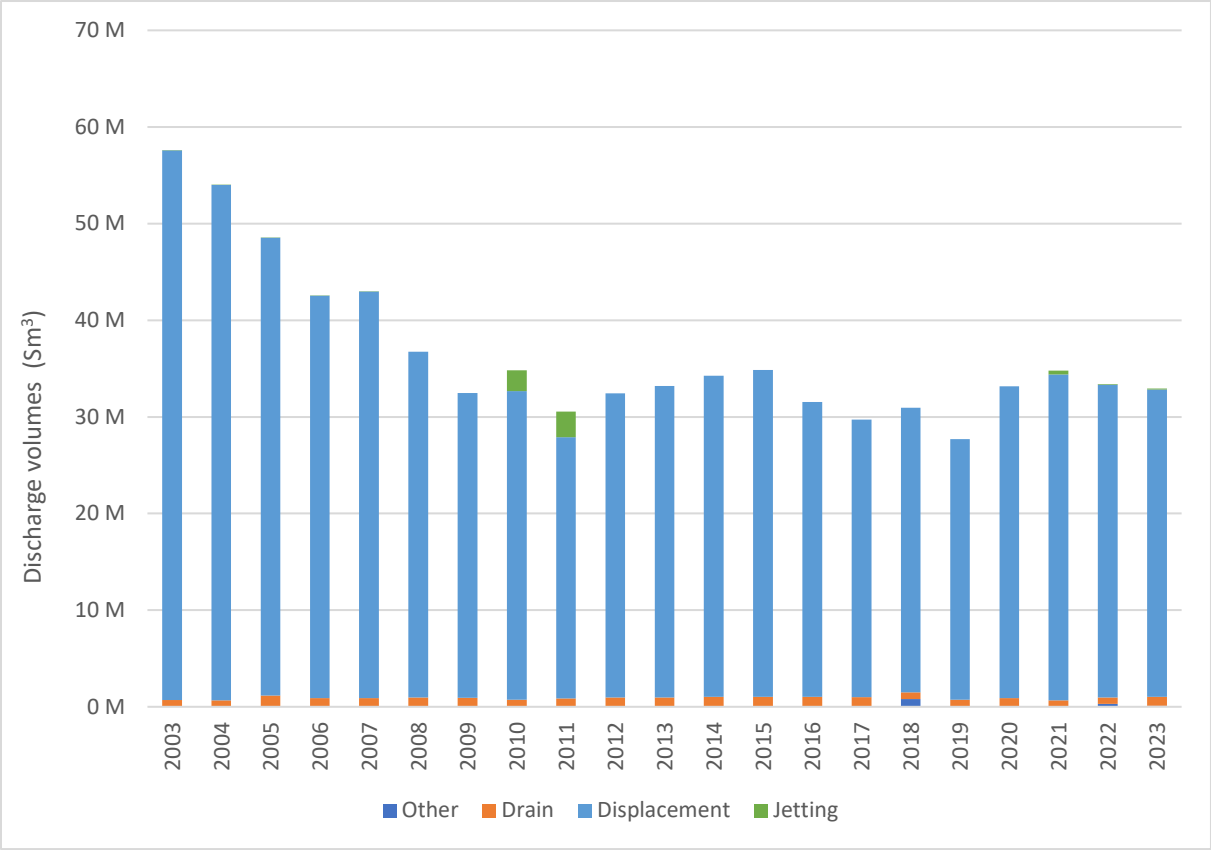


Figure 10: Discharge volumes to the sea of other types of oily water

Discharges of oil with water

The amount of oil discharged to the sea with produced water decreased from 1,370 tonnes in 2022 to 1,305 tonnes in 2023, as shown in Figure 11. A total of 1,377 tonnes of oil were discharged with water from drainage, displacement, produced water, and jetting. In 2022, this figure was 1,451 tonnes.

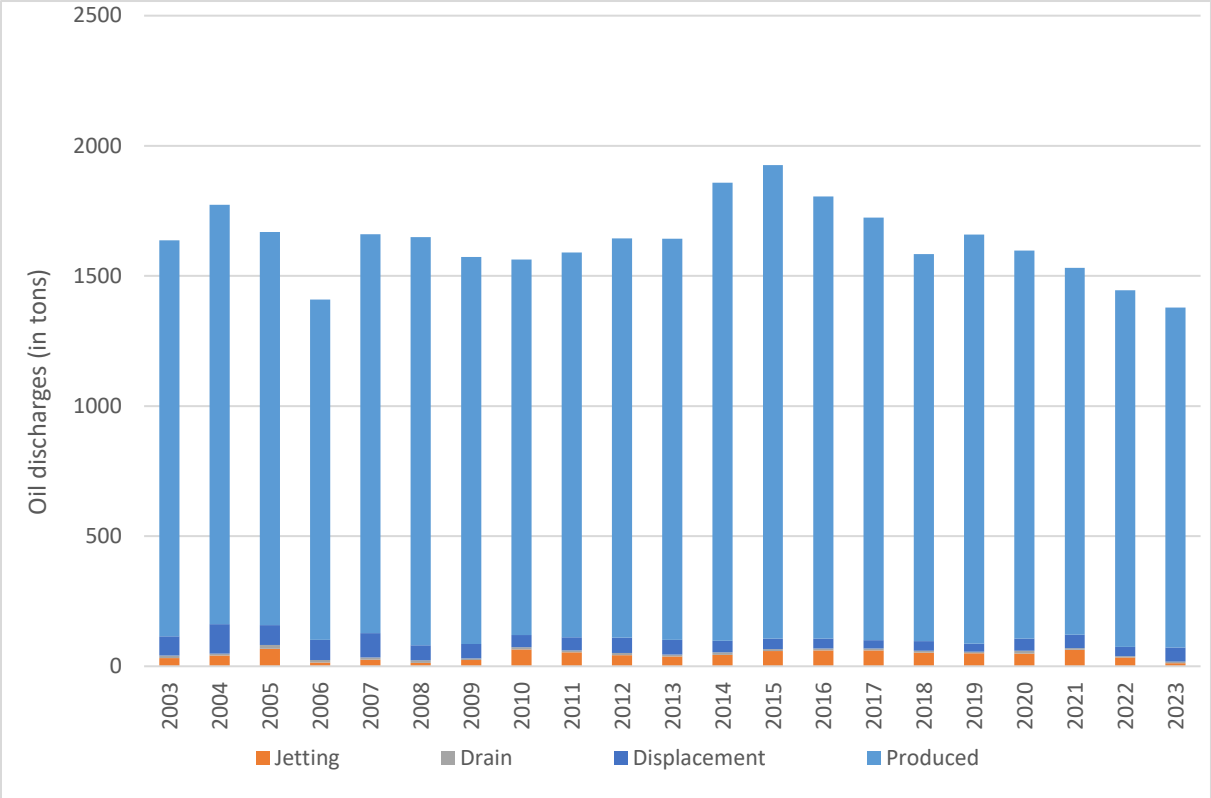


Figure 11: Oil discharges accompanying water discharges from the NCS

Discharges 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 includes mono- and polycyclic aromatic hydrocarbons (PAHs), alkylphenols, heavy metals, naturally occurring radioactive materials, organic matter, organic acids, inorganic salts, mineral particles, sulphur, and sulphides. The composition will vary between fields depending on the properties of the bedrock.

4.2 Chemical discharges

Chemicals are assessed according to their environmental properties, including their 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 activities.

Chemical additives that are subject to discharge permit requirements are divided into four categories according to the classification in the Activities regulations:

Green	Zero or minimal environmental impact. Discharges allowed without special conditions.
Yellow	Normally acceptable environmental impact. A discharge permit is required but generally approved.
Red	Must be prioritized for substitution with chemicals in the green or yellow category.
Black	Discharge is not permitted. Exceptions may be made in special cases, for example, if it is crucial for safety reasons.

A more detailed description of the classification is provided in the NEA's guideline M-107, Guidelines for reporting from offshore petroleum activities.

Discharges of chemical additives from Norwegian petroleum operations in 2023 totalled approximately 162,000 tonnes. This is a decrease of about 6 percent from 2022. Ninety percent of the discharges were green chemicals. Red and black chemicals together accounted for about 0.3 percent of the discharges, with the distribution shown in Figure 12.

Replacing chemicals with less environmentally harmful alternatives, known as the substitution obligation, is an important part of the environmental initiative to reduce potentially harmful effects from offshore discharges. Operators regularly assess the chemicals used to determine if they can be substituted. The substitution of chemicals has been extensive and has reduced the discharges of the most environmentally harmful chemicals to a fraction of what they were just ten years ago.

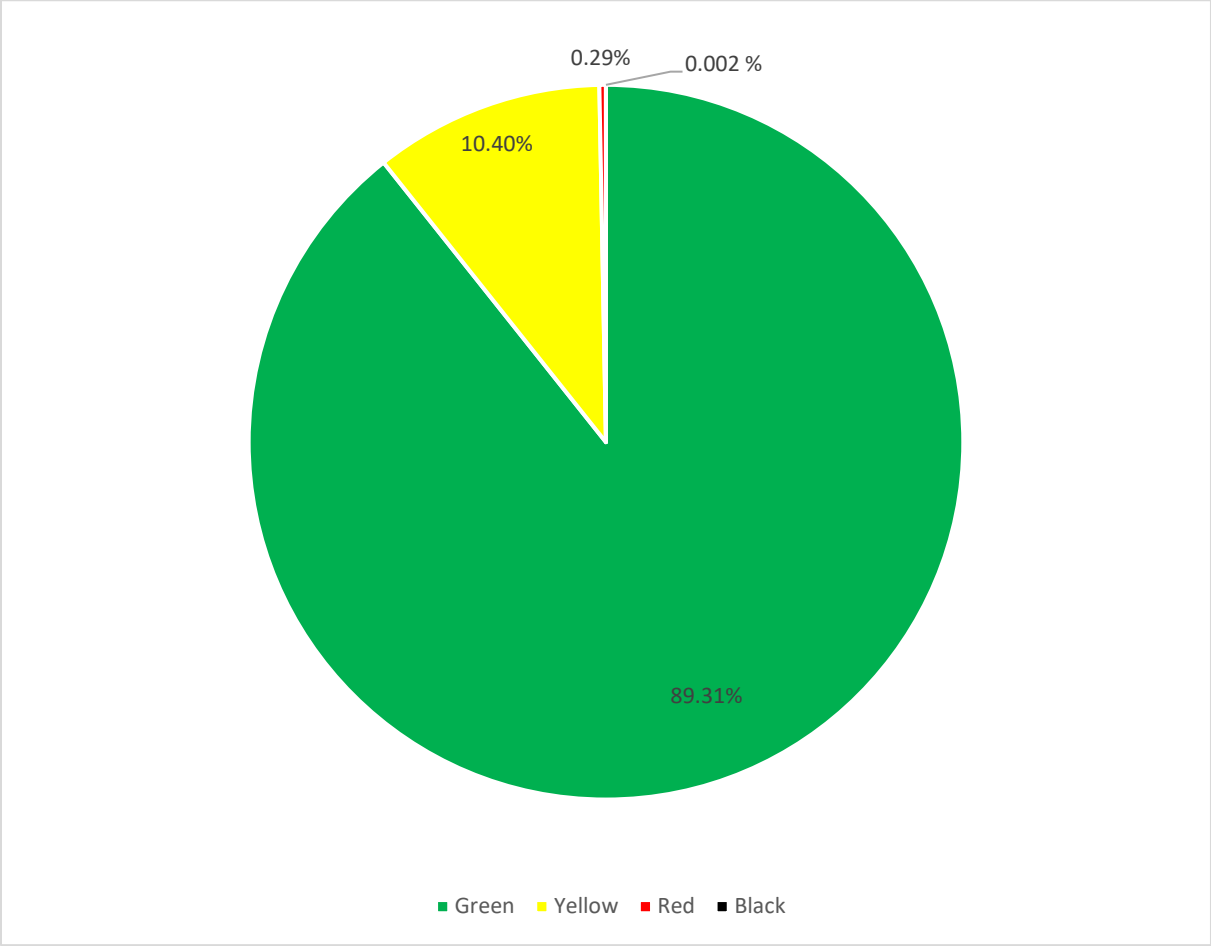


Figure 12: Distribution of discharges of chemical additives from the NCS by the NEA's colour categories

From 2011 to 2014, however, there was a substantial increase in reported discharges of black chemicals. This is primarily because discharges of fire-fighting foam were previously not reported as it was defined as a contingency chemical. There are now alternatives with less environmentally harmful properties, and fire-fighting foam has therefore been included in the substitution requirement. These new alternatives have now been phased in across all fields on the NCS.

The increase observed in 2020 is partly because lubricants leaking from submerged seawater pumps became reportable as black category discharges. Discharges from black category substances are expected to further decrease in the coming years as part of the ongoing substitution efforts. There

are now alternatives to the lubricants used in submerged seawater pumps. For some older pumps, the substitution work has stalled due to pump failures, and more knowledge about the reasons for the failures is necessary before the substitution efforts can continue.

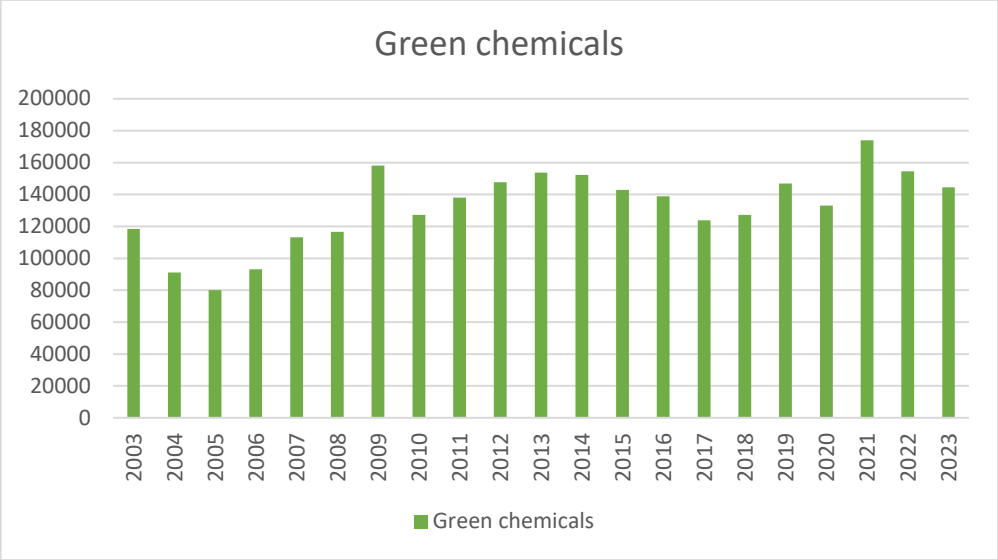
Black chemical discharges totalled 4.1 tonnes in 2023, a slight increase from 3.7 tonnes in 2022, as shown in Figure 13. This increase is partly due to boric acid and several borates used in corrosion inhibitors becoming reportable as black category, after receiving a new classification as harmful to health from the European Chemicals Agency. However, boron occurs naturally as an inorganic salt in seawater, and the environmental risk in the marine environment is assessed as low. Several of the chemicals used in freshwater production offshore lack Harmonized Chemical Notification Format (HOCNF) and are therefore classified as black.

Figure 13 shows that chemicals in the red category had a steady increase in reported discharges since 2013, when they were around 8 tonnes. In 2023, 410 tonnes of red chemicals were discharged, a decrease from 419 tonnes in 2022.

The apparent increase in recent years is due to changes in reporting requirements. For instance, the antifouling agent sodium hypochlorite, which is also used in drinking water treatment and indoor swimming pools, was reclassified from yellow to red.

In 2020, a new reporting requirement was also introduced for chemicals used in the production of freshwater. Here, several fields use self-produced hypochlorite, which must now be reported and classified as red.

Furthermore, Figure 13 shows a reduction of 11,000 tonnes in the discharge of green chemicals from 2022 to 2023, while discharges of yellow chemicals remained relatively stable.



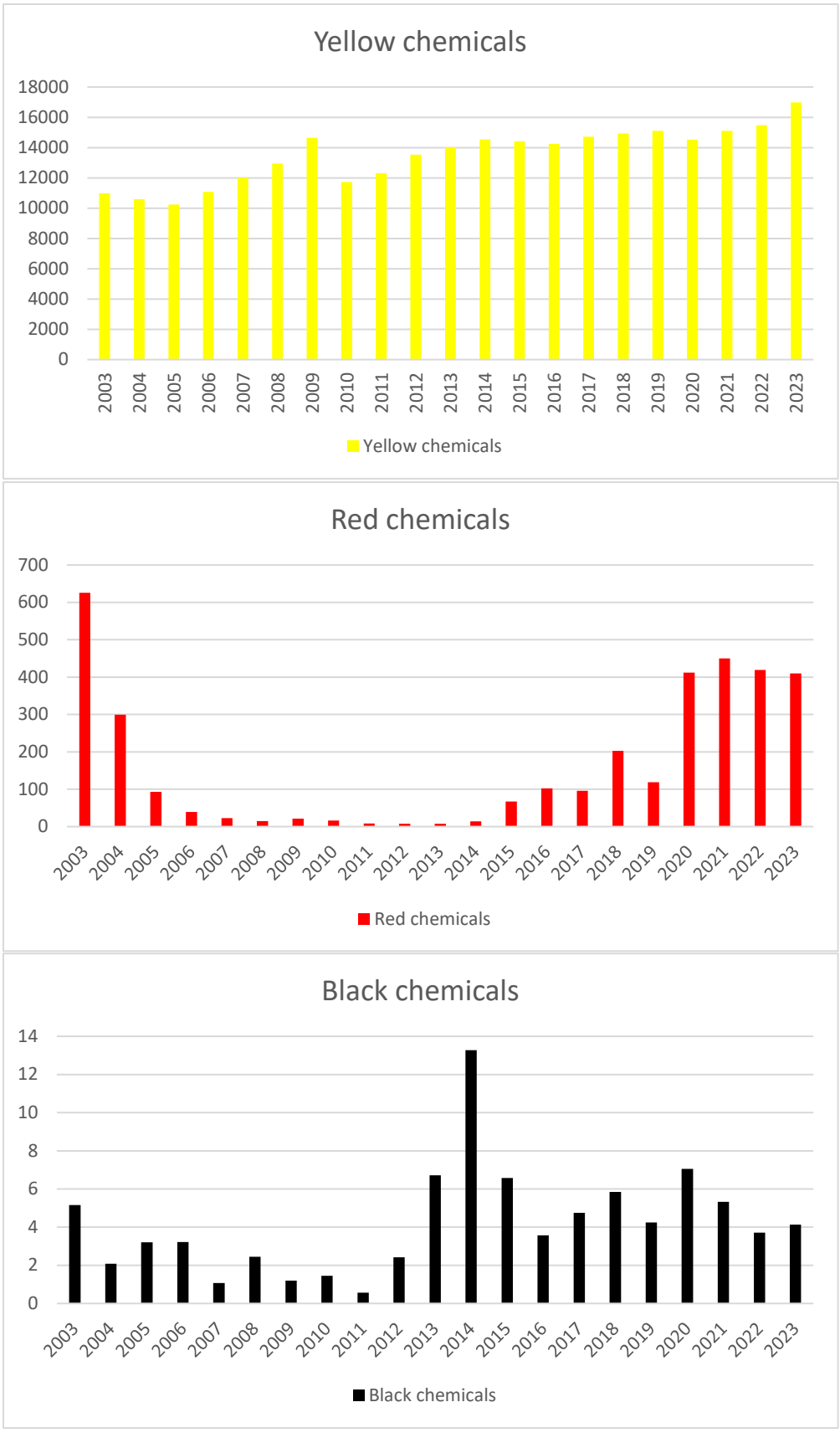


Figure 13: Discharges of chemical additives from the NCS categorized by the NEA.

4.3 Unintentional spills

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

Unintentional spills are classified according to three main categories:

- Oil: diesel, fuel oil, crude oil, waste oil, and other oils
- Chemicals and drilling fluids
- Gas emissions to sea and air

The oil and gas industry prioritizes preventive measures. These are measures (barriers) that 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 types of oil has generally decreased over the past 20 years. The marked decrease in the number of spills from 2013 to 2014 is due to a clarification of regulations, resulting in fewer oil spills of less than 50 litres, while the number of unintentional chemical releases in the same volume category increased correspondingly.

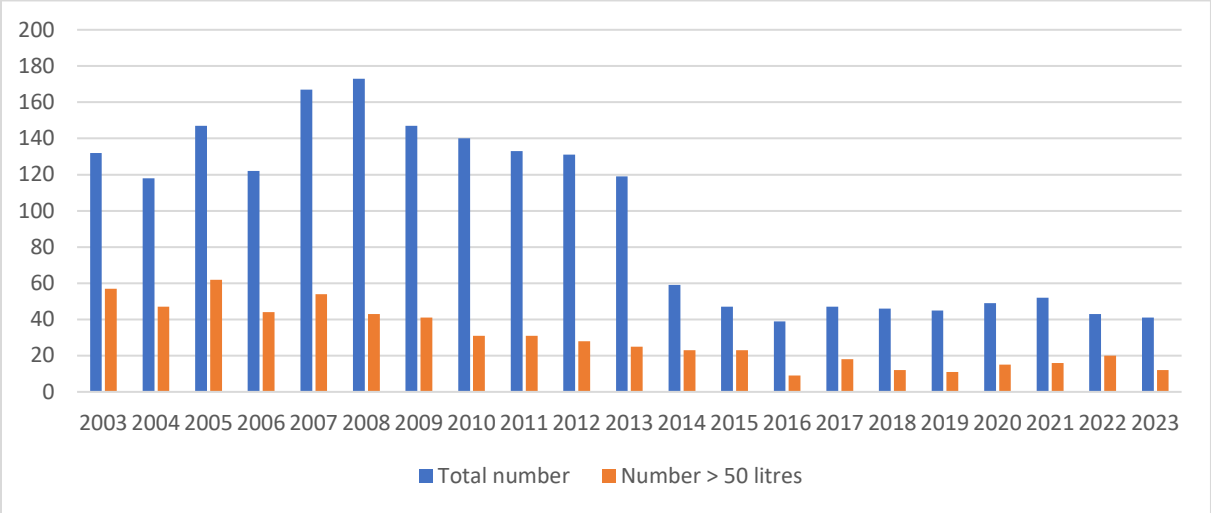


Figure 14: Number of unintentional oil spills to sea on the NCS

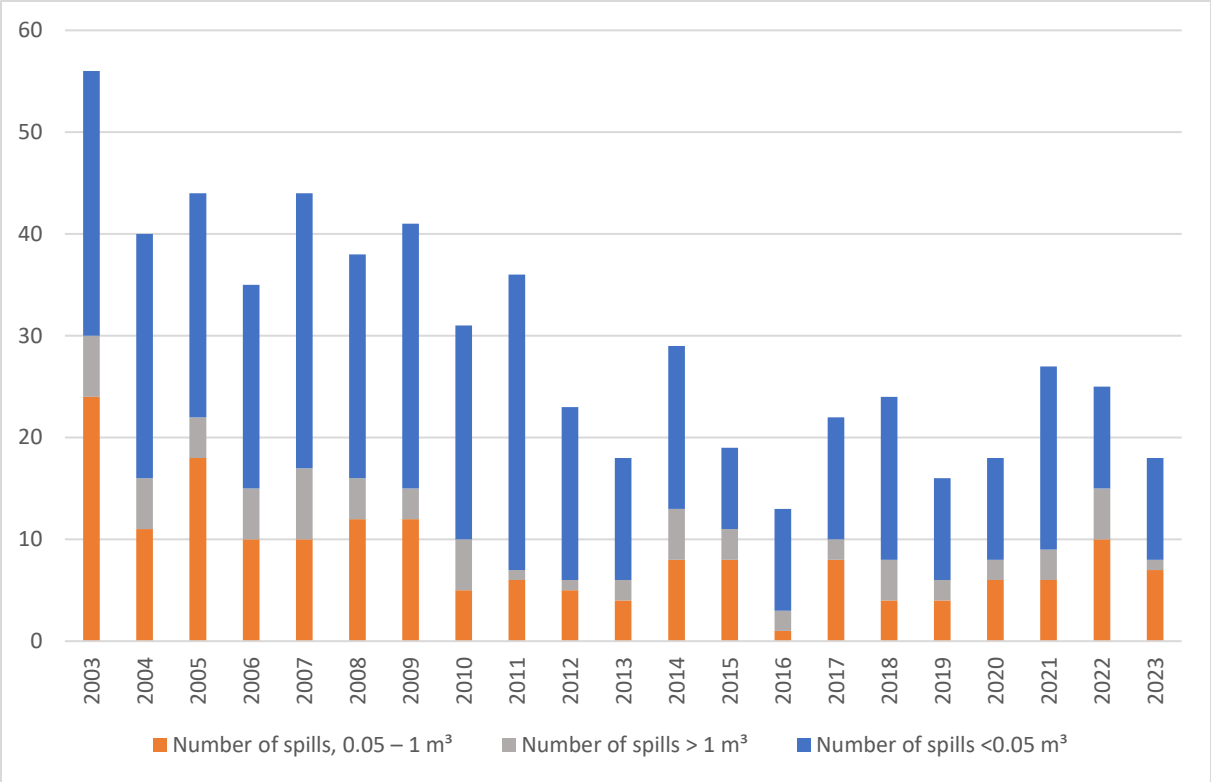


Figure 15: Number of unintentional crude oil spills to sea on the NCS.

In 2023, there were 41 incidents involving oil spills compared to 42 in 2022, as shown in Figure 14. There have been around 10 to 15 incidents per year in recent years involving spills of over 50 litres. In 2023, there were a total of 12 spills exceeding 50 litres, of which 3 were greater than 1 m³. The largest isolated spill in 2023 was 64 m³, an incident at Alvheim in November 2023.

Looking only at crude oil spills in Figure 15, there is also a clear downward trend over the past 10–15 years. In 2023, there were 18 such spills.

The total oil spill volume from unintentional oil spills varies significantly from year to year, as shown in Figure 16. The statistics are influenced by large single incidents. In 2007, the second-largest oil spill on the NCS occurred, amounting to over 4,000 m³, while total spills since then have ranged between 10 and 200 m³. In 2023, the total volume was 70 m³, dominated by a single spill.

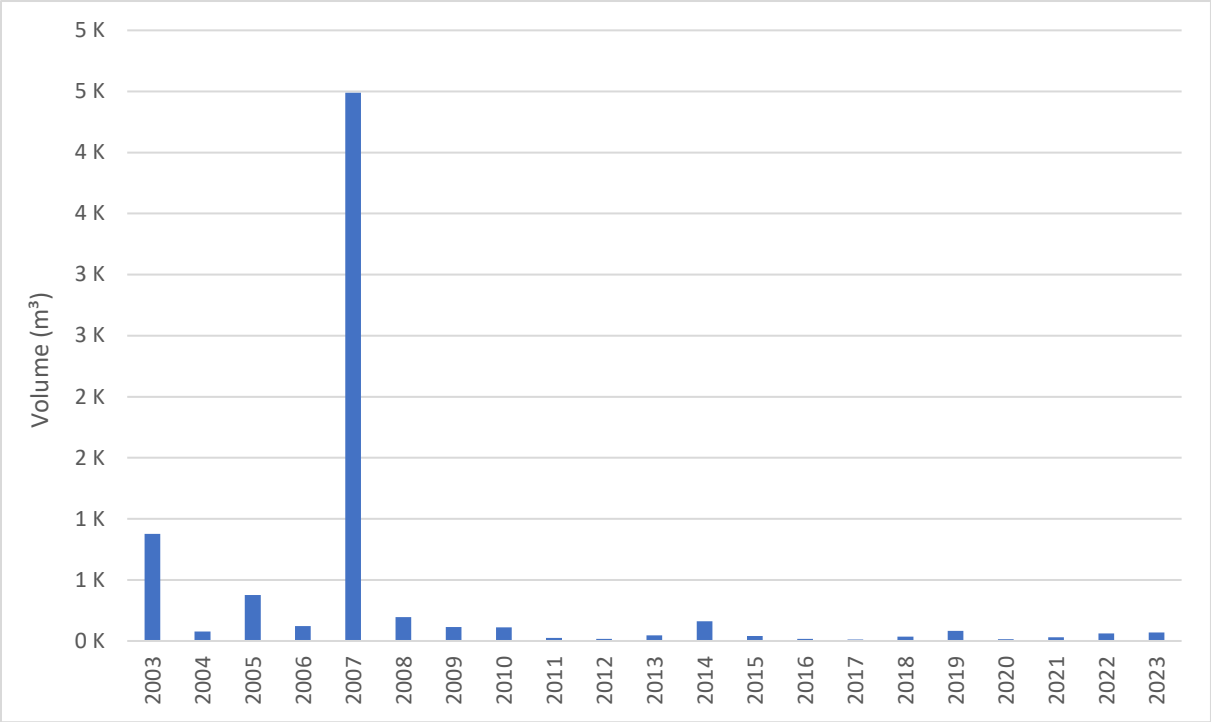


Figure 16: Spill volume from unintentional oil spills on the NCS.

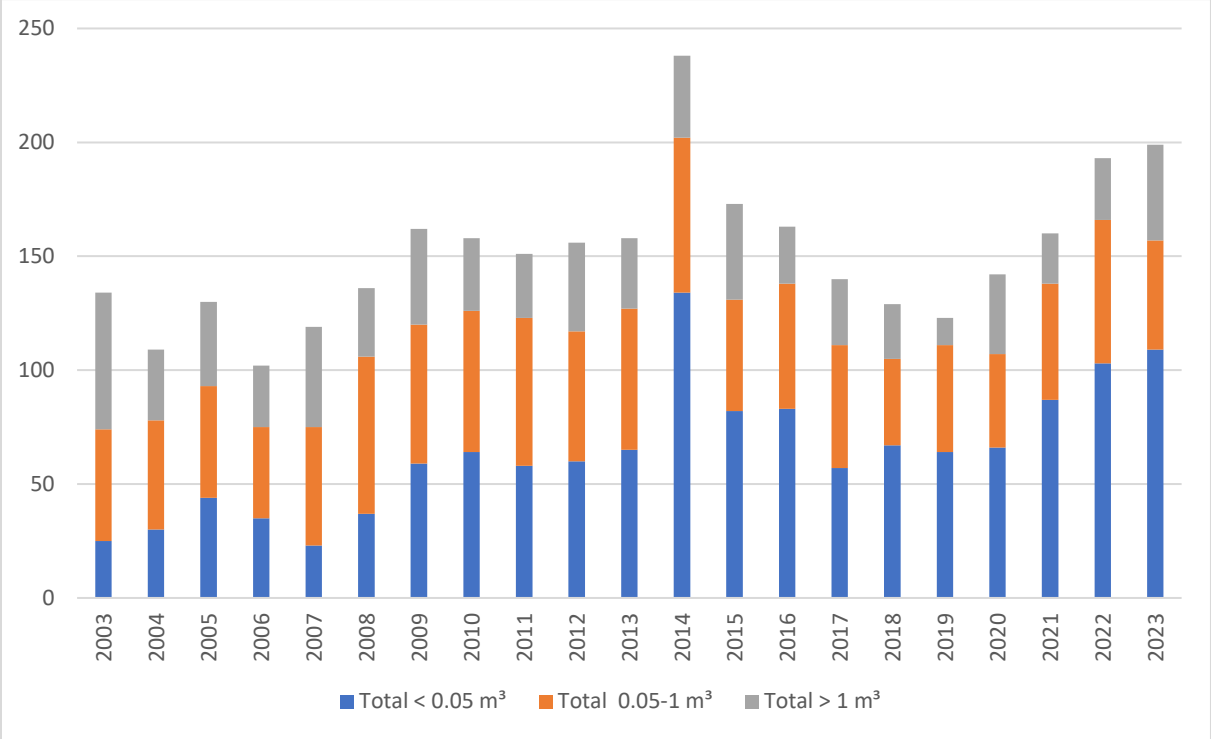


Figure 17: Total unintentional chemical spills on the NCS distributed across three spill sizes.

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 was attributed to a clarification of regulations, which led to fewer oil spills and more chemical spills. In 2023, the number of spills was 199, of which 42 were larger than 1 m³. Their distribution is shown in Figure 17.

The total volume of unintentional chemical spills in 2023 was 349 m³, a decrease from 2022 when the spills totalled 398 m³. The unintentional spills were distributed as follows: 89 percent green chemicals, 10.3 percent yellow, 0.8 percent red, and 0.1 percent black.

In the period from 2007 to 2010, the spill volumes were dominated by individual years where leaks from injection wells were detected. These wells are now permanently plugged.

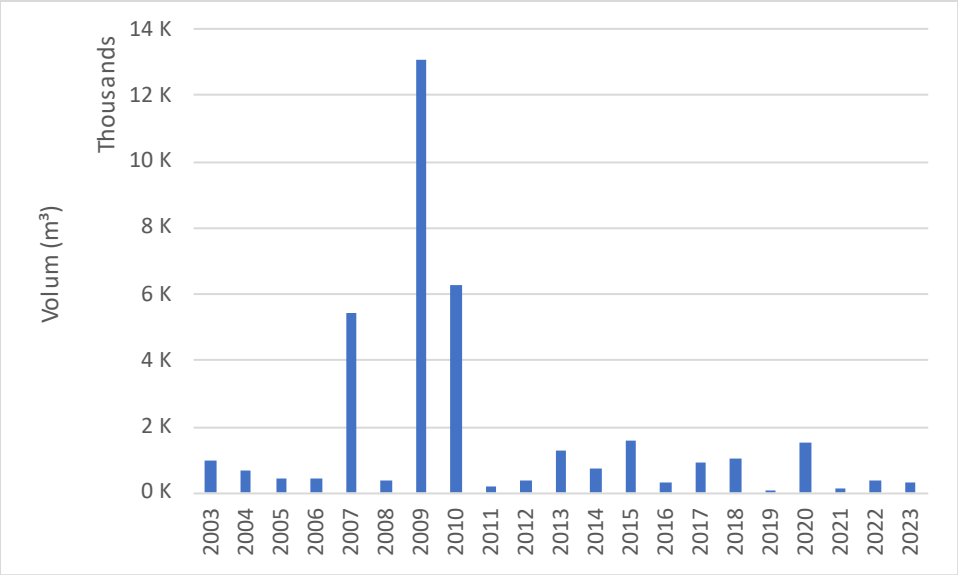


Figure 18: Total volume of unintentional chemical spills.

Unintentional discharge of gas to sea.

From the reporting year 2023, unintentional discharges of gas to the sea are also reported in Footprint. The number of unintentional discharges was 23, with a total volume of 32,907 Sm³.

Unintentional gas emissions to air.

Unintentional gas emissions are mainly small leaks of hydrocarbon gases and refrigerants from process equipment. In 2023, the number of emissions was 155, up from 132 in 2022. However, the total mass was reduced from 24,016 kg in 2022 to 7,206 kg in 2023.

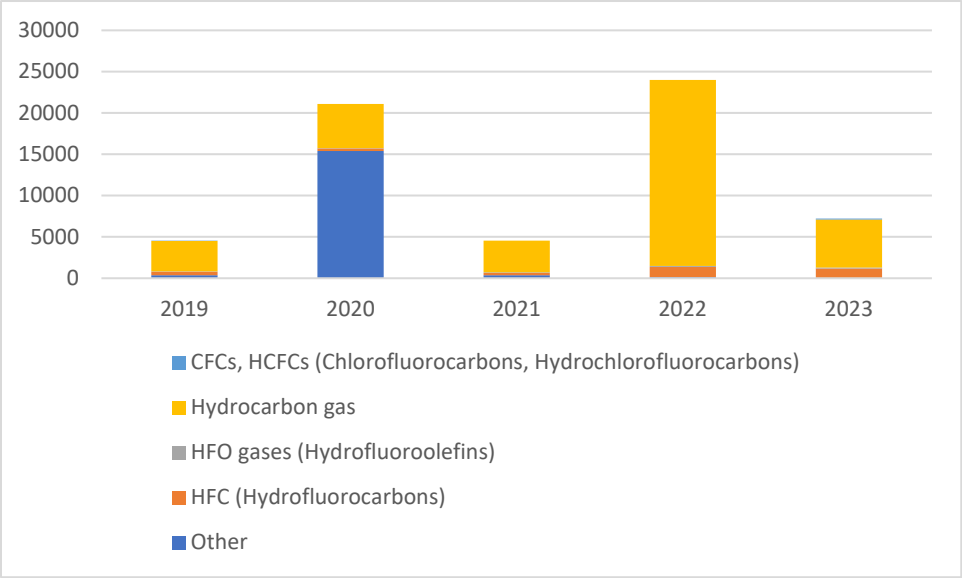


Figure 19: *Unintentional gas emissions to air.*

Leak detection.

A detection system is an important barrier for identifying leaks and other unintentional spills as quickly as possible. The system is designed to provide the necessary data so that relevant actions can be initiated as promptly as possible, also ensuring that spills are notified, reported, and documented in accordance with regulations. All facilities on the NCS currently have one or several leak detection technologies installed.

The number of incidents involving unintentional spills from subsea installations is low and is highlighted each year in the Norwegian Petroleum Safety Authority's report RNNP Trends in Risk Level.

Large spills can be detected immediately through process monitoring, and daily satellite monitoring and radar monitoring of the sea surface. However, it can be more challenging to detect small spills from subsea installations. Modern subsea installations are equipped with local leak detection systems, but this is not always the case for older installations built before such technology was available.

The NEA and the Norwegian Ocean Industry Authority (formerly the Petroleum Safety Authority) conducted 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. Some common deviations were identified among all operators, particularly related to the detection of minor leaks and performance requirement procedures. A work group was therefore established under the directive of Offshore Norge to investigate this jointly.

The findings from the audits are largely due to insufficient risk assessments of potential spills from individual installations, as well as insufficient documentation and holistic evaluations of the systems' capabilities/performance. The industry is currently working to address these issues, and assessments are ongoing to identify gaps and how to close them. Consideration must also be given to the limitations of technology; most leak detection systems can only cover a limited area and cannot always detect small spills from a distance. For the very smallest spills, inspections may therefore be the only option for detection. Inspections are carried out on all fields at regular intervals.

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

5. The marine environment, offshore operations, and management plans

Norway is a maritime nation with the goal of integrated and ecosystem-based management of marine resources and ecosystems. In 2006, the first integrated ocean management plan for the Barents Sea and the waters off Lofoten was introduced. The plan has since been expanded to include the other two marine areas, the Norwegian Sea and the North Sea – Skagerrak. The latest update of the management plans was presented in the Norwegian Parliament's White Paper (2019–2020), which for the first time combined all management plans for the marine areas. A revision of the integrated ocean management plans will be considered by the Norwegian Parliament in June 2024.

In addition to the ocean management plans, other overlapping processes within ocean management are also taking place, such as marine conservation and the follow-up of international commitments (the Kunming-Montreal Global Biodiversity Framework) as well as the development of industry plans. Offshore Norge believes that 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.

In April 2024, the Norwegian government presented the revised ocean management in the Norwegian Parliament's White Paper (2023-2024): "Norway's Integrated management plans for the Norwegian marine areas. Barents Sea, the areas off Lofoten, Norwegian Sea, North Sea, and Skagerrak" , hereinafter referred to as Meld. St. 21 (2023–2024). It clearly states that the purpose of the management plan is to create value through the sustainable use of marine area resources and ecosystem services while maintaining the structure, function, productivity, and biodiversity of ecosystems. Currently, there are primarily three major marine industries in Norway that are considered in the management plans. These are fisheries, shipping, and petroleum activities. Additionally, new industries such as offshore wind, CCS, mineral extraction, and aquaculture (outside 12 nm) are also included.

The management plans are a good and democratic tool, and Offshore Norge's members have been, and will continue to be, active contributors to building knowledge about the marine areas on the NCS and the impact that various industrial activities can have on marine natural resources. The petroleum industry has for many years been an important contributor to building knowledge about environmental values and the environmental impact of its activities on the NCS. It is important that this knowledge also becomes part of the professional basis and is utilized in management.

Offshore Norge actively works with our members to highlight this knowledge and participates with input. In this update cycle, we have participated in consultation meetings and submitted written input on the SVO report regarding environmental values , responses to factual errors/omissions in the professional basis , responses to the final professional basis , and responses to the Meld. St 21 (2023–2024) on ocean management plans for the Norwegian marine areas (2023–2024). The next revision of the ocean management plans is underway, and data about updates on the scientific basis can be found on Havforum .

The participation of interest groups is an important part of ecosystem-based management. In the process leading to the final professional basis for the management plan, the involvement of industries has been significantly weaker than in previous updates of the professional basis. The Meld. St 21 (2023–2024) released in April 2024 now proposes the development of a concrete plan for involving affected interest groups in the work on the professional basis for the next management plan paper.

It is important that the management plan remains the overarching governance tool for Norwegian marine areas alongside relevant sector regulations.

5.2 Particularly valuable and vulnerable areas

Particularly valuable and vulnerable areas (SVO) have been identified through ocean management plans for marine areas. These are areas that, based on scientific assessments, are of great importance for biodiversity and biological production, and where potential harmful effects may have long-term or irreversible consequences. The areas have been identified based on the EBSA criteria (Ecologically or Biologically Significant Marine Areas), an internationally recognized methodology for identifying environmental values in the sea.

SVOs do not have direct effects in the form of restrictions on industrial activity but signal the importance of exercising particular caution in these areas. Such caution is maintained through management measures, for example, through area-specific frameworks for petroleum activities. This can include restrictions such as drilling time limits, environmental mapping, measures to reduce the risk of acute discharges and emissions or long-term environmental damage, and requirements for monitoring and environmental assessments to follow up on the impact of petroleum activity. Which management measures are relevant should be assessed based on the distribution of environmental values in time and space, and where and when the relevant environmental values are vulnerable to different activities.

In Meld. St 21 (2023–2024), there are 19 SVO areas, which is a consolidation of several previously defined areas, adjustments of earlier distributions, as well as the introduction of new areas. The number of SVOs is fewer, but the total area is significantly larger (approximately 60 percent of the Norwegian economic zone). Offshore Norge believes that when the management plan defines larger SVO areas, it underscores the need for concrete caution assessments and targeted measures to ensure relevant considerations for various environmental values. The areas have varying degrees of vulnerability and distribution in time and space, and without such concrete and sector-specific assessments, the significance of the SVO concept will be diluted. A qualitative assessment of many factors per area means that large areas are defined as valuable, which can weaken the intent of SVOs as particularly valuable areas. The white paper emphasizes that area-specific frameworks for activities should not coincide with SVO boundaries and that management measures should be based on the best available knowledge of the distribution of environmental values in time and space. Offshore Norge believes that commercial activity should only be restricted if there are actually vulnerable environmental values where the activity is planned, in order to avoid regulations based on environmental values that are not present in the relevant area.

5.3 Marine protection/international agreements related to biodiversity

Measures for conservation, sustainable use, and expertise are key components of comprehensive marine management. Conservation of areas can be achieved through marine conservation and other effective area-based conservation measures and is mentioned in St.meld.no. 29 (2020–2021)

Comprehensive National Plan for the Conservation of Important Areas for Marine Nature . Marine conservation areas can be established under the Nature Diversity Act. This law has a limited scope on the NCS, and the rule for establishing marine conservation areas does not apply beyond 12 nautical miles. Area-based measures can be implemented based on sector legislation, and this has been done, for example, within fisheries management, where several coral reef areas are protected against harmful impact from fishing activities.

Norway has also signed several international conventions and agreements on biodiversity and has actively contributed to implementing them. The UN Convention on Biological Diversity was adopted in 1992, and in December 2022, a revised nature agreement was adopted in Montreal, "Kunming-Montreal Global Biodiversity Framework." The new agreement includes specific targets for conservation, restoration, and financing, and states that 30 percent of all nature (land and sea) must be protected by 2030.

The Norwegian government has begun working on the implementation of the new global framework, and part of this work will involve establishing a new marine environment law allowing areas beyond 12 nautical miles to also be protected.

5.4 Nature risk (and nature positivity)

As pointed out by the UN Nature Panel, the world is experiencing a dramatic and accelerating loss of biodiversity caused by human activities. Nature and climate are mutually dependent, and challenges related to climate and nature must therefore be addressed together and simultaneously. This balance and the ability to find holistic solutions will be important in the coming years.

The loss of nature and biodiversity is receiving increasing attention in public debate, and there are expected to be much greater demands for documentation and reporting in these areas moving forward, partly as a result of the EU's sustainability reporting (CSRD).

The work on climate risk has been ongoing for many years and is well established in the industry. Nature risk has many similarities with this, and it is natural to use the same approach and terminology where possible. The Nature Risk Committee was established in 2022 and delivered its work in February 2024 NOU 2024:2 In Harmony with Nature. Offshore Norge has provided input to this work.

Oil and gas activities have been ongoing on the NCS for more than 50 years, and significant resources have been invested in research and development during this period to document any impact on nature and ecosystems. This work has shown that it is possible to conduct commercial activities at sea with very low impact on nature and the environment.

At the same time, the actors on the NCS want to continue to be a driving force for further improvement, and several companies have therefore set ambitious goals related to biodiversity, biodiversity conservation, or nature positivity in their corporate objectives.

5.5 Environmental risk and the precautionary principle

Knowledge about vulnerable environmental resources that may be affected by the activities of the petroleum industry is crucial, and substantial resources are allocated for mapping, environmental monitoring, impact studies, and risk analyses in all phases of petroleum operations.

Knowledge of the factual vulnerability of environmental values is essential for making sound assessments of any operational restrictions imposed on commercial activities. Both authorities and the developer can better avoid costly restrictions on activities during periods when the vulnerable resources are not present and/or when activities do not affect the relevant resource. Offshore Norge

has previously commented that the vulnerability assessments made in the scientific basis for ocean management plans have not been sufficiently precise. Before making any major changes to the existing SVOs with associated operational limitations, there must be complete clarity on what the valuable component of the ecosystem is actually vulnerable to.

The Nature Diversity Act with 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 biodiversity. It is clearly stated in the Nature Diversity Act and supporting material that the precautionary principle should be used at a decision-making level. The precautionary principle should not be applied just in case nor in situations of general or hypothetical uncertainty. The principle ensures that uncertainties are considered within a professional, fact-based, and scientifically supported decision-making framework. It is not advisable for the precautionary principle to be incorporated into the scientific basis and presented to decision-makers as an exaggerated potential for damage, an expansion of possible outcomes, or an increased uncertainty. The role of science and scientific institutions is to present the best factual understanding and the most accurate estimates, highlighting the actual range of outcomes and the uncertainty inherent in the data.

The precautionary principle does not imply that the risk must be zero. In administrative areas where the precautionary principle is well-integrated into decision-making processes, decisions are also based on an acceptance of risk, and the precautionary principle is considered alongside cost-benefit assessments.

Historical data from the NCS shows that over the course of 50 years of oil and gas activity, no unintentional spills have occurred that have caused significant environmental harm, either from offshore operations, related transport, or associated onshore facilities. This does not mean that the industry claims a serious incident cannot occur from its operations. Therefore, it has been a priority for the petroleum industry to contribute to increasing knowledge about the actual potential for harm and to develop methods for communicating this in a way that provides a complete picture of possible outcomes and uncertainties.

This includes understanding when environmental resources are at their most vulnerable, when they are present, and which activities pose the highest environmental risks. Examples of such activities include the mapping and monitoring of seabirds (SEAPOP and SEATRACK), research on the effects on fish and other resources in the water column (such as PROOFNY and SYMBIOSES), and research and development of models to predict the presence of seabirds and marine mammals (for instance MARAMBS).

5.6 Environmental monitoring

The industry has invested significant resources in understanding which discharges could cause an impact, so that the most effective measures can be implemented. This commitment includes environmental mapping and monitoring to assess its condition, developing better methods for environmental monitoring, and conducting research. Measures include both preventive actions and mitigation measures, such as the substitution of chemicals (see chapter 9.3) and oil spill preparedness.

A key part of this work is the comprehensive annual environmental monitoring of the NCS. Environmental monitoring on the NCS has been ongoing for nearly 50 years. The goal of the monitoring is to document the environmental condition and development, both as a result of human impact and natural variations. In addition, there is significant research activity organized by individual

companies. This includes both the development of monitoring methodologies and a better understanding of the impact on the marine environment from the petroleum industry's discharges.

Today, monitoring is carried out in accordance with the Norwegian Environment Agency's guidelines M-300. The extent of the monitoring is to be related to offshore petroleum activities in the respective regions, and the monitoring program is planned by the operators. The environmental monitoring is carried out 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 Norwegian Environment Agency.

Monitoring includes studies in the water column, of seabed sediments, and benthic fauna. Additionally, visual mapping of the seabed is conducted in areas with presumed particularly vulnerable species, such as corals and sponges. Some of the data from the environmental monitoring, which are not confidential or commercially sensitive, are shared and uploaded to Mareano. Mareano is an interdisciplinary program for mapping the seabed in Norwegian marine areas, led by the NEA, with the Institute of Marine Research, the Geological Survey of Norway (NGU), and the Norwegian Mapping Authority responsible for its daily scientific operations.

Water column monitoring

Water column monitoring consists of field surveys and method development. Field surveys are conducted every three years and must, as a minimum, include hydrographic measurements, chemical analyses, and studies of caged organisms (mainly mussels) and free-living organisms (mainly fish). The time period between any two field surveys is used for further development and qualification of methodologies for future water column monitoring.

In 2021, a major program was conducted in the Ekofisk area. This work is described in more detail in Offshore Norge's climate and environmental report from 2022. In 2021 and 2022, several attempts were carried out to develop methodologies for future field surveys, but no large-scale field survey was conducted. Many of the findings were presented at the Forum for offshore environmental monitoring in the autumn of 2022. The next program for water column monitoring will take place in 2024.

Seabed surveys

Seabed habitat monitoring involves taking samples of the seabed, usually using a grab, and then analysing the physical, chemical, and biological condition of the sediment. Certain stations have been monitored regularly for over 30 years, making the data extremely valuable for both researchers and authorities in assessing both natural occurring and anthropogenic changes to the environment over time. It is therefore of great interest to utilize this material in the ocean management work of the authorities.

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. Additionally, all fields to be put into operation must conduct a baseline survey before startup to document the natural environmental condition of the field.

The monitoring program is extremely comprehensive, covering approximately 1,000 stations on the NCS. Fieldwork and surveys are usually conducted in May and June. All data is stored in a database (MOD) that is accessible after being registered in Veracity by DNV.

The Norwegian Environment Agency's guidelines M-300 were revised in 2023, with a new chapter on environmental monitoring at closure. The chapter addresses environmental surveys before, and

possibly during, and after the production phase has ended at a field. The need for and extent of such surveys will vary depending on the area's discharge history, vulnerability, available existing studies, and the scope of planned decommissioning activities. The need for continued environmental monitoring after the cessation of petroleum activities depends on the survey results and recommendations in the operator's decommissioning report, concerning pollution levels, the area's vulnerability, and suitability for other purposes. The guidelines indicate that in areas with minimal or no proven pollution or impact on fauna, continued environmental monitoring may be considered unnecessary.

A number of large research projects and programs have been conducted where independent researchers have investigated the possible impact of the oil and gas industry's discharges to sea. Notable examples include the Research Council of Norway's program Marinforsk, launched in 2015, and the earlier Havet and Kysten (Oceans and Coastal Areas) (PROOF/PROOFNY 2004-2015). The results of the environmental monitoring have also been used in various scientific articles.

Summaries from PROOFNY conclude that the potential for harmful environmental impact from discharges is generally moderate. The effects of discharges from drilling operations are only detectable in the immediate vicinity of the drilling location, typically limited to 150–200 meters from the discharge source. Often, the effects are related to particle discharges and impacts on filter-eating benthic fauna, such as tube-building polychaetes.

The Offshore Environmental Monitoring Forum takes place every autumn, where annual results from monitoring programs are presented, along with findings from research and development.

In the autumn of 2022, Jonny Beyer and Torgeir Bakke from NIVA began working on a new peer-assessed review, funded by Offshore Norge, the companies' budget for monitoring programs, and the NEA. The review will provide a comprehensive and updated overview of the knowledge gained through many years of environmental research and monitoring within Norwegian offshore oil and gas operations. Based on the findings, the review will provide recommendations on how future environmental monitoring offshore will be structured. The published version is expected to be completed by the end of 2024.

Surveys and assessments of vulnerable benthic areas

The petroleum industry operates on the NCS in the North Sea, Norwegian Sea, and Barents Sea. The industry is required to survey the seabed and benthic fauna before activities commence. This provides a basis for describing the potential environmental impact of the activities and aims to ensure that the footprint of the activities is minimized. The impact is primarily related to drill cutting discharges. The surveys are mainly conducted by collecting seabed samples using a grab, followed by analysis of physical properties (particle size), chemical properties (hydrocarbons and metals), and biological properties (description of biodiversity). In areas with hard substrate or the presence of vulnerable benthic habitats, visual and acoustic surveys are conducted as a substitute or in addition to grab surveys of the seabed. This is particularly relevant in areas with sponges and corals, which are believed to be vulnerable to particle discharges from drilling activities. The purpose of the visual surveys is to map the presence and scope of species and natural habitats that are red-listed in Norway. The natural habitats of coral reefs, hard substrate coral forests, and sponge spike bottoms are considered to be near threatened. Visual monitoring is an effective tool for mapping occurrences and avoiding damage to the natural environment.

Offshore Norge's guidelines for vulnerable benthic habitats was updated by DNV in 2023. The objective of such a guideline is to prevent physical damage to coral reefs and sponge areas, etc.

6. Greenhouse gas emissions and other emissions to the air

Emissions to the air from oil and gas activities consist mainly of exhaust gases containing CO_2, NOx, SOx, CH4, and nmVOC from various types of combustion equipment. Emissions to the air are, in most cases, calculated based on the quantities of fuel gas and diesel oil used on the facilities. The emission factors are based on measurements from suppliers, standard factors 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 authorities since the start of the oil and gas industry in Norway over 50 years ago. There are both environmental and economic reasons why this is important. In addition, it has been a fundamental element of Norwegian petroleum management ever since "the 10 oil commandments" were established in 1971. Several of these gases are defined as greenhouse gases (GHG), and the efforts to reduce them as much as possible for climate reasons now dominate the debate on emissions to air.

6.1.1. Climate strategy for the Norwegian continental shelf

The oil and gas industry in Norway launched ambitious climate goals in January 2020, pledging to reduce emissions to near zero by 2050, in collaboration with the KonKraft partners. KonKraft's follow-up towards achieving the 2030 goals is based on the Norwegian Parliament's target of a 50 percent absolute reduction in emissions, which was adopted by the Parliament in connection with the decision to make temporary changes to the petroleum tax law. KonKraft's climate strategy also includes ambitious objectives for the development of new value chains for low- and zero-emission technologies, such as offshore wind, hydrogen, CO_2 capture and storage on the NCS maritime zero- and low emissions requirements and maritime emission goals.

This year's status report will be available by June 2024.

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

- Combustion of natural gas in turbines, engines, and boilers
- Combustion of diesel in turbines, engines, and boilers
- Flaring
- Combustion of oil and gas for well testing and well maintenance.

Other sources of emissions to the air include:

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

Power generation using natural gas and diesel as fuel is the primary source of CO_2 and NOx emissions. These emissions primarily depend on the energy consumption of the facilities and the efficiency of power generation. The second-largest source is the direct combustion of gas, known as flaring. Flaring occurs only to a limited extent on the NCS, as stipulated by the Petroleum Act, but is permitted for safety reasons during operations and in connection with certain operational issues.

Half of the methane emissions (CH4) from offshore oil and gas installations are direct emissions from production processes, such as from compressors and the handling of produced water. For non-methane volatile organic compounds (nmVOC), the main sources offshore are the loading and storage of crude oil. Emissions of nmVOC occur, for example, when gaseous air is displaced by crude oil during the loading of crude tankers.

SOx emissions are primarily caused by the combustion of sulphur-containing natural gas and diesel. Since Norwegian natural gas contains low sulphur, the use of diesel is the primary source of SOx emissions which is very low compared with the international average. To minimize SOx emissions, low-sulphur diesel is used.

Figure 20 illustrates emissions to air on the NCS compared to the international average per barrel of produced oil equivalent. All figures are from 2022 because international data for 2023 are not available as of June 2023.

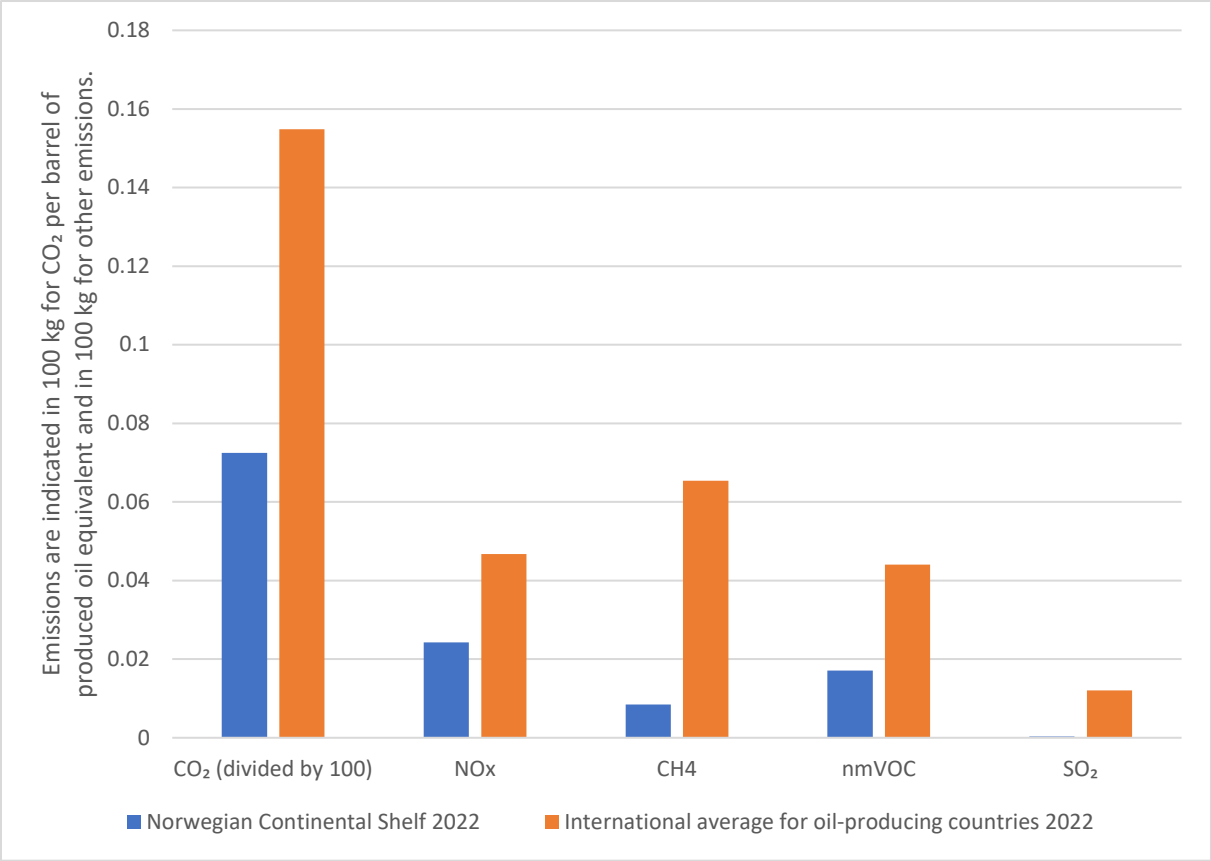


Figure 20: Emissions to air on the NCS compared to the international average.

6.2 Greenhouse gas emissions

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

As part of the Paris Agreement, Norway has committed to reducing its greenhouse gas emissions by at least 55 percent by 2030 compared to 1990 levels. This will be achieved in cooperation with the EU, and Norway has entered into agreements with the EU on how this will be achieved for both the emissions trading sector and the non-emissions trading sector. For the emissions trading sector, which includes the petroleum industry, the most important instrument is the EU Emissions Trading System (EU ETS).

The Norwegian government intensified the climate goals as defined by the Hurdal governmental platform, calling for a 55 percent reduction in GHG gases by 2030, compared to 1990 levels. This commitment applies to the entire economy, including the emissions trading sector. The Norwegian Parliament has requested that the petroleum industry reduce its greenhouse gas emissions on the NCS by at least 50 percent by 2030. To stimulate further reductions in greenhouse gas emissions in the petroleum sector, the Norwegian Parliament passed a Climate Plan in spring 2021, which proposed an increase in the CO_2 tax on emissions from oil and gas production subject to the ETS in line with the tax increase on non-emission trading emissions. The goal is for the total carbon cost (CO_2 tax + quota cost) to be approximately 2000 kroner per tonne of CO_2 by 2030 (estimated in 2020 currency). The Climate Plan further stipulates that the total carbon cost should not exceed 2000 kroner during the period from 2021 to 2030 unless the quota price alone becomes higher.

Through The European Green Deal, the EU has committed to an emissions reduction of at least 55 percent by 2030 and to being climate-neutral by 2050. The EU's Green Deal and the "Fit-for-55" package will lead to changes in laws and regulations enabling these climate goals to be reached. Additionally, in March 2022, the EU launched a series of measures through REPowerEU aimed at becoming independent from Russian gas due to the war in Ukraine. These measures are designed to reduce gas imports from Russia 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 reported figures and the development trends from year to year can vary significantly depending on the source. There are several reasons for this, but the most important is the differing definitions of which activities are included in the Norwegian oil and gas sector.

- The environmental report from Offshore Norge is published annually at the beginning of June and contains total emission figures from the industry. Which emissions to include are mainly 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 facilities such as Kårstø and Kollsnes. All activities at Melkøya are also included. Data is retrieved from the Collabor8 Footprint database, which has been developed to simplify the reporting of emission figures and the submission of annual emission reports from operators to the government.
- Statistics Norway (SSB) publishes preliminary total 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 UN Climate Convention on Climate Change and the Convention on Long-Range Transboundary Air Pollution. The emission 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. Therefore, the emission figures from Statistics Norway (SSB) will normally be higher than the corresponding Footprint figures, while figures from most emission sources are generally comparable. The emission figures from SSB also form the basis for the website Miljøstatus.no.
- The NEA has its own database for Norwegian emissions (norskeutslipp.no) which is accessible to the public and contains emission data from all Norwegian sources, including oil and gas production. Generally, these are the same emission figures found in Footprint. However, the main category "Offshore Petroleum Activities" does not include land-based facilities or exploration activities. Therefore, the total figures for the industry will be lower than the corresponding figures reported in the Environmental Report and by the SSB.

In addition, there are also emission figures from the quota-liable part of the activities on the NCS and from the tax-liable part of Norwegian oil and gas production. Both of these have different delimitations in relation to each other and in relation to the three sources described above, so both the total figures and figures from different sources will therefore vary.

Greenhouse gas emissions from petroleum activities

Figure 21 shows that total greenhouse gas emissions from the NCS and land-based facilities subject to the Petroleum Tax Act in 2023 were 11.1 million tonnes of CO_2 equivalent, a decrease of just over 4% from 2022. The decrease from 2022 to 2023 is partly linked to the electrification of Edvard Grieg and the electrification of Snorre and Gullfaks with wind power from Hywind Tampen. Additionally, Knarr was shut down in 2022. At the same time, emissions from Hammerfest LNG increased as it was fully operational throughout 2023, and Njord resumed production in 2023. Methane emissions also continued to decline from 2022 to 2023.

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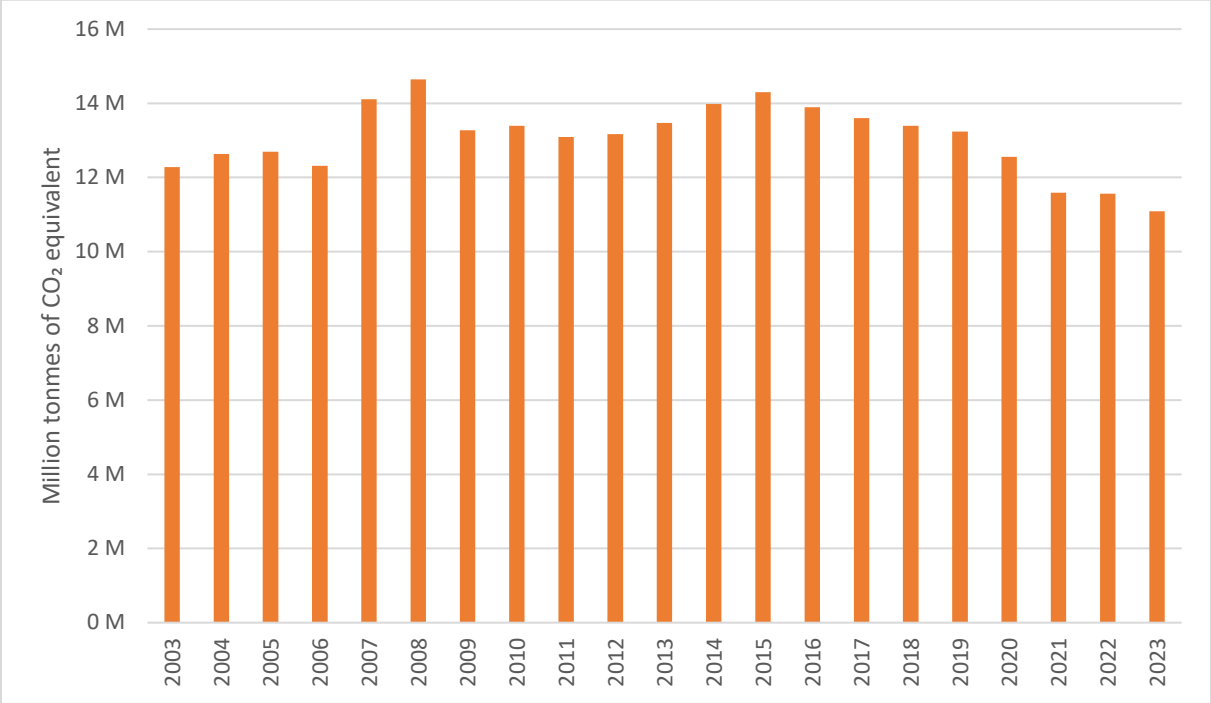


Figure 21: Emissions of CO_2 equivalent on the NCS

Emissions of greenhouse gases per produced unit are low for Norwegian oil and gas production compared to production in other geographic areas, as shown in the data in Figure 22 from the International Association of Oil and Gas Producers (IOGP). International figures for 2023 are not available as of May 2024. This report presents figures at a regional and not national level. Other studies from, among others, Rystad Energy confirm this picture.

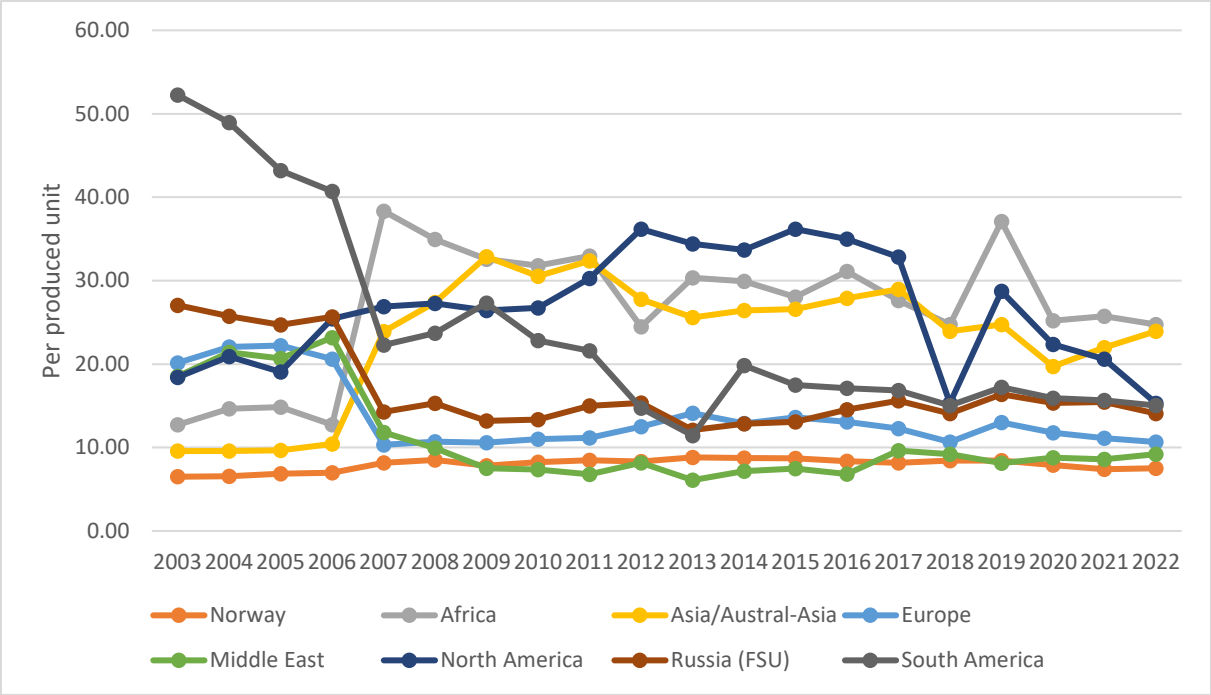
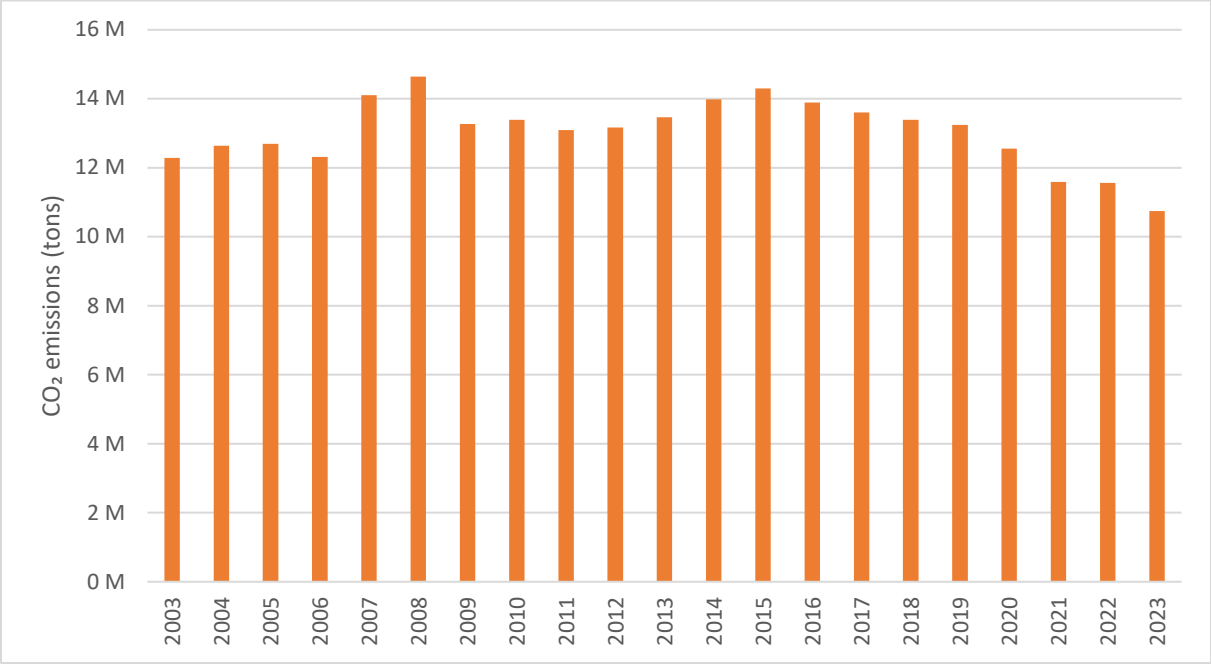


Figure 22: Greenhouse gas emissions per produced unit in various petroleum provinces 2003-2022 (Source: IOGP)*

CO_2 emissions

In 2023, direct CO_2 emissions from operations on the NCS and onshore installation subject to the Petroleum Tax Law were 10.7 million tonnes, down from 11.1 million tonnes in 2022 (see Figure 23).

- IOGPs data only reflects the performance of the IOGP Member Companies that have provided data in a given year. It does not represent the entire global upstream oil and gas industry



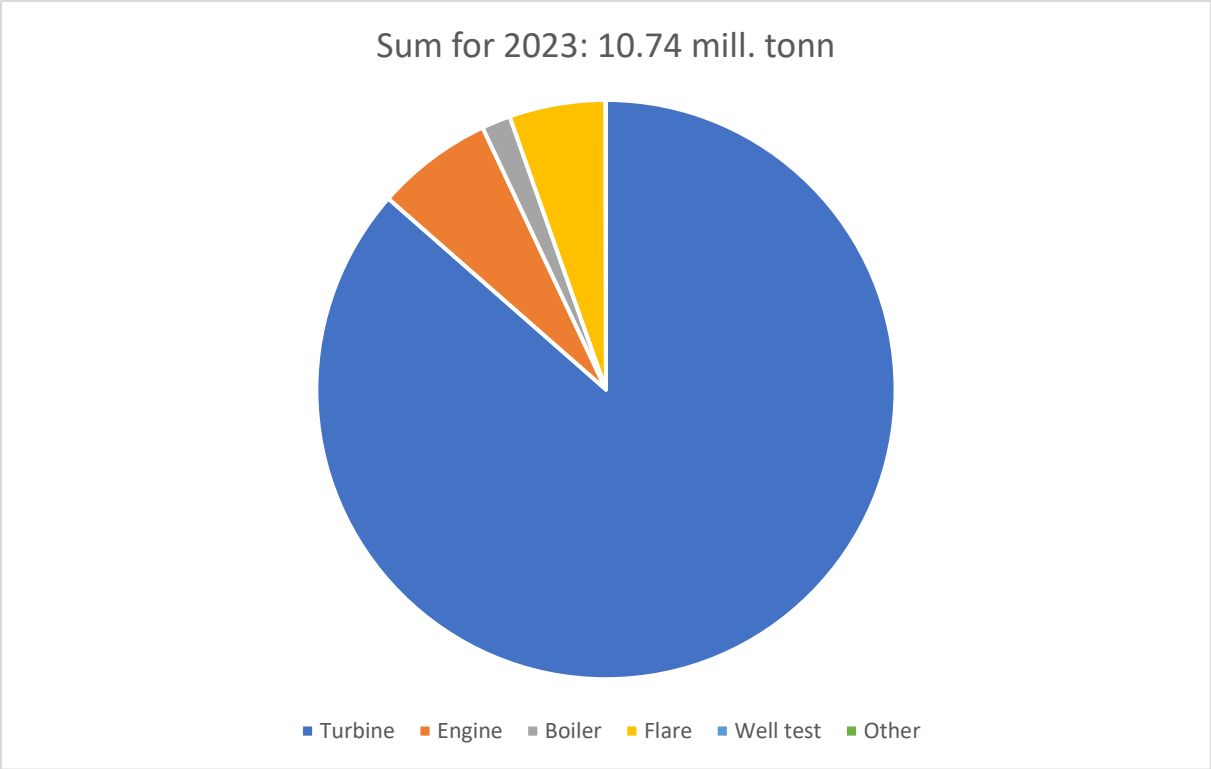


Figure 23: Historical development of direct CO_2 emissions (millions of tonnes and source distribution)

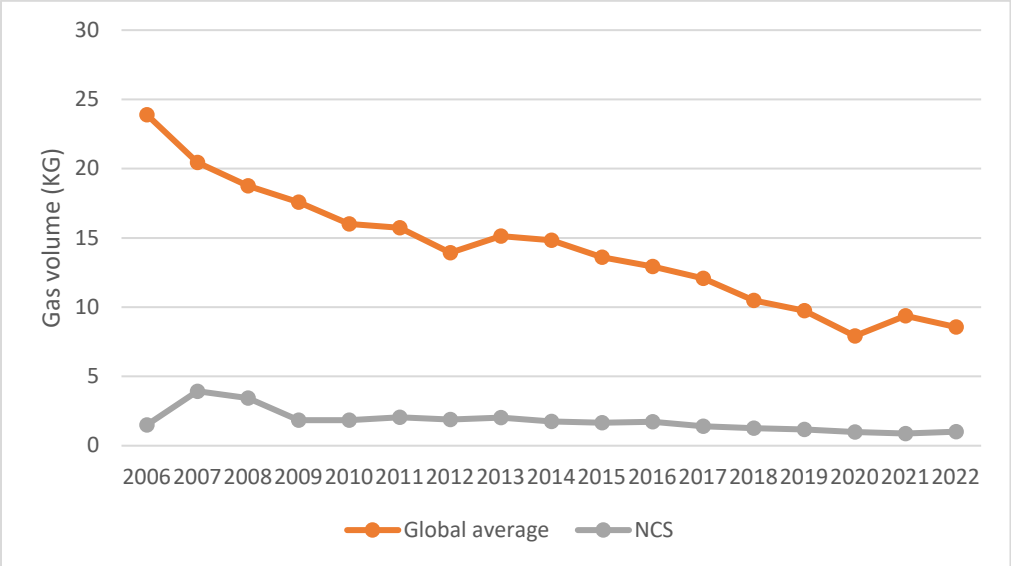


Figure 24: Volumes of gas flared per produced tonne o.e. on the NCS, compared to the international average

Figure 24 shows the historical development of flared gas volumes per produced unit of oil equivalent in Norway and the international average (IOGP) for the period 2006–2021. International figures for 2023 are not available as of May 2024. Emissions from flaring are a significant reason why Norwegian production has much lower CO_2 emissions than other countries. In 2021, volumes of flare gas were ten times higher globally than in Norway. Figure 24 indicates that the reduction in flare gas volumes in Norway from 2006 to 2022 was 58 percent. In the same period, the reported volumes of flare gas globally were reduced by 60 percent.

Figure 25 shows the historical development of direct CO_2 emissions from the three primary sources, where flaring has been the smallest source of the three since 2019.

Total Norwegian greenhouse gas emissions in 2023 were, according to Statistics Norway (SSB), 46.6 million tonnes CO_2e, of which the petroleum industry's share accounted for about one-quarter.

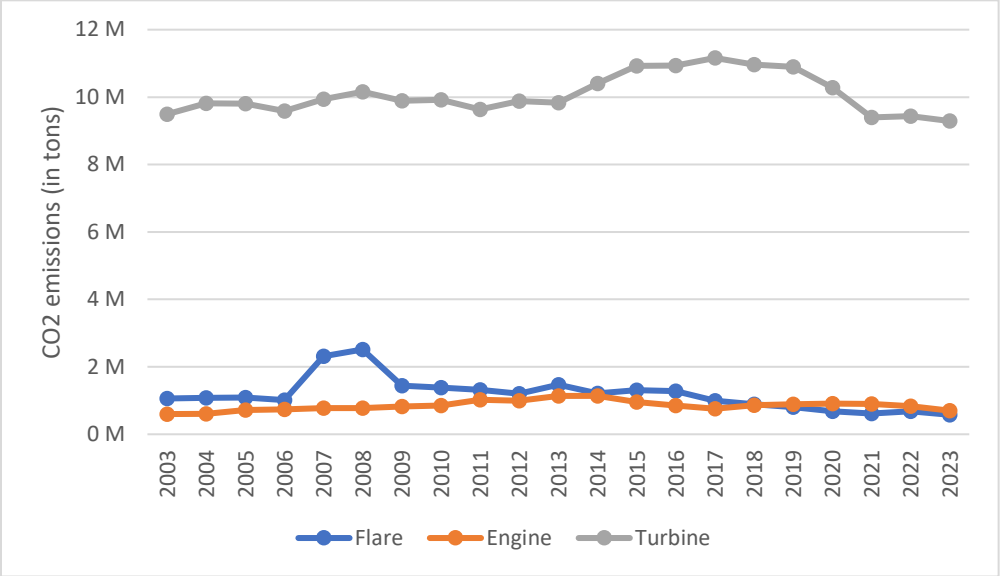


Figure 25: Historical development of direct CO_2 emissions (tonnes) from the three primary sources

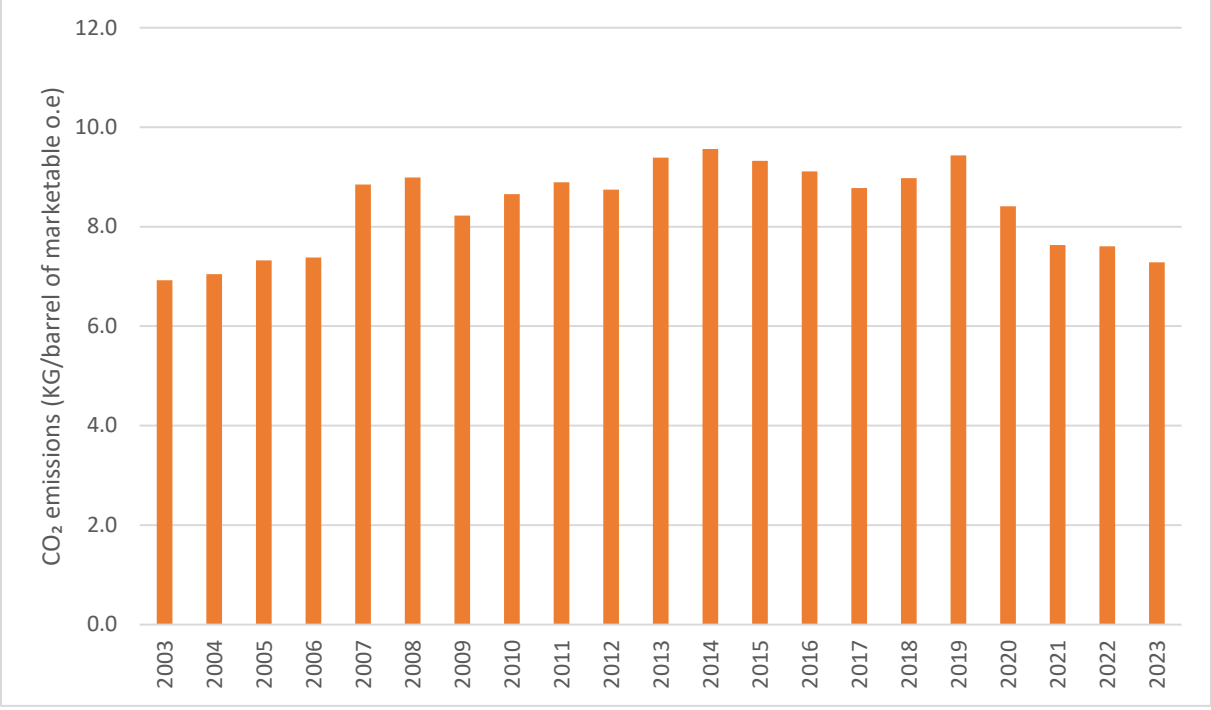


Figure 26: CO_2 emissions intensity for the period 2003–2023

Norwegian oil and gas production has for many years been world-leading in low greenhouse gas emissions. The average greenhouse gas emissions per produced unit are less than half of the global average. The sector is subject to a range of measures such as CO_2 tax, EU ETS, NOx tax/fund, flaring

restrictions in production licences, emission permits with energy management requirements, and mandates for the use of best available technology. Additionally, there are requirements for assessing onshore power in connection with new developments. Together with a robust resource and recovery policy, these regulatory measures have triggered and will continue to trigger actions that represent emission reductions on the NCS.

Prolonged and increased production on existing fields will normally increase energy consumption per produced unit. It is therefore a significant achievement that the NCS has succeeded in maintaining low emissions per produced unit even as the age of the fields has increased.

The result is a Norwegian offshore industry that ranks among the best internationally in terms of low CO_2 emissions per produced unit, as shown in Figure 22. At the same time, we see that some other countries are gradually demonstrating clear emission improvements by implementing operational practices similar to those we have on the NCS, such as reduced flaring. This is very positive. Reduced flaring not only lowers CO_2 emissions but also boosts energy supplies for the market, as the gas is consumed rather than flared.

Figure 26 shows the historical development of CO_2 emissions per delivered volume of hydrocarbons. In 2023, the specific CO_2 emission was 7.3 kg per barrel of oil equivalent produced (marketable). This is down from 7.6 in 2022.

Short-lived climate forcers

Short-lived climate forcers consist of particles and gases with a short lifespan in the atmosphere and are characterized by their negative effects on climate and health. If emissions of short-lived climate forcers can be reduced, both climate and health benefits will be achieved. In the offshore petroleum industry, emissions of methane (CH4) and nmVOC from cold venting and diffuse emissions are the main sources of emissions.

Methane emissions

The primary sources of methane emissions from offshore oil and gas activities are 1) planned or unplanned emissions directly to the atmosphere, 2) incomplete combustion in flares and turbines, and 3) emissions during the storage and loading of crude oil. Annual methane emissions are reported according to methods and emission factors established by the Norwegian Environment Agency and the industry in collaboration. The petroleum industry is continuously working to improve the methodology and emission factors for methane and nmVOC. The use of equipment for direct measurement of methane emissions is essential in improving the quality of reported data. To detect leaks from process equipment, dedicated leak detection programmes (Leak Detection and Repair, LDAR) are conducted, utilizing handheld infrared cameras, among other tools. The use of cameras (Optical Gas Imaging) enables quick implementation of measures to reduce or eliminate emissions associated with minor leaks.

Figure 27 shows methane (CH4) emissions from activities on the NCS in 2023, categorized by source. Total methane emissions in 2023 were 11,579 tonnes, compared to 12,997 tonnes in 2022. This is a decrease despite increased gas production. Compared to 2014, there is a reduction of over 60 percent. The significant reduction from 2014/2015 to 2016 is primarily due to much more detailed monitoring of individual emission sources and the revision of emission factors.

Methane emissions associated with gas exports to Europe.

Natural gas produced on the NCS is primarily exported to Europe, where it is used in households, industry, and gas-fired power plants. Natural gas is composed mainly of methane, which is a highly potent greenhouse gas.

Since CO_2 emissions from gas-fired power plants are about 50 percent lower than those from coal-fired power plants per produced power unit, transitioning from coal-fired to gas-fired electricity generation is considered a good climate measure. To do this, the industry first needs to ensure that methane emissions from production and the gas pipeline system, out to the consumer, are not so high that they outweigh this advantage. Methane concentration on the NCS was 0.02 percent in 2022 (emissions per unit of gas sold), which is about 1/10 of the global average for upstream oil and gas production. This demonstrates that Norwegian natural gas has a clear climate advantage compared to the use of coal.

The reasons for the low methane concentration of Norwegian natural gas include subsea gas pipelines, a ban on routine flaring, high taxation levels, and a strong focus on minimizing gas leaks for both climate and safety reasons.

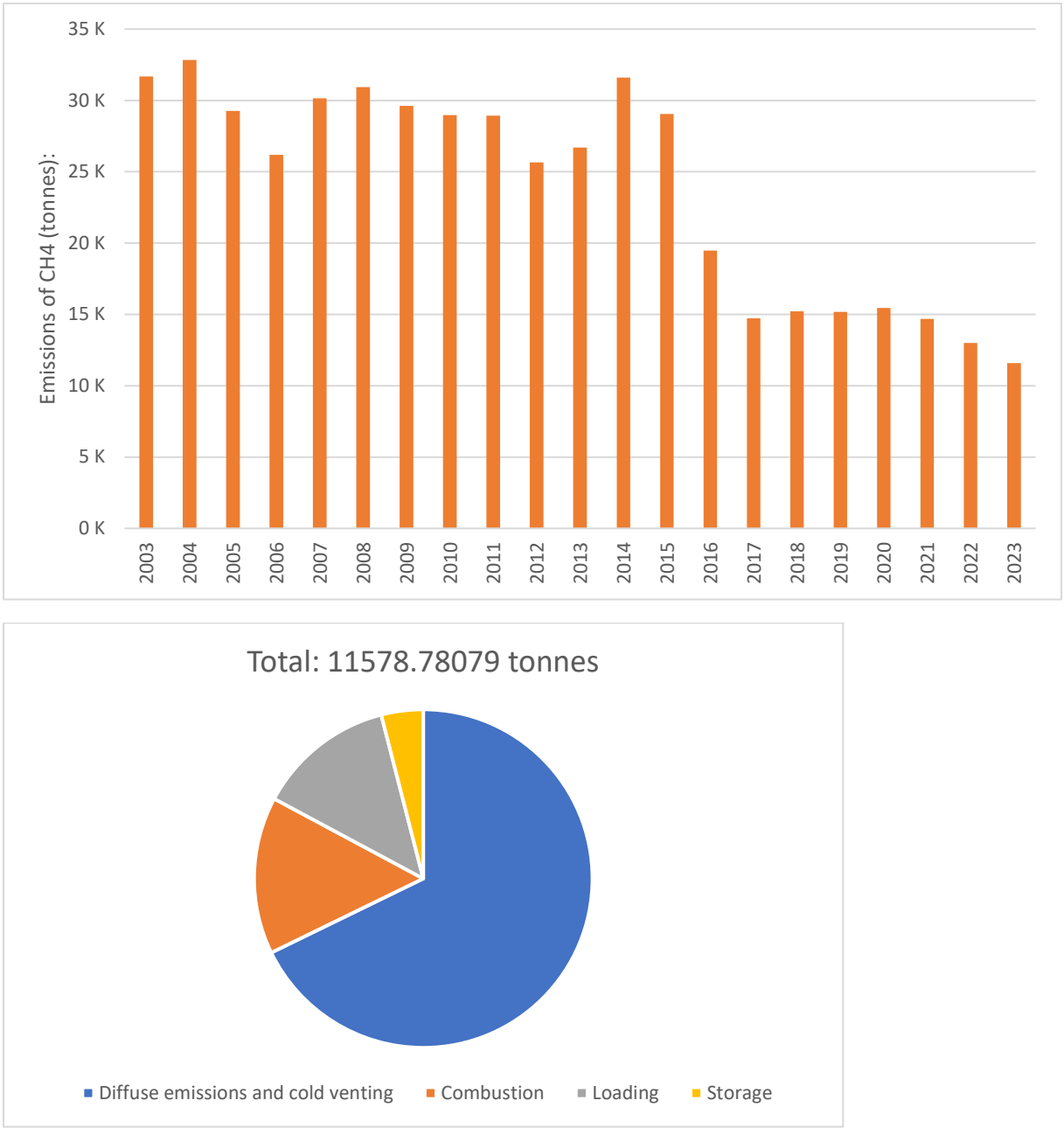


Figure 27: Historical development of total CH4 emissions (tonnes) and distribution by source.

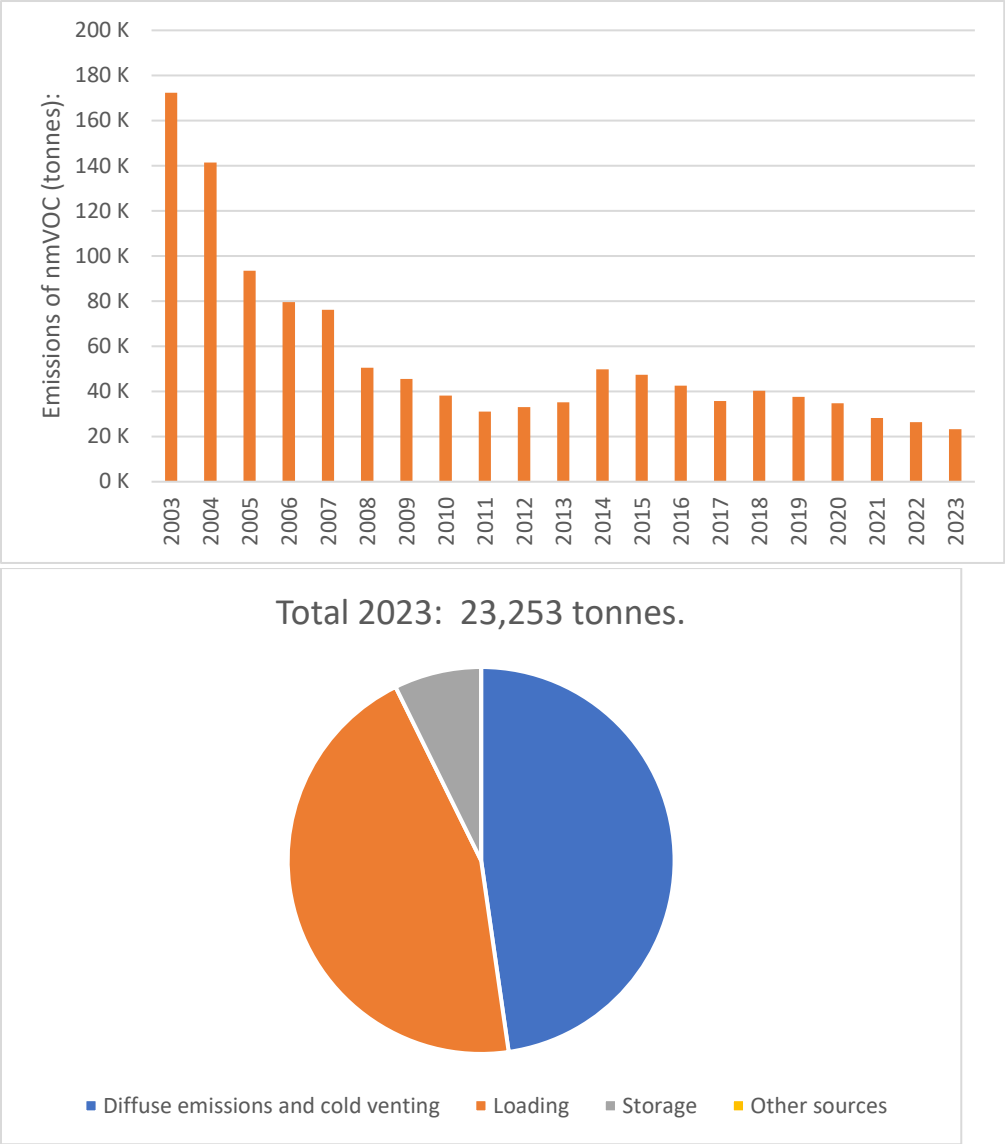


Figure 28: Historical development of total nmVOC emissions (tonnes) and distribution by source.

6.3 Emissions of nmVOC:

In 2023, the total nmVOC emissions from the NCS were 23,253 tonnes. This represents a decrease compared to 2022, when emissions were 26,423 tonnes, as shown in Figure 28.

Since 2001, total nmVOC emissions have been reduced by almost 90 percent. A significant reduction in emissions has been achieved through investments in new facilities for the removal and recovery of oil vapour on storage ships and shuttle tankers. In recent years, the collaboration between the NEA and the industry on methane and nmVOC has also resulted in significant emissions.

6.4 Emissions of NOx:

The primary source of NOx emissions on the NCS comes from the combustion of natural gas and diesel for energy production on the installations. Additionally, diesel-powered engines on mobile rigs are a significant source of NOx emissions. These mobile rigs are used for both exploration drilling and production drilling.

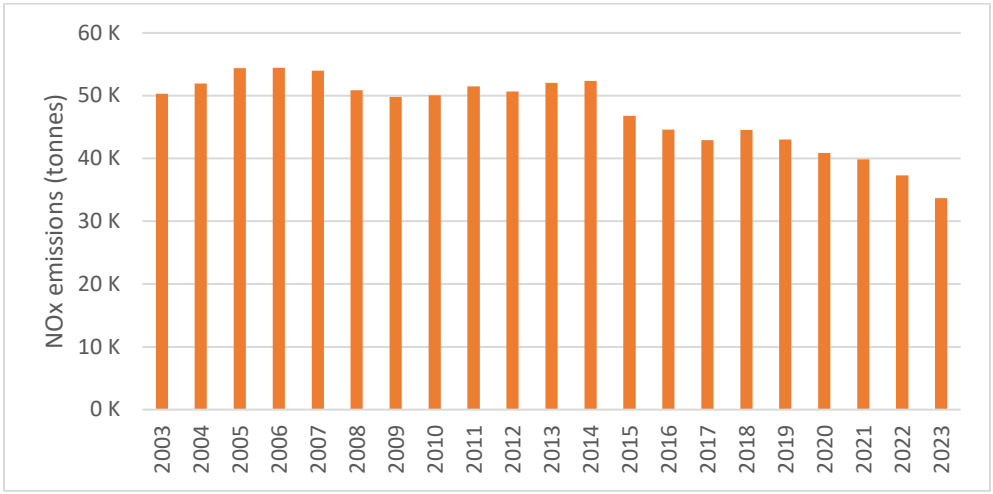
The environmental agreement on NOx regulates the obligations of industry organizations towards the authorities to reduce their total NOx emissions. Norway met its NOx obligations under the

Gothenburg Protocol well before 2020, and efforts to reduce NOx emissions through the NOx Fund have been crucial in fulfilling this obligation. The importance of the NOx Fund for emission reductions is described below.

NOx emissions have been significantly reduced through measures initiated by the NOx Fund. The NOx agreement for the period 2018–2025 was approved by the ESA in 2018 and has now been extended to 2027.

In 2023, total NOx emissions from petroleum activities amounted to 33,691 tonnes. This is a decrease from 2022, when emissions were 37,430 tonnes. The reduction is due to a general decrease in combustion.

Figure 29 shows NOx emissions from activities on the NCS and their distribution across sources in 2022, while Figure 30 displays specific NOx emissions.



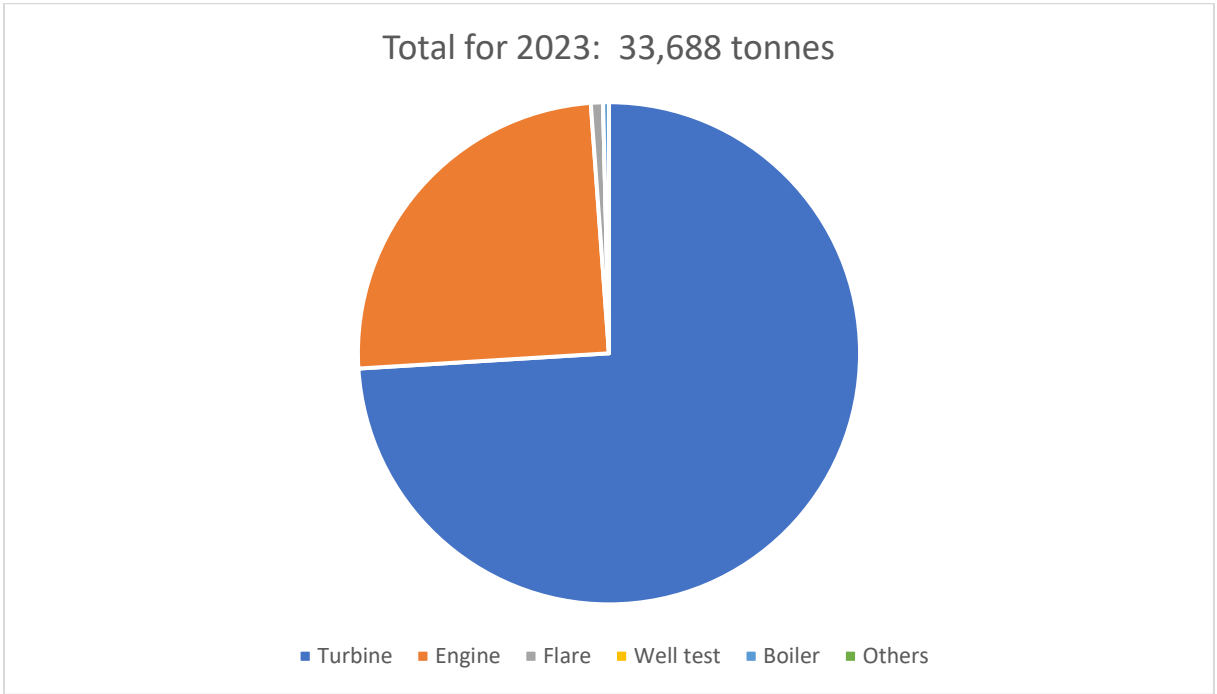


Figure 29: Historical development of total NOx emissions (tonnes) and distribution by source

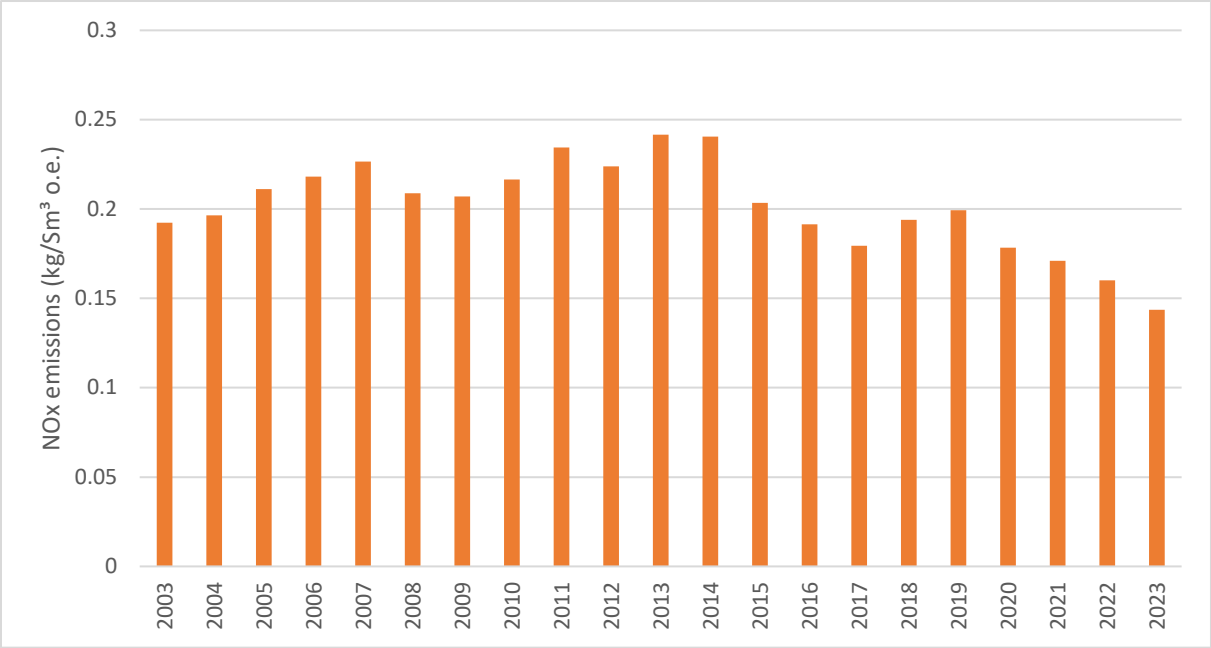


Figure 30: Specific NOx emissions

6.5 The NOx Fund and its significance for emission reductions

The NOx agreement is an environmental agreement between businesses and Norwegian authorities, which involves businesses committing to keep total NOx emissions below established biennial emission caps. The agreement was established in 2008 and has been extended several times since.

The business community set up a NOx fund in 2008, where participating companies are exempt from the financial NOx tax. Instead, businesses contribute to the fund based on a payment model linked to reported emission figures, with rates somewhat lower than the financial tax would have been. The NOx Fund uses the contributions to support businesses that implement measures to reduce their NOx emissions. Support from the NOx Fund is disbursed when the measure has been implemented and documented. Funding can also be requested for certain types of industries that are exempt from the financial tax.

The following sectors are included:

- Oil and gas
- Shipping
- Industry and mining
- Fishing and hunting
- Aviation
- Railway

In the first two periods of the agreement (2008–2010 and 2011–2017), the goal was annual or biennial emission reductions. Overall, throughout the entire period, emissions reductions of 34,000 tonnes were achieved.

In the current agreement period (2018–2025, with an extension until 2027), the agreement is structured to adhere to a specified biennial emission cap:

- Total for 2018 and 2019: 202,510 tonnes
- Total for 2020 and 2021: 192,510 tonnes

- Total for 2022 and 2023: 182,510 tonnes
- Total for 2024 and 2025: 172,510 tonnes
- Total for 2026 and 2027: 161,000 tonnes

If the target is not met, it may result in sanctions, and the entire or part of the financial NOx tax must be refunded.

For 2022 and 2023 combined, the reported emissions were 166,495 tonnes, well within the cap of 182,510 tonnes. Emissions are decreasing across all industry categories.

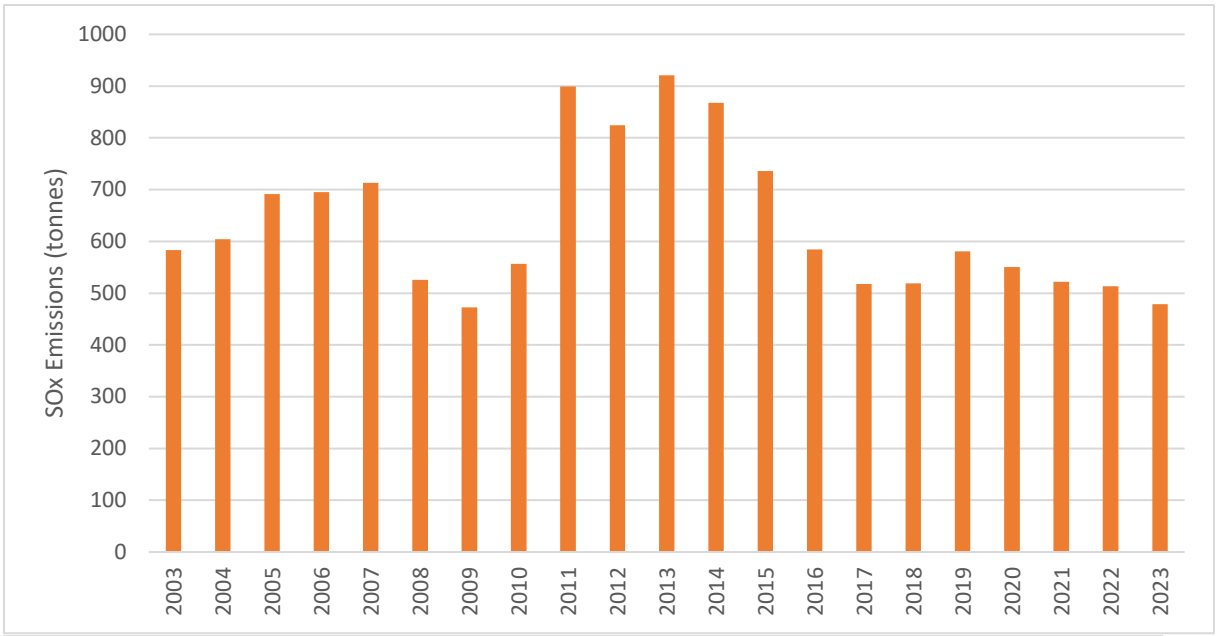
From 2018 to 2023, a total of 404 projects were implemented and verified, resulting in a total NOx reduction of 13,304 tonnes. Many of these projects also contribute to reduced CO_2 emissions. DNV has calculated on behalf of the fund that projects completed from 2018 to 2023 have contributed to a reduction of CO_2 emissions of approximately 720,000 tonnes per year. If all projects that have received funding commitments are included and all are completed, the estimated expected reduction is around 3.3 million tonnes of CO_2 for the agreement period 2018 to 2023. The most significant individual measures contributing to large CO_2 reductions are electrification projects within oil and gas.

Examples of measures in the petroleum industry that have received support from the NOx Fund:

- Hywind Tampen
  Partial electrification of Gullfaks and Snorre with 11 floating offshore wind turbines. Production started in November 2022, cutting approximately 200,000 tonnes of CO_2 and 1,100 tonnes of NOx annually.
- Electrification of platforms with power from land: Troll B and C, Sleipner Vest, Draugen, Oseberg, Njord
- Drilling rigs installing catalytic NOx reduction, battery technology, and other energy efficiency measures.

6.6 SOx Emissions

Figure 31 shows SOx emissions from operations on the NCS and the distribution of emissions in 2023 based on source. In 2023, total SOx emissions were 479 tonnes, a reduction from 516 tonnes in 2022.



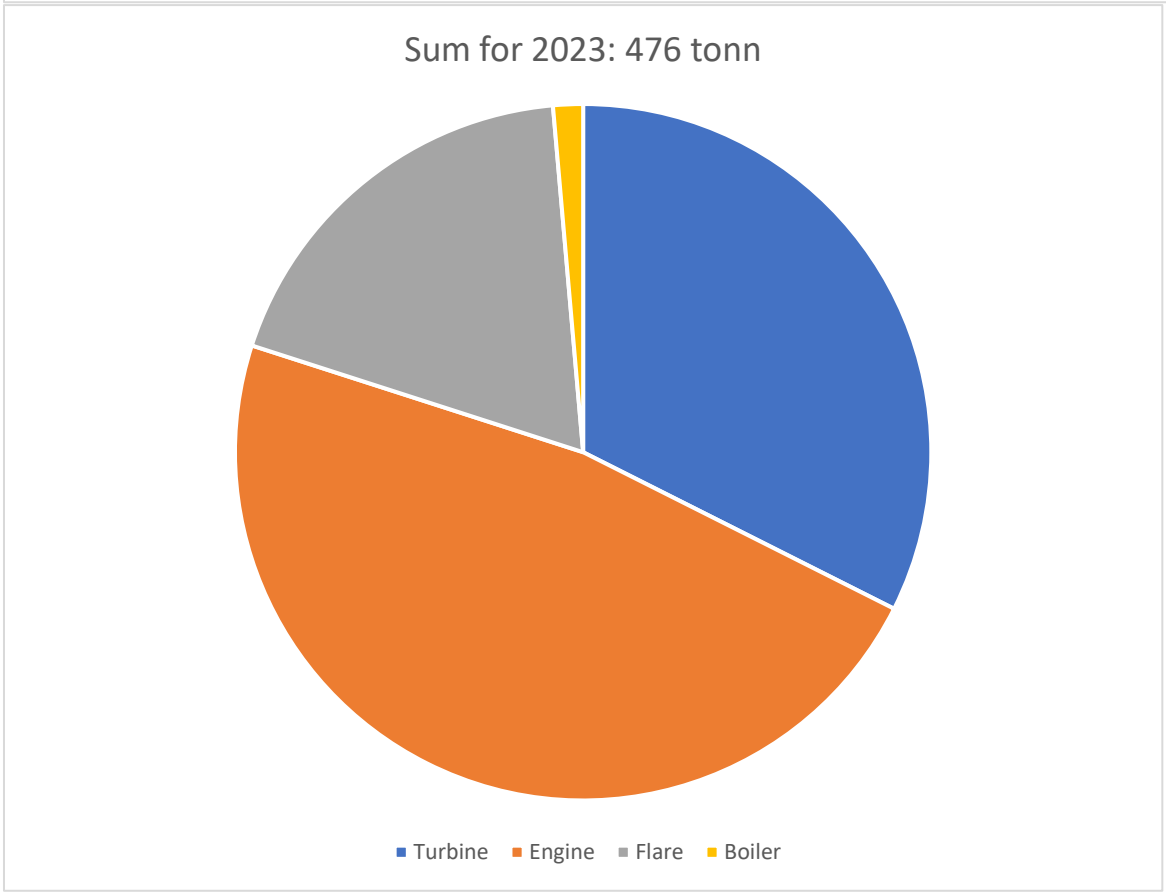


Figure 31: Historical SOx emissions from the shelf, broken down by source.

7. Waste

The petroleum industry is among the largest waste producers in Norway. The primary waste fractions offshore include drilling waste such as drill cuttings and used drilling fluids, along with various liquid fractions such as wash water and drainage water. The industry places great emphasis on the proper handling of waste. The operators' main goal is to generate as little waste as possible and to establish systems to ensure that as much waste as possible is recycled.

Offshore Norge has developed guideline 093 for waste management in offshore operations. This guideline is scheduled to be revised in 2024. The guideline is used for the declaration and further handling of waste. All waste is sent ashore in accordance with the industry's guidelines.

Waste is generally classified into hazardous and non-hazardous waste according to applicable regulations and must be declared in accordance with national regulations and international guidelines.

7.1 Non-hazardous Waste

In 2023, 19,092 tonnes of non-hazardous waste were produced, a decrease from 2022 when the volume was 20,090 tonnes. Figure 32 shows the distribution of non-hazardous waste in various categories. Metals are the largest waste fraction within source-separated waste. Metals from the industry have a high degree of recycling and are sent ashore for re-melting or direct reuse.

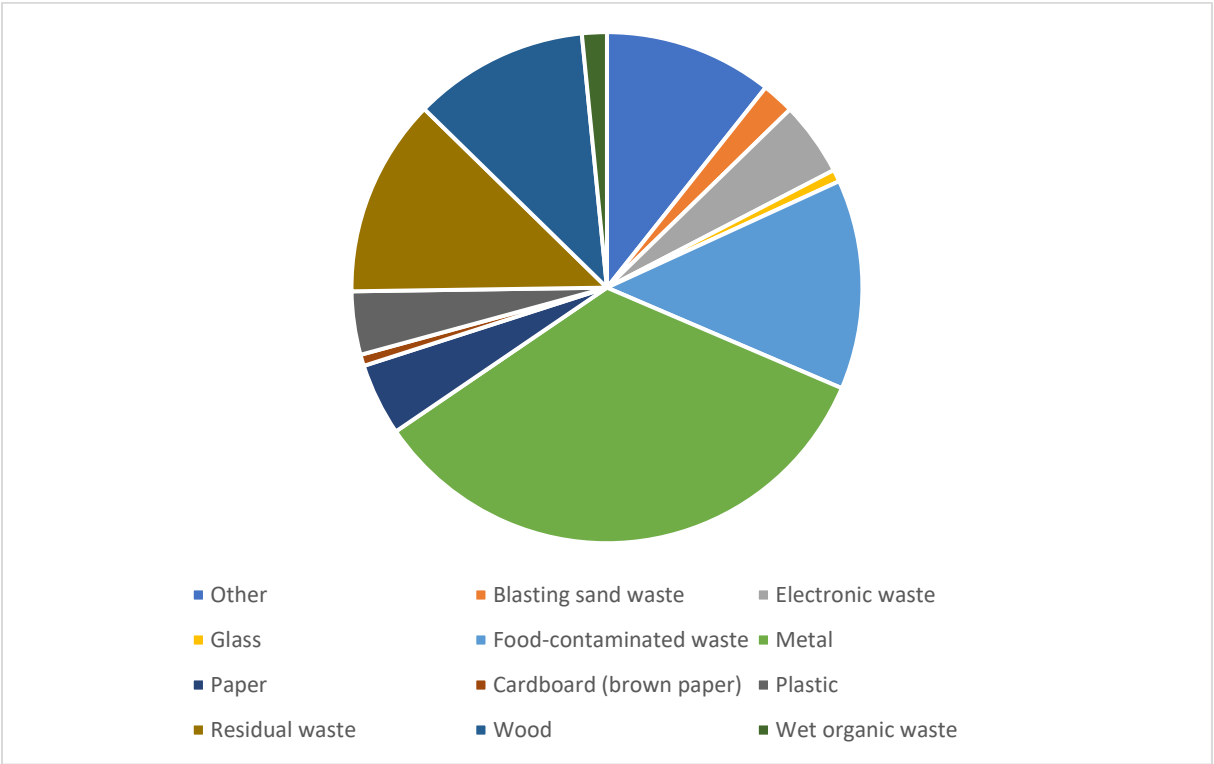


Figure 32: Distribution of non-hazardous waste in various categories from offshore operations (tonnes)

7.2 Hazardous Waste

Figure 33 shows that in 2023, just under 310,000 tonnes of hazardous waste were delivered for treatment on shore, compared to 273,000 tonnes in 2022. Approximately 270,000 tonnes of this is

drilling-related waste that is treated on shore. Tank washing and oily waste each account for 11,000 tonnes, totalling 22,000 tonnes.

The reason for the marked increase in oily waste from 2009 and for several years thereafter is that previously, much of this waste would have been reinjected. Up until 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 for easier injection. Slurrification involves crushing the cuttings and adding water. It is not uncommon for the volume of cuttings to expand by a factor of between 4 to 10 during slurrification. This practice continued, and cuttings were sent ashore as slurry, resulting in a significant increase in drilling waste from certain fields.

Injection provides significant environmental benefits and can be cost-effective compared to final treatment on shore. Drilling of new injection wells has led to a slight increase in the volume of injected oily waste (see chapter 4.1). On installations and fields where injection will not be resumed, efforts are being made to reduce slurrification to decrease waste volumes.

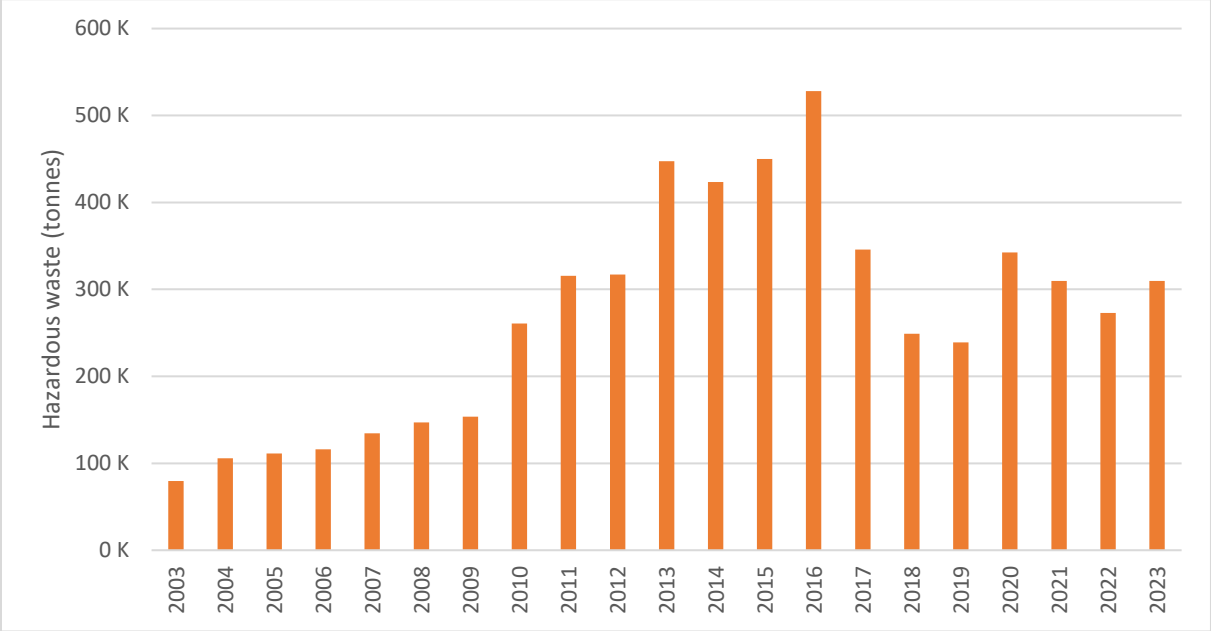


Figure 33: Volume of hazardous waste from offshore operations sent ashore.

7.3 NORM 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 naturally occurring radioactive materials (NORM). In Norway, the term LRA refers to what is commonly known internationally as NORM or low-specific activity (LSA)..

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 conducted by accredited laboratories. The waste is categorized and declared according to three categories: no enhanced concentrations, radioactivity levels below 10 Bq/g, and radioactivity levels higher than 10 Bq/g. Both radioactive categories are treated according to regulations issued by the Norwegian Radiation and Nuclear Safety Authority. The most radioactive waste is transported to a designated landfill in Gulen.

Figure 34 shows the volumes (tonnes) of waste delivered for final disposal in the two categories. The waste containing radioactivity levels below 10 Bq/kg varies somewhat due to fluctuating site capacity.

A total of 258 tonnes of low-level radioactive waste were sent ashore in 2023, a decrease from 2022 when the volume was 394 tonnes.

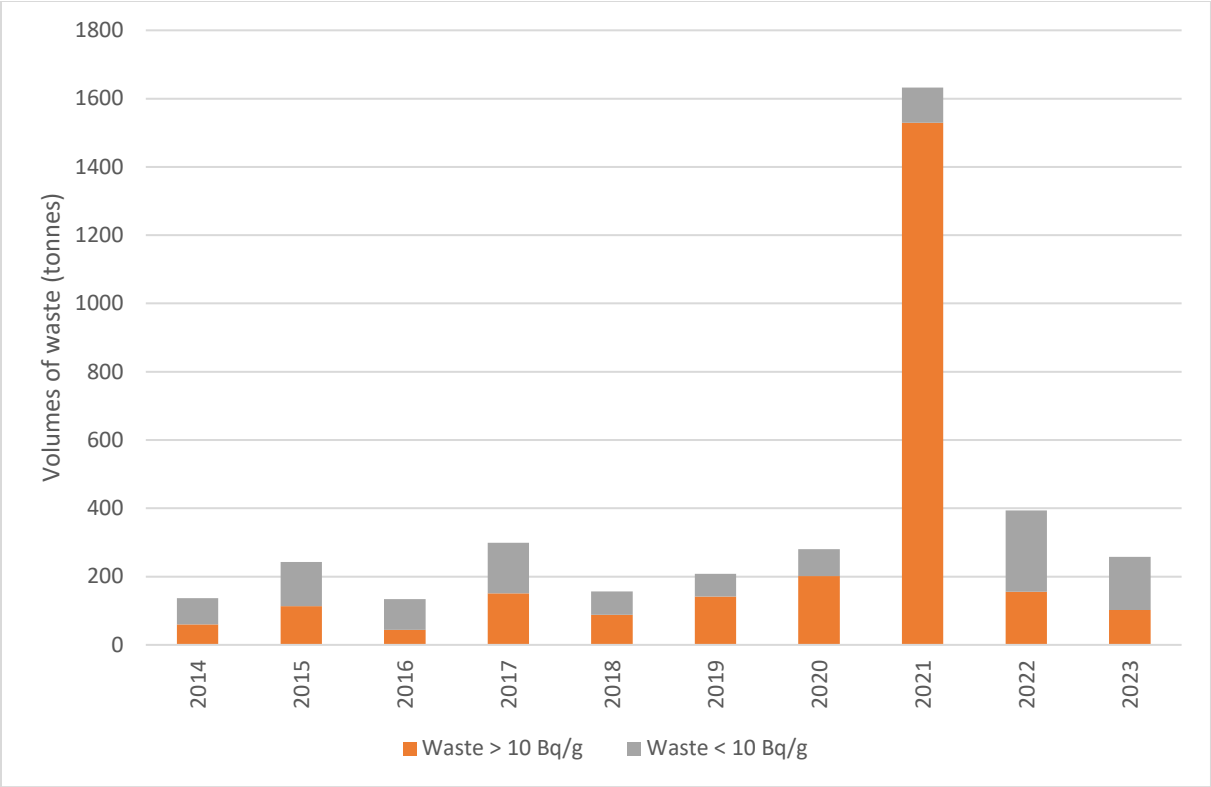


Figure 34: Volumes of waste with naturally occurring radioactive material

7.4 Decommissioning and circular economy

Decommissioning of offshore oil and gas installations in Norway is expected to increase leading up to 2030, while the industry anticipates reducing greenhouse gas emissions by 50 percent. Reuse and circular economy are central measures to achieve climate goals.

Waste from the decommissioning of fields has a high degree of recycling and contributes to a very high level of circularity for offshore platforms. Offshore installations are largely composed of metals, and the recycling of metal typically ranges from 94 percent to 98 percent by weight. In addition, there is increasing effort to find ways to reuse equipment instead of recycling through melting, for example, through direct reuse on other offshore platforms or by adapting them for other users and sectors.

The development of regulatory and market systems is crucial for successfully achieving a sustainable transition. Offshore Norge has therefore entered into a collaboration with the University of Bergen (UiB) to investigate the legal and economic framework conditions for a circular economy related to decommissioning in the petroleum industry. The project will explore barriers and incentives in the regulations for reuse and recycling in Norway compared to Australia, the Netherlands, and the United Kingdom. Based on a mapping of various practices, the project will investigate potential opportunities for reuse of installations and coordination and multiple use of marine areas in the

Norwegian context. The results will be presented in a knowledge report prepared by Offshore Norge and UiB.

8. CCS activities

From the reporting year 2022, Footprint has been adapted to also report on drilling activity from CCS wells. These are not defined as petroleum activities, but there are significant similarities with "normal" drilling, and the NEA grants permits for operations based on the same framework. Therefore, an agreement was reached between the operators and the NEA that these well activities will also be reported in Footprint.

Currently, activities are limited but are expected to increase as new storage licences are awarded. In 2023, 3 exploration licences were granted in the North Sea under the CCS storage regulations on the NCS, bringing the total to 7 licences.

In 2023, there was activity related to the preparation of subsea control in the Northern Lights licence (Aurora), with very limited discharges and emissions to sea and air. Some key figures are provided below:

Emissions of chemicals:

- Yellow category 79 tonnes
- Green category 595 tonnes

Emissions to air:

- CO_2 emissions 176 tonnes
- NOx emissions 3 tonnes
- nmVOC 0.3 tonnes

9. Improving the knowledge base

The petroleum industry has for many years contributed actively to building knowledge about the effects of activities on climate and the environment. Much of this knowledge is made publicly available and forms a knowledge base that public authorities are encouraged to use in their management of marine areas, for example, when updating the ocean management plan (see chapter 5). This chapter describes some of the activities that the petroleum industry has carried out in 2023.

9.1 Seabirds

Seabird populations in Norway have shown declining trends over many years, with 34 out of 54 species listed on the Norwegian red list, and 24 of these are considered threatened. Norwegian seabird populations account for as much as 20–25 percent of all seabirds nesting in Europe, and Norway therefore has a significant national and international management responsibility.

SEAPOP (derived from the English term for seabird populations) was initiated in 2005 and is a comprehensive and long-term monitoring and mapping program for Norwegian seabirds. The program provides and maintains fundamental knowledge about seabirds that contributes to better management of these marine environments.

SEAPOP's work is organized and carried out by personnel from the Norwegian Institute for Nature Research (NINA) and the Norwegian Polar Institute (NP). The program has so far been funded by the sector agencies, the Norwegian Ministry of Climate and Environment (KLD), the Norwegian Ministry of Petroleum and Energy (OED), and Offshore Norge.

SEAPOP conducts detailed mapping of the distribution of breeding, resting, and wintering seabirds along the entire Norwegian coastline and in Svalbard, and a number of key locations have been established for monitoring.

SEATRACK is a project under SEAPOP that was initiated in 2014. The purpose of the project is to increase knowledge about the distribution of seabirds in the Northeast Atlantic outside the breeding season. Many species migrate far during the winter season and utilize large areas for foraging.

In the project, nest loggers or GPS devices are attached to the birds when they are in their breeding colony during the summer. When they return to the breeding colony in the following year, the loggers are collected, and the data is analysed. The project is a large collaborative effort involving several countries.

The project is currently in its third phase. The two previous phases were funded by participating 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 with industry funding, with a total of 17 industry partners (including Offshore Norge).

The results from the programs are actively used in the industry's work with, for example, impact assessments and environmental risk analyses.

In 2023, Offshore Norge, along with Equinor, also contributed funds to build a kittiwake hotel in Røst, as well as follow-up research on the effects of such a measure. Kittiwakes nest on rooftops in Røst, and necessary maintenance required relocating the nests to a new location. The "hotel" is built to better monitor the kittiwakes, which could contribute to increased knowledge about whether such measures can have positive effects.

9.2 Environmental risk assessments and ERA Acute

Risk assessments are an important part of the operators' safety work, helping to identify which activities, times of the year, and environmental elements contribute to the highest risk for an exploration well or a producing field. The results provide a basis for assessing the most effective measures to prevent potential consequences. These can include both preventive measures that prevent acute discharges and consequence-reducing measures such as oil spill preparedness.

ERA Acute is the recommended method for environmental risk assessments for NCS activities. It can also be used internationally, handling various levels of detail depending on the data available. The analyses are built up step by step, and guidelines for best practices have been developed to ensure that the analyses use the best available input data and are performed in a comparable manner.

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 assurance of the models and tools used in the industry's environmental risk analyses and preparedness needs for acute pollution. This work is carried out by key executing institutions and also includes updates of meteorological and oceanographic tide data. In 2023, the work also included verification of the calculations conducted for the coastal zone, which are foundational for both environmental risk assessments and

preparedness planning in the coastal and shoreline areas. The results of this work will be incorporated into the next version of the oil drift model, available in Q1 2024.

- ERA Acute Marginal Ice Zone Project/dynamic data
  This project is funded by the Research Council of Norway. It was launched in 2018 and concluded in 2023. The project consisted of two parts: facilitating the use of high-resolution data for selected valued ecosystem components (VEC) in ERA Acute analyses and developing a methodology to calculate environmental risk in a simplified manner for the ice zone (Marginal Ice Edge Zone) as an independent VEC habitat of ecological significance. The industry partners in the project include Equinor, Lundin (now Aker BP), OMW, Wintershall Dea, and Offshore Norge.
- Development project for seabirds
  The objective of this project is to improve the assessment of the consequences of acute oil pollution on declining seabird species and populations. The work is conducted in dialogue with NINA.
- Improved toxicity curves for early life stages of fish resources and datasets on spawning areas are being developed.

  The project includes the revision of loss calculations for eggs and larvae using new knowledge about sensitive species and methods, as well as discussion and revision of the classification of spawning stocks. The project is conducted in dialogue with the Institute of Marine Research.

9.3 Zero emissions work

The zero emissions work on the shelf is based on a risk-based approach, known as RBA – Risk Based Approach from OSPAR. Risk assessments are used to implement measures where they are most environmentally effective while also providing a reasonable balance between cost and benefit. The zero emissions work has resulted in a significant reduction of oil and chemicals released into the sea. The volumes of oil discharged into the sea have decreased through reinjection on many fields, and substantial investments have been made in treating water before discharge. For chemicals, the most environmentally hazardous added chemicals have been reduced by over 99 percent, a result achieved even before 2010. Nevertheless, operators continue to work on assessing and phasing out hazardous chemicals. Discharges of chemicals in the red and black categories typically account for less than 1 percent of total emissions.

The potential environmental risk associated with the discharge of produced water is assessed for each field through analyses and model calculations, expressed as the Environmental Impact Factor (EIF). Oil in produced water constitutes a very small part of the overall risk associated with the discharge, while added chemicals can contribute more significantly. The EIF factor is linked to a specific discharge, and its purpose is to evaluate which components in produced water contribute to the risk, thereby providing a basis for the substitution of chemicals containing these components. Certain added chemicals and natural components from the bedrock that are released with produced water have the potential to cause harmful effects on aquatic organisms. This is supported by research and the EIF calculations. Primarily, this applies to concentrations near the discharge sources, which vary from one hundred meters to one thousand meters away. Added chemicals that contribute to environmental risk are subject to regular assessments and substitution. Offshore Norge's guideline 084 for modelling and calculating the EIF was updated and published in the autumn of 2022. Results from the water column monitoring on the shelf in 2021 indicate that no significant acute biological effects from discharges can be detected beyond the immediate area. Additionally,

research and modelling of produced water discharges have so far found no significant effects. Research continued in 2022. Significant investments in treatment technology and injection have been made to reduce oil discharges from produced water. Most fields have discharges well below the discharge requirement of 30 mg/l, while a few fields, for various reasons, experience challenges with the stable operation of injection facilities and treatment processes, resulting in slightly higher levels, especially during the integration of new well streams. IOGP published a guideline for RBA in the autumn of 2020. This guideline describes the approach to RBA and recommends how to implement its principles, with results determining whether the risk is acceptable or if further measures should be taken. The NEA tasked the expert group with providing an overview of whether higher environmental risks or effects from produced water discharges are expected in the Barents Sea and Arctic compared to the continental shelf elsewhere in the Norwegian Sea and the North Sea. The expert group concluded in late 2019 that, based on the data gathered, there is no reason to believe that organisms and ecosystems in the Barents Sea are significantly more sensitive to chemical pollution and ecotoxicological effects than elsewhere on the shelf. This aligns with findings from the PROOFNY project under the Marine and Coastal Program from 2005 to 2015 and in environmental monitoring.

9.4 KnowSandeel

Sand eels or herring are considered a key species in the North Sea ecosystem. There is a need for further knowledge about sand eels to improve the assessment of environmental risks associated with various types of discharges. KnowSandeel is a collaboration between the petroleum industry and the Norwegian Institute of Marine Research, aimed at enhancing knowledge related to the vulnerability of sand eels to human activities. The project was completed in 2023, and robust methods have been established to produce eggs and sand eel larvae from wild-caught spawning-ready sand eels. This has enabled the mapping and documentation of egg and larval development in sand eels, allowing for the examination of vulnerability to oil exposure at different life stages. Additionally, it is possible to study the natural behaviour of sand eel larvae and how sensitive that behaviour is to environmental changes. In KnowSandeel 1.0, sand eel eggs were exposed to oil, and despite oil droplets adhering to the sticky surface of the eggs, the natural larval development was less affected by this than in other fish species. The petroleum industry and the Norwegian Institute of Marine Research have continued their efforts to enhance knowledge about sand eels in KnowSandeel 2.0. The main goal is to integrate knowledge about the vulnerability of sand eel larvae to oil exposure and the dynamics of sand eel larvae, for implementation in risk assessment models such as Symbioses. This will provide more precise data about where and when particular caution should be exercised regarding activities in sand eel areas.

9.5 Methane

Methane is the main component of natural gas and is a potent greenhouse gas. Methane has a lifespan of about 12 years in the atmosphere, making it a so-called short-lived climate driver. In a 20-year perspective, the climate effect of methane is approximately 80 times greater than that of CO_2. The petroleum industry places significant emphasis on minimizing emissions of natural gas—both for safety reasons and due to the climate impact of methane emissions into the atmosphere.

To detect methane emissions from the production and transportation of oil and gas, a variety of technical solutions and instruments are available. On behalf of Offshore Norge, Carbon Limits has prepared the report "Overview of methane detection and quantification technologies for offshore

applications.” The report shows that satellites are best suited for detecting large emission sources over land. To detect and quantify emissions from individual sources, handheld instruments must be used that can be brought right up to the source. There are limited technical solutions available for detecting and quantifying methane leaks underwater. Carbon Limits has conducted the study "Overview of subsea methane emissions detection and quantification technologies" on behalf of Offshore Norge to shed light on this.

Methane emissions on the Norwegian shelf totalled 11,579 tonnes in 2023. This corresponds to an emission intensity of 0.02%. This is very low compared to oil and gas production in other countries. This is clearly illustrated in the IEA's overview.

10. Terms and abbreviations

CH4	Methane
CO_2	Carbon dioxide
EFTA	European Free Trade Association
EIF	Environmental Impact Factor
ESA	EFTA Surveillance Authority
HOCNF	Harmonized Offshore Chemical Notification Format
IOGP	International Association of Oil and Gas Producers
KLD	Ministry of Climate and Environment
LRA	Low Radioactive Discharge
MOD	Environmental Monitoring Database
NGU	Geological Survey of Norway
NINA	Norwegian Institute for Nature Research
NIVA	Norwegian Institute for Water Research
NOx	Nitrogen oxide
NP	Norwegian Polar Institute
nmVOC	Non-methane volatile organic compounds
OD	Norwegian Petroleum Directorate (now the Norwegian Offshore Directorate)
ED	Norwegian Ministry of Petroleum and Energy
o.e	Oil equivalents
OIC	Offshore Industry Committee
OSPAR	Oslo-Paris Convention. This is a legally binding international environmental cooperation for the protection of the marine environment in the Northeast Atlantic. Fifteen countries with coastlines or rivers flowing into the Northeast Atlantic are members.
PLONOR	Pose Little Or No Risk to the Marine Environment is a list from OSPAR of chemical compounds that are believed to have little or no effect on the marine environment when discharged.
RBA	Risk Based Approach
SOx	Sulphur Oxides
SO2	Sulphur Dioxide
Sodir **Sm^3**	The Norwegian Offshore Directorate Standard cubic meter
SFT	Norwegian Pollution Control Authority (now the Norwegian Climate and Pollution Agency)
SSB	Statistics Norway

Conversion factors

Based on the energy content of hydrocarbons. Calculated according to definitions from the Norwegian Offshore Directorate:

Oil 1 m^3 = 1 Sm^3 o.e.

Oil 1 barrel = 0.159 Sm^3

Condensate 1 tonne = 1.3 Sm^3 o.e.

Gas 1,000 Sm^3 = 1 Sm^3 o.e.

NGL 1 tonne = 1.9 Sm^3 o.e.