# Bacheloroppgave

**PET600 Petroleumslogistikk**

**The role of the Norwegian petroleum industry in Norway's transition to a low emission society**

Mari Hope

Totalt antall sider inkludert forsiden: 63

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Høgskolen i Molde
Vitenskapelig høgskole i logistikk

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## Abstract

Through the Paris Agreement, Norway has made a commitment to reduce its greenhouse gas emission with 50-55 % by 2030 and has set a target in its climate change act to become a low-emission society by the year 2050. At the same time, the country's largest industry is the petroleum industry, regarded as being a "bad guy" in the battle against climate change. Through qualitative document analysis from governments, institutions, industry actors and researchers and analysis of performance data, this thesis examines the ways in which the Norwegian petroleum industry might be an asset in the country's battle against climate change. Governmental implementation of policies and measures such as carbon tax, emission trading and subsidies, as well as R&D, innovation and technology developments within the industry, has resulted in the Norwegian petroleum industry having one of the cleanest productions of oil and gas in the world, as well as gradually increasing their production of renewable energy, leading to significant reductions in greenhouse gas emission.

Table of Content

# 1.0 Introduction

The “Stockholm declaration” resulting from the United Nations’ Conference in June of 1972, proclaims that “Man has constantly to sum up experience and go on discovering, inventing, creating and advancing. In our time, man's capability to transform his surroundings, if used wisely, can bring to all peoples the benefits of development and the opportunity to enhance the quality of life. Wrongly or heedlessly applied, the same power can do incalculable harm to human beings and the human environment. “ (United Nations 1972) At this conference, the concept of “eco development”, from which the concept of “sustainable development” is derived, appeared for the first time (Bajdor 2012).

A common used definition of ‘sustainable development’ is found in the so-called “Brundtland report”, “Our common future” (United Nations 1987): “Sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development; and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.”

In 2015, the UN put forth its “2030 Agenda”, laying down 17 goals for sustainable development (see Figure 1-1). These goals are meant to balance the three dimensions of sustainable development: people (“We are determined to end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment.”); planet (“We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.») and profit (“We are determined to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature.») (United Nations 2015) In corporate decision making processes this people-planet-profit principle is often known as ”triple bottom line”.

In the same year as the UN presented its 2030 agenda, the Paris Agreement set a globally collective goal of keeping the global average temperature below 2°C above the pre-industrial temperatures (United Nations Treaty Collection 2016). According to the UN’s

2019 Emission Gap Report, temperatures can be expected to rise by 3.2 % this century as things stand. In order to reach the 2°C goal, the emissions need to drop at an annual rate of 7.6 % from 2020, meaning the countries collectively need to increase their commitments more than fivefold. However, as data from the last decade shows, the emission gap is not closing. (UN 2019) There is a finite net amount of $CO_2$ that can be emitted to “stay on the sustainable path”, and the more we use of the carbon budget today, the less we have left tomorrow. ”The world will continue to chase a moving target until it manages to stabilise and start reducing $CO_2$ emissions.” (Equinor (a) 2019)

In accordance with the Paris Agreement, every signatory country is required to submit their updated nationally determined contributions (NDCs) to the UNFCCC (United Nations Framework Convention on Climate Change) secretariat every 5 years, starting from 2020. In February of 2020, Norway was the third country in the world to do so, after the Marshall Islands and Suriname. As of August 2020, seven countries have submitted their enhanced NDCs, with Moldova, Japan, Singapore and Chile being the last four. (UNFCCC (a) 2020).

Norway’s updated NDC calls for a reduction of greenhouse gas emission by 50 to 55 percent by the year 2030 compared to 1990 levels, up from its 2016 NDC of 40 percent emission reduction by 2030. The 2016 target is put into the legislation in the climate change act of 2017 (Norwegian Ministry of Climate and Environment 2017), and the same act states that Norway is to become a low-emission society by the year 2050, with an 80 to 95 percent reduction of GHG emissions compared to 1990 levels, defining a low-emission society as “a society where the greenhouse gas emissions, from the best of our scientific knowledge, the global emission development and national circumstances, is reduced to counter-effect harmful consequences as described in the Paris agreement.” This target has further been defined by the current Norwegian government as an emission reduction of 90 to 95 percent in 2050 compared to 1990 levels. (Norwegian Ministry of Climate and Environment (b) 2020)

These are ambitious targets, positioning Norway as an “environmental frontrunner”. While the country is gaining reputation as such, it is also known for its significant petroleum industry. This industry is by far the biggest in Norway, estimated in the Norwegian national budget for 2020 to account for 14 % of the GDP, 19 % of total investments, 19 %

of the state's revenues and 37 % of total export (The Norwegian government (b) 2019). On a global scale, Norwegian production of crude oil and natural gas cover respectively 2 percent and 3 percent of the global demand, and the country is supplying between 20 and 25 percent of EU's gas demand. This places it as the third largest exporter of natural gas in the world, beaten only by Qatar and Russia. (Norwegian Ministry of Petroleum and Energy, 2020)


*Figure 1-1 UN sustainability goals*

## 1.1 Research question

This paper is intended to give an overview of the ways in which the Norwegian petroleum industry might contribute to reaching the nation's climate targets set in the Paris Agreement and Norway's legislation, and assess the environmental effects stemming from the industry. I want to see whether the industry can be sustained if Norway is to reach its climate ambitions.

I have chosen to take a closer look at the Norwegian energy company Equinor (former Statoil) where I will present their activities and projects relating to sustainable energy production, as well as their overall environmental performance. Since this is a partly state-owned company, I believe that it can serve as a measure of the country's performance in this area.

My research question is as follows:

What is the role of Norway's petroleum industry in the country's transition to a low-emission society?

## 1.2 Structuring of the paper

In chapter **Feil! Fant ikke referansekilden.**, I will present the methodology used in this paper. Chapter 3.0, "Energy perspectives", introduces three possible future scenarios in an energy context – rivalry, reform and renewal. In the 4.0th chapter, "Norway's climate policy", I will lay out the political and juridical framework of the country's climate policies and its climate targets, implemented measures and global commitments. In chapter 5.0, "The Norwegian Petroleum Industry", I will be focusing on the economic aspects of the industry and its significance related to the "people" and "profit" pillars of sustainability. Chapter 6.0, "Environmental effects and performance" looks at the environmental effects stemming from the petroleum activities, particularly with regards to emission to air and discharging to sea, as well as the general environmental performance. Chapter 0, "ctions
Equinor – "Shaping the future of energy"", describes Equinor's environmental ambitions, measures and performance within the context of sustainable development and emission reduction. My research question will be discussed and concluded in chapter 8.0.

# 2.0 Methodology

In this thesis I will be looking at the environmental performance of the Norwegian petroleum industry, as well as the national and international policies and measures put in place to battle climate change. This means I will have to collect and select information on areas such as framework, legislation and procedures; environmental performances;

research, development and technologies, among others. I have chosen to do so by qualitative document analysis as well as a quantitative presentation of performance data. Examples of such documents I have used are public reports by governments (e.g. white papers, national budgets and political platforms) and reputable institutions (e.g. UN, the EU and the OECD); relevant acts regulating the climate policies; agreements and declarations; articles from journals and books within the disciplines relevant in the context of my thesis, like environmental sciences, green SCM, petroleum logistics etc; published research from universities and other research institutions; and reports, articles and self-reported data from Equinor.

In order to ensure reliability of my sources, and to avoid biased selectivity of data, I have worked under a set of criteria for the selection of information.

1) As close to the primary source as possible.
2) Where possible, find more than one source per claim.
3) Make sure the source is reputable.
4) Consider possible vested interests from my sources on the given topic.
5) Be aware of the possibility that my information could be outdated - focus on newer research in the fast-moving fields like for instance research, technology and public opinions.

In the last part of my thesis I will discuss and conclude my research question in view of the gathered information.

# 3.0 Energy perspectives

Since 2011, Equinor has published its "Energy perspectives" reports outlining possible scenarios for the global economy, international energy markets and energy related greenhouse gas emissions. The 2019 edition (Equinor (a) 2019) provides perspectives on possible macroeconomic and global energy market developments towards 2050, and relevant trends, energy sources, sectors and regions are analysed across the three different scenarios "Reform", "Renewal" and "Rivalry".

The Reform and Rivalry scenarios describe the directions the world may move in if there are no significant changes made to the current energy market and macroeconomic and geopolitical developments – which include the global order, levels of conflict, political ideologies, trade and cooperation, demographics, migration and urbanisation, as well as the security of energy supplies and energy export being used as leverage in foreign policy - while the Renewal scenario shows the directions the energy markets need to go in order to contribute to a sustainable future.

In all three scenarios, renewable energy is expected to grow significantly, particularly in the electricity sector, with solar and wind energy being the most prominent. It is estimated that solar and wind energy will grow to between 30 % and 50 % of the total global electricity, compared to 7 % in 2018, in large part due to reduced costs, continued regulatory support and technological improvements. Natural gas for power generation is seen as the main area of growth. (Equinor (b) 2019)

The estimates in the three scenarios are based on the assumptions that the economy will be much larger by 2050, that the energy efficiency will be higher than today, and that the world population will reach almost 10 bn, in line with UN's forecast on population growth. (Equinor (a) 2019)

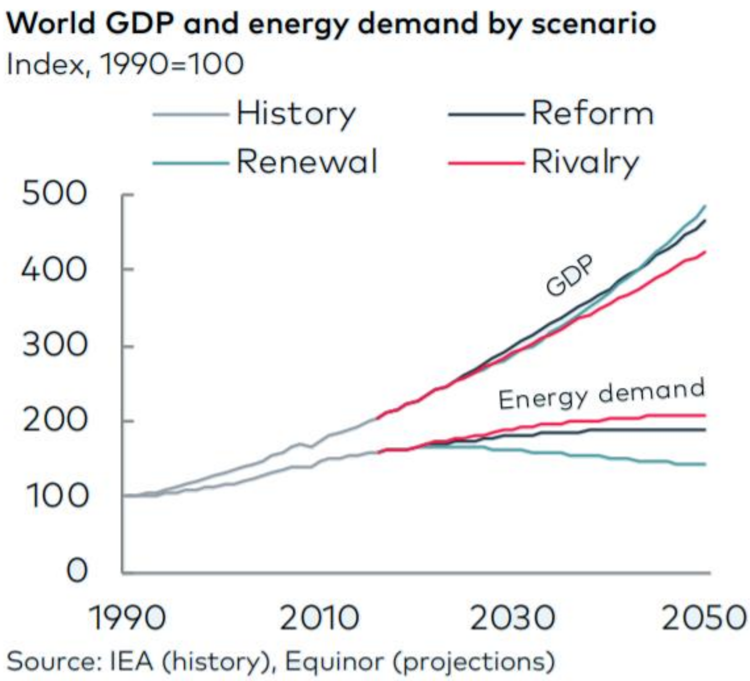



*Figure 3-1 World GDP and energy demand by scenario, (Equinor (a) 2019)*

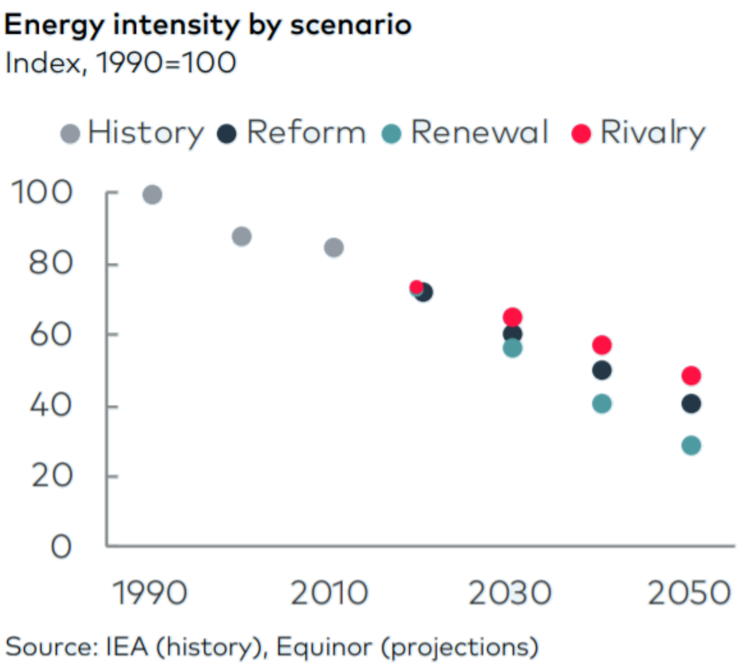



*Figure 3-2 Energy intensity by scenario, (Equinor (a) 2019)*

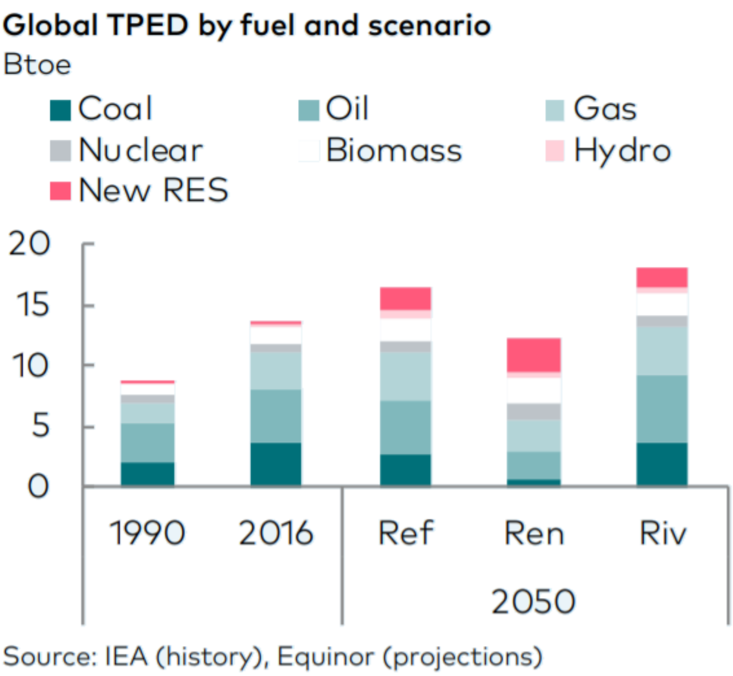



*Figure 3-3 Global TPED (total primary energy demand) by fuel and scenario, (Equinor (a) 2019)*

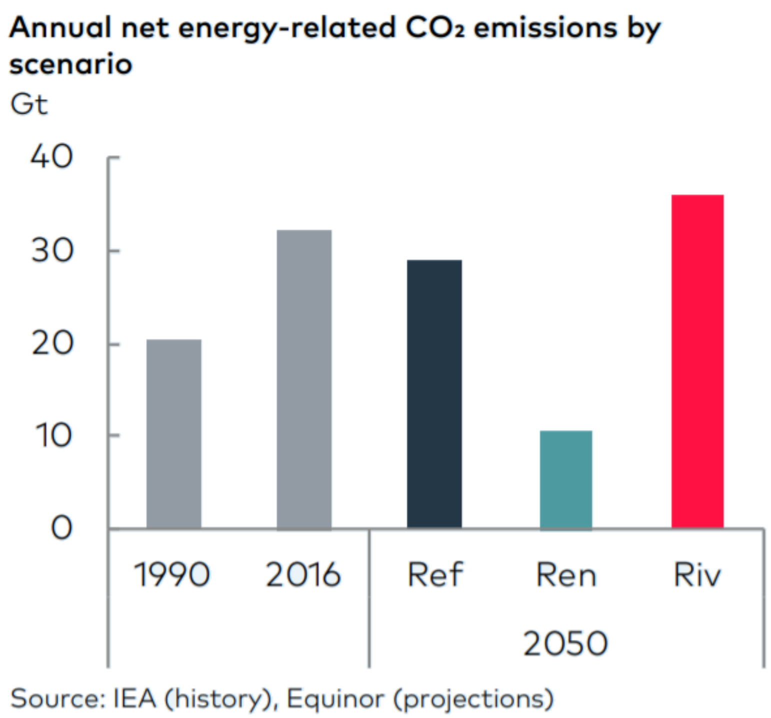



*Figure 3-4 Annual net energy-related $CO_2$ emissions by scenario (Equinor (a) 2019)*

## 3.1 Rivalry

The Rivalry scenario illustrates a future where the energy transition is slowed down by ineffective solutions to common challenges, a lack of trust, and geopolitical volatility and uncertainty which leads to less priority given to climate policies. This is where we globally can be said to stand today (Equinor (a) 2019).

The competition between the major powers is predicted to increase, and we will see a resurgence in commercialism, isolationism, growing protectionism and nationalistic political ideologies, leading to exclusionary bilateral agreements being favoured over the inclusionary multilateral agreements better suited to solve the climate challenges. Inadequately handled urbanisation and migration will result in increasing inequality. The challenges and uncertainties in this scenario push the global climate concerns further down the priority list of policy objectives and could give higher priority to policies like for instance energy security focusing on developing domestic energy sources rather than relying on energy import. These domestic energy sources will not always be renewable ones and, as can be seen in Figure 3-3, the non-renewables like coal and oil are biggest in the rivalry scenario. There is, however, growth in renewables also in this scenario, both due to their growing competitiveness and the concerns of local pollution stemming from coal. Renewable energy is also considered to contribute to lower dependency on energy import. (Equinor (a) 2019)

Due to less environmental regulations, coupled with little or no out-phasing of fuel subsidies and less investment in energy efficiency, the growth in energy demand will be the highest in this scenario, as can be seen in Figure 3-1 and Figure 3-3. This leads to slower improvements in energy intensity compared with the Reform and Renewal scenarios (see Figure 3-2).

The electrification rate is lowest in the rivalry scenario, but due to the total energy demand being higher here, the growth of electricity demand is similar to the one in the renewal scenario. By 2050, fossil fuels will account for more than 75 % of the total primary energy demand, and the emissions of $CO_2$ will continue to grow at a moderate pace until it will start to slowly decline from 2040.

## 3.2 Reform

The Reform scenario describes a future where the energy transition is driven by the market and technology forces while the current policy momentum continues, with a gradual tightening of the energy and climate policies.

On the world stage, the relations between actors is described as a coexistence of competition and cooperation, with few or no large-scale conflicts. While there may be some friction between the different kinds of global governance, it is the market competition that will dominate. A key political consideration will be the securing of energy access, including access to nuclear and renewable energy. (Equinor (a) 2019)
The dominant policy guidance that the Reform scenario is built on, are the NDCs provided from the different nations in accordance with the Paris Agreement. Climate and policy targets are considered in the Reform scenario, though if reaching them is seen as coming at an unacceptably high economic cost, the assumption is that they will not be met.

The developments in this scenario are driven by market and technology, largely understood by economic factors and signals such as the end-user prices on energy providing insight into the market operations and the costs of energy and technology shaping long-term investment decisions. As the $CO_2$ prices are being introduced in most regions and the energy subsidies are being gradually phased out, the end-user prices on energy are expected to increase gradually over time.

The improvements in technology will continue to move at a rapid pace in the reform scenario, though with no new ground-breaking technologies, and with the coexistence of different technologies over time. There may be policies made to support the new technologies at an early stage, through subsidies or otherwise, but the only technologies that will sustain are the ones that become competitive or show the potential to be so.
The energy transition will speed up but will largely be confined to the road transport sector and electricity generation.

The changing energy mix will see an increase of all low-carbon energy sources, particularly in new renewable sources, and the $CO_2$ emissions from the changing energy mix will end up at a level that is around 10 % lower in 2050 compared to the predicted peak in 2020. These levels will not be sufficient to achieve the climate targets.

## 3.3 Renewal

The renewal scenario shows a way to reduce the greenhouse gas emissions to limit the global warming to less than 2°C compared to the pre-industrial levels, consistent with the target put forth in the Paris Agreement. This scenario is in line with the International Energy Agency's Sustainability Development scenario (International Energy Agency (a), 2019). This calls for a rapid and significant tightening of the energy and climate policies, with substantial changes in the business and consumer behaviours, fast technology changes and considerable global cooperation.

The cumulative $CO_2$ emissions between 2017 and 2050 related to energy are set at a little over 770 Gt. This would limit global warming to about 1.7-1.8°. If the reductions in emission follow at the same pace after 2050, we will reach zero emissions a few years before 2070. (Equinor (a) 2019)

In this scenario, the demand for oil and gas in 2050 is estimated to be reduced by about 50 % and 20 % respectively. Due to the natural decline of the existing production, investments in oil and gas will still be needed, though on a much lower scale compared to the other scenarios. Low-cost and low-emission oil and gas resources will have an advantage. (Equinor (b) 2019)

Almost all use of coal must be phased out. In order to achieve this, natural gas plays an important role, providing a flexible source of electricity able to support the uptake of variable renewables. However, by the middle of the 2030s, the use of gas also needs to be reduced according to the renewal scenario, particularly in the developed regions. (Equinor (b) 2019)

Generally, three main paths to reach a long-term decarbonization of the energy systems are presented: electrification, hydrogen and CCUS (Carbon Capture, Utilisation and Storage). Most likely we will need a combination of these, together with improvements in energy efficiency, in order to reach the climate targets. The renewal scenario focuses strongly on energy efficiency and electrification, while being more cautious in regard to CCUS. I will go more into this in chapter 7.1.

If either the improvements in energy intensity, changes in energy mix or CCUS does not deliver in accordance with the projections, one or two of the others will have to compensate for that in order to reach the targets of the renewal scenario.

# 4.0 Norway’s climate policy

## 4.1 Framework

The climate policy of Norway is founded on the objectives and targets set in the UN Framework Convention on Climate Change (United Nations (a) 1992), the Kyoto Protocol (United Nations 1997) and the Paris Agreement (United Nations Treaty Collection 2016), and put into legislation by several acts, particularly relevant in this context being the Climate Change Act (Norwegian Ministry of Climate and Environment 2017), the Pollution Control Act (Norwegian Ministry of Climate and Environment 1983), the Greenhouse Gas Emission Trading Act (Norwegian ministry of climate and environment 2004), and the act related to carbon tax for the petroleum industry on the continental shelf (Norwegian Ministry of Finance 1990).

The pollution control act states that pollution is prohibited unless given specific permission by the relevant authority. The act also applies to greenhouse gas emissions, though that is largely covered by the $CO_2$ tax, the EU Emission Trading Scheme (EU ETS) and other specific industry agreements on emission reduction.

The Rio Declaration on Environment and Development (United Nations (b) 1992) is a short document of 27 principles, produced at the UNs Conference on Environment and Development in June 1992, also known as the "Earth Summit". The principles were intended to be used to guide countries in future sustainable development. Two of these can be worth mentioning in regard to the framework of the Norwegian climate policy:

> Principle 15: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

> Principle 16: "National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment."

Both the precautionary principle and the polluter-pays principle are cornerstones in the framework of the Norwegian climate policy.

The government wants to lead a climate and environment policy based on the precautionary principle (The Norwegian government (a) 2019). This principle has four central components: (1) taking preventive action in the face of uncertainty; (2) shifting the burden of proof to the proponents of an activity; (3) exploring a wide range of alternatives to possibly harmful actions; and (4) increasing public participation in decision making. (Kriebel, et al. 2001).

The polluter-pays principle was first mentioned in recommendations from the (OECD 1972), “The principle to be used for allocating costs of pollution prevention and control measures to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment is the so-called polluter-pays principle”, and reaffirmed in (OECD 1974), “when negotiating new bilateral or multilateral agreements countries should […] strive for the application of efficient pollution prevention and control measures in accordance with the polluter-pays principle.”

The OECD recommendation was taken up by the European Community’s first Environmental Action Program (1973-1976), and later in a recommendation in 1975 regarding the governments’ measures on environmental matters. The principle has been enshrined in the Treaty of the European Communities since 1987 and are to be found in numerous national legislations worldwide. (EU 2012)

## 4.2 Cross-sectoral economic policies and measures

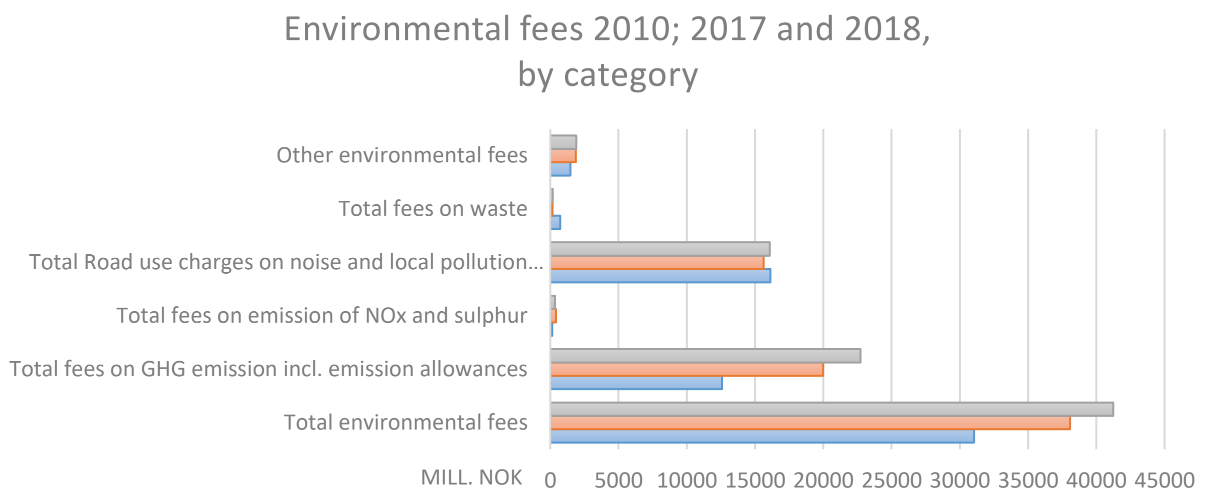
In Norway, 50 % of the greenhouse gas emissions are covered by the EU ETS, and more than 80 % of the emissions are covered by the EU ETS and/or $CO_2$ taxes. (Norwegian Ministry of Climate and Environment 2019) There are considerable variations in the price on greenhouse gas emission between the different sectors and sources, with the petroleum sector and domestic aviation paying the highest price. These two sectors are subject to both the $CO_2$ tax and the EU ETS, paying a total price on greenhouse gas emission of about 760 NOK and 710 NOK respectively per tonne $CO_2e$ emitted. (Norwegian Ministry of Climate and Environment (a) 2020)

### 4.2.1 Carbon taxes and environmental fees

Environmental taxes are taxes put on any activities resulting in negative externalities and is set as the marginal damage cost of the environmentally harmful activity. Environmental taxes have two main purposes: (1) they give cost-effective emission reductions when the reduction costs are less than the tax level, and (2) the cost of the remaining emission is paid by the polluter (Bruvoll 2009).

In Norway, $CO_2$ taxes on petrol, mineral oil and emission from extraction of petroleum on the Norwegian Continental Shelf were introduced in 1991, and taxes on natural gas and liquified petroleum gas (LPG) were included in 2010. Emission stemming from petroleum extraction was also included in the EU ETS in 2008. (Norwegian Ministry of Climate and Environment (a) 2020)

Figure 4-1 below shows the revenues generated from environmental taxes and fees in the years 2010, 2017 and 2018. As can be seen, the total revenues from environmental fees have increased quite substantially since 2010.




| | Total environmental fees | Total fees on GHG emission incl. emission allowances | Total fees on emission of NOx and sulphur | Total Road use charges on noise and local pollution etc. | Total fees on waste | Other environmental fees |
|---|---|---|---|---|---|---|
| 2018 | 41238 | 22725 | 346 | 16081 | 182 | 1904 |
| 2017 | 38075 | 19991 | 417 | 15630 | 165 | 1872 |
| 2010 | 31046 | 12579 | 142 | 16124 | 726 | 1475 |

*Figure 4-1 Environmental fees 2010, 2017 and 2018, by category, in million NOK. Based on data from (Statistics Norway 2020)*

### 4.2.2 The EU emission trading system

The biggest carbon market, and the world's first major one, is the EU Emissions Trading System, operating in all countries in the European Union plus Iceland, Liechtenstein, Norway and Switzerland, the latter being the first country, in 2020, to successfully link its greenhouse gas (GHG) emission trading system with the EU ETS (European Council 2019). About 45 % of all GHG emission from Europe is covered by this market. (EU 2020)

The EUs Emissions Trading System sets a cap on the total amount of $CO_2e$ that can be emitted each year. This cap is reduced over time, meaning that the total GHG emissions also decrease.

Within this cap, companies receive and buy emission allowances that can be traded freely on the EU ETS market as needed. In this way one creates a market and a price for $CO_2$, and as the cap reduces and the price for $CO_2$ increase, it gives the companies incentives to reduce their GHG emissions instead of buying allowances.

After each year, the companies covered by the system must surrender enough emission allowances to cover all its emissions. Failure to comply will result in heavy fines. If a company has spare allowances after the year is over, it can choose to either keep them for - its future needs or sell them to another company.

The system focuses on emissions that can be measured, reported and verified accurately, and covers the following sectors and gases:

- Carbon dioxide ($CO_2$) from
    - power and heat generation;
    - energy-intensive industry sectors including oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard acids, and bulk organic chemicals; and
    - commercial aviation.
- Nitrous oxide ($N_2O$) from production of nitric, adipic and glyoxylic acids and glyoxal.
- Perfluorocarbons (PFCs) from aluminium production. (EU 2020)

In 2020, the emission cap is set 21 percent lower compared to the 2005 emission levels from the covered sectors, and the reduction rate will further increase from 2020 to an overall cap reduction of 43 percent in 2030 compared to 2005 (Norwegian Ministry of Climate and Environment (a) 2020).

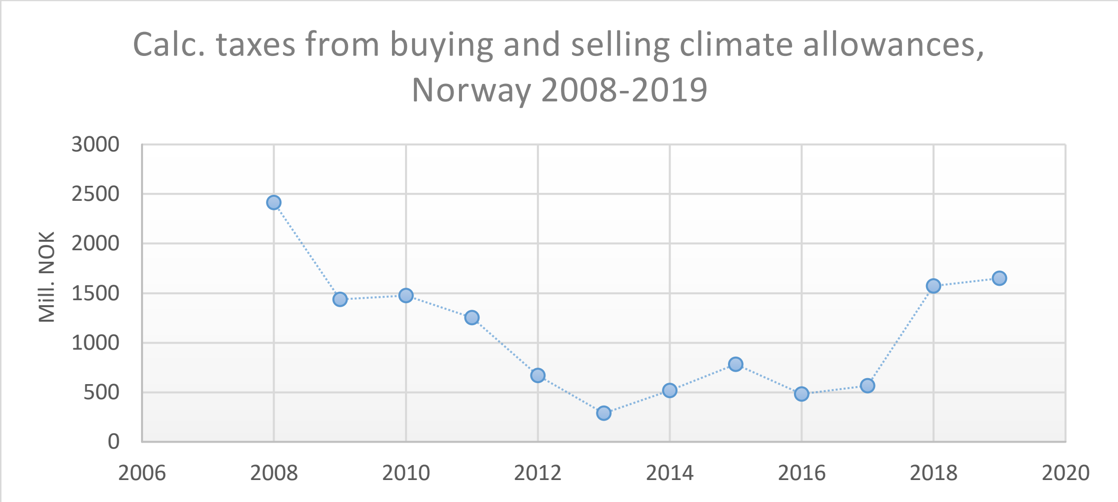



*Figure 4-2 Taxes from buying and selling climate allowances, Norway 2008-2019, based on data from Statistics Norway*

Because emission allowances can be traded between installations across borders, the effects of the scheme on a national level can be difficult to assess. There are, however, estimates from Statistics Norway showing that the emission trading scheme in its second phase (2008-2012) may have resulted in a yearly overall national emission reduction of 0.3 million tonnes $CO_2$. For the trading period 2013-2020, EU ETS phase three, Norway's allowance (excluding aviation) has been around 18 million tonnes per year, with an estimated yearly demand of 25 million tonnes. Consequently, this has resulted in emission reductions that may have taken place anywhere in the area covered by the scheme. (Norwegian Ministry of Climate and Environment (a) 2020)

### 4.2.3 Subsidies

Policies that internalize the cost of negative environmental effects create a demand for, and thus stimulate the creation of, climate friendly technologies and solutions. Environmental taxes and fees, in addition to emission trading systems, are considered the "first-best" in reaching the emission reduction targets. (NOU 2015) However, several researchers have addressed issues that may arise if the market is being left unregulated, only leaning on the "first-best" climate policies.

(Popp 2006) points to two market failures as reasons to expect underinvestment in the area of climate friendly research and development. First there is the problem of environmental externalities in the terms that companies and consumers will not have incentives to reduce emission without policy intervention because the emission is not priced by the market. The effect of this is a reduction in the market of emission reducing technologies.

The second market failure referred to, is “the public goods nature of knowledge”. For the innovator to reap the rewards of his innovation, new technologies must, in most cases, be made available to the public, thus its embodied knowledge becomes public knowledge. “These knowledge spillovers provide benefit to the public as a whole, but not to the innovator. As a result, private firms do not have incentives to provide the socially optimal level of research activity» (Popp 2006). (Rezai and Ploeg 2016) refers to this as “the failure of markets to internalize the full benefits of learning by doing in the production of renewable energy”.

(Popp 2006) mentions several policies to address these issues, such as publicly funded subsidies or tax credits for research and development, and improvements in the area of intellectual property rights that lets inventors reap more of the innovation’s benefits, claiming that this will result in higher levels of spending on research and development and, presumably, more innovation.

(Jaffe, Newell and Stavins 2005) also advocates for “government intervention” in the field of environmental research and development. “Where research produces potentially large social benefits, but is so prone to the spillover problem that firms will not view it as profitable, there is an analytical basis for performing that research in the public sector or through direct private research contracts.” They propose counter-balancing this spillover problem by publicly subsidizing research in the private sector, as opposed to performing the research in the public sector, suggesting that companies might be more successful at choosing the right technologies to pursue due to them having better information than the government about how commercially feasible the technologies are likely to be.

(NOU 2015) refers to the problem of overconsumption and overproduction - “Subsidies to climate friendly activity used as an alternative to setting a fee on a negative external effect will, however, lead to overproduction or overconsumption of the product” - and the country’s climate policy is leaning heavily on first-best methods like taxation and emission trading, stating that they, ideally, will regulate the negative external effects fully and lead to desired production changes. There is, however, an acknowledgement of the value of subsidies as a supplement to the aforementioned policies. “When subsidies are combined with the right fees it will be up to the market operators to find the solution, invest in new technology or produce or use less. To stimulate for technological development subsidies is a supplement to fees and emission permits."

In 2017, environmental subsidies and similar transfers accounted for 6.5 %, or 8.4 bn NOK, of all subsidies and current transfers from Norwegian public administration, with the purpose of supporting activities protecting the environment or reducing the use of natural resources (Statistics Norway (a) 2019). These transfers fund multiple public support schemes to promote zero- and low-emission solutions, like for instance Enovo, Klimasats, and several programs under The Research Council of Norway and Innovation Norway.

#### 4.2.3.1 The transport sector

About 60 % of non-ETS emissions in Norway comes from the transport sector (Norwegian Ministry of Climate and Environment 2016), and the sector, including fishery and construction machinery, account for about one third of the country's total GHG emissions (Norwegian Ministry of Transport 2017). Thus, there is potential for significant emission reduction in this sector.

The National Transport Plan 2018-2029 proposes several measures for emission reduction of GHGs in the transport sector in order to reach the country's climate targets, in particular regarding zero-emission vehicles and other emission reducing technologies. To mention a few of the goals put forth in this report:

- By 2025, all new cars and light commercial vehicles shall be zero-emission vehicles, and all new city buses shall be zero-emission or run on biogas;
- by 2030, all new heavy goods vehicles, 75 % of new long-distance buses, and 50 % of new trucks shall be zero-emission vehicles;
- it shall always pay off to choose zero-emission when buying a car; and
- the government shall contribute to reduce the greenhouse gas emissions from freight transport by stimulating the use of climate friendly vehicle technology, alternative fuels and the effectivization of transport and logistics. (Norwegian Ministry of Transport 2017)

According to whitepaper no. 41, 2016-17, “Climate strategy for 2030”, analyses show that “ambitious targets for emission cuts in the transport sector will not be achieved without the use of incentives”. (Norwegian Ministry of Climate and Environment 2016)

In terms of electrification of the transport sector, there are no countries in the world with more electric cars per capita, in large part due to these vehicles being heavily subsidized. The country is also a frontrunner in the field of zero- and low-emission solutions for maritime transport, as well as having an ambitious policy on the use of sustainable biofuels. (Norwegian Ministry of Climate and Environment (b) 2020)

## 4.3 The Paris Agreement

From November 30th to December 12th 2015 the “2015 United Nations Climate Change Conference” was held in Paris, negotiating the Paris Agreement, a global agreement which aims to “strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and
c) Making finance flow consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.” (United Nations Treaty Collection 2016)

174 countries signed the agreement in New York on April 22nd, 2016 and began adopting its aims into their own respective legal systems. As of August 2020, 189 out of the 197 parties to the convention have ratified (UNFCCC (b) 2020).

It is up to each nation to set its own climate targets, nationally determined contributions (NDCs), for the battle against climate change. These contributions are not binding by law, but by signing the agreement one agrees to have a national plan for reduction of GHG emission, and to implement increasingly progressive climate targets over time. “Each

Party's successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."(Article 4 3. of the Paris Agreement (United Nations Treaty Collection 2016)) From 2020, this "battle plan" must be renewed every fifth year, and each one must be more ambitious than the last. These renewed plans are to be reported every fifth year from 2023 (Article 4 9. of the Paris Agreement (United Nations Treaty Collection 2016)).

In the winter of 2020, Norway reported their updated NDCs to the UN, as the third country in the world to do so, increasing their aim to reduce GHG emissions by at least 50 %, up to 55 % compared to the 1990 levels (Norwegian Ministry of Climate and Environment (b) 2020) . The government states that it wants to work for an increase in the EUs collective ambitions to 55 % (The Norwegian government (a) 2019). The European Commission aims to propose an increase of at least 50 % and towards 55 % "in a responsible way", awaiting responses from the stakeholders, when the EU's 2030 emission reduction targets will be revised in September 2020. (EU (a) 2018)

# 5.0 The Norwegian Petroleum Industry

## 5.1 Framework

The roles and responsibilities regarding the petroleum activities are divided between the state and the industry. While the oil companies and other actors in the industry are responsible for the operational activities, such as exploration, development and production, the role and responsibility of the state is to regulate and provide a clear framework intended to balance the interests of the companies, the state and its population, as well as environmental considerations, in compliance with the triple bottom line perspective. Section 1-2. "*Management of resources*" in the petroleum act states that "The petroleum resources are to be managed in a long-term perspective for the common good of the Norwegian society as a whole. The managing of resources are to give revenues to the country and contribute to the ensuring of welfare, employment and a better environment, as well as to strengthen Norwegian business and industrial development, while at the same time take into consideration the regional political interests and other businesses" (Ministry of Petroleum and Energy 1997), thus putting the triple bottom line perspective into the legislation.

This perspective can be seen reflected in the government policies, for instance through the Granavolden-platform: "The government wants to lead a policy which strengthens Norway's competitiveness, creates green growth and new green jobs while at the same time reduces the emission of greenhouse gases." With regards to the petroleum policy, the Norwegian government further states in the platform that the main objective in the government's petroleum policy is "to provide for a profitable production of oil and gas in a long-term perspective. The government wants to continue with a stable and long-term petroleum policy. The exploration policy will contribute to this. New, profitable discoveries that ensures revenues, value creation and employment are important to maintain our welfare society." (The Norwegian government (a) 2019)

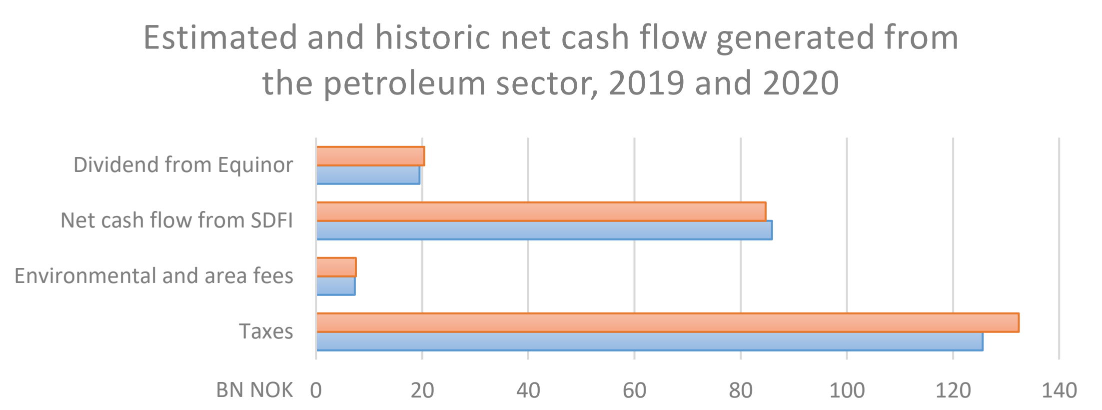
## 5.2 Economic perspective

The petroleum industry is Norway's biggest industry in terms of value creation, state revenues, investments, and export values, and therefore plays a key part in the Norwegian economy. In today's NOK value, the production of oil and gas has contributed to more than 14 900 bn NOK to Norway's GDP since it started in the early 1970s. This is excluding the value creation from services related to the extraction of crude oil and natural gas and petroleum-oriented supplier industry. It is estimated that only around 47 % of what is expected to be recoverable resources on the Norwegian Continental Shelf (NCS) has been recovered. (Norwegian Ministry of Petroleum and Energy 2020)

### 5.2.1 State revenues from petroleum activities

The state petroleum revenues are generated through taxes, area fees and environmental taxes, net cash flow from the State's Direct Financial Interest (SDFI) and dividends from direct ownership in Equinor.

The national budget for 2020 estimates a distribution of the net cash flow generated from the petroleum sector in 2020 vs 2019 as follows (The Norwegian government (b) 2019):




| | Taxes | Environmental and area fees | Net cash flow from SDFI | Dividend from Equinor |
|---|---|---|---|---|
| 2020 | 132,4 | 7,5 | 84,7 | 20,4 |
| 2019 | 125,6 | 7,3 | 85,9 | 19,5 |

*Figure 5-1 Estimated and historic net cash flow generated from the petroleum sector, 2019 and 2020*

Figure 5-2 below shows the state revenues generated from petroleum activities from 1985 to 2020, based on data from Statistics Norway.

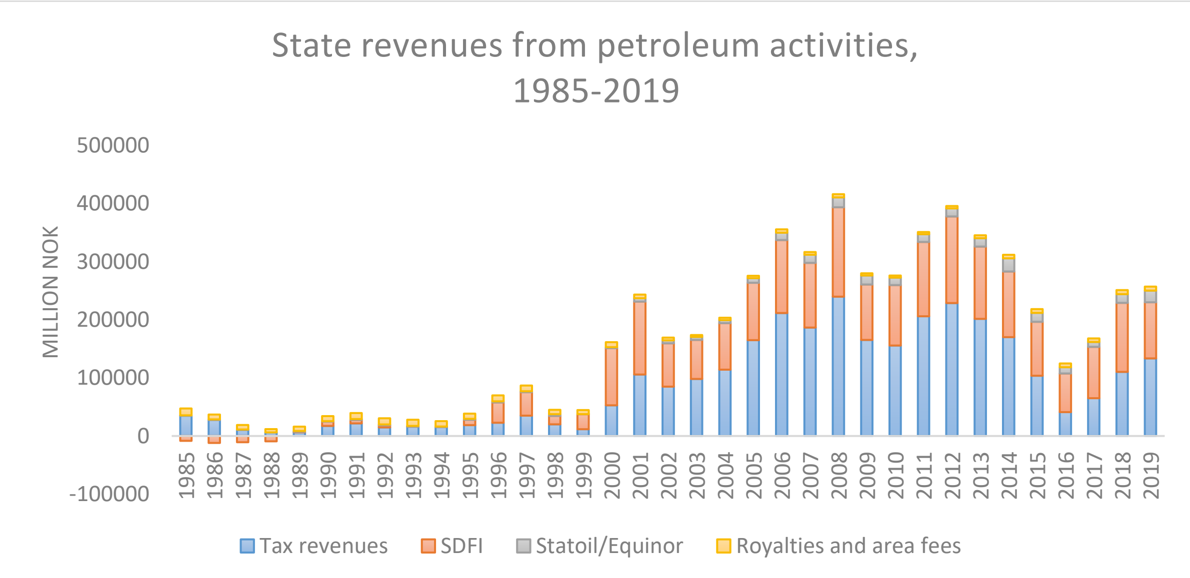



*Figure 5-2 State revenues from petroleum activities, 1985-2019*

All petroleum activities on the NCS are taxable to Norway, in accordance with the act pertaining to petroleum taxation (Norwegian Ministry of Finance 1975). Taxes are the biggest source of state revenues from the petroleum sector, as can be seen in Figure 5-1 and Figure 5-2, accounting for 53 % of the total in 2019. The rate for taxation of petroleum activities is 78 %, which is comprised of the ordinary corporate income tax rate currently at 22 % and an added 56 % special tax. Over the last few years, when the corporate income tax has been reduced, the special petroleum tax has increased proportionally so that the marginal tax for the NCS operators has remained at 78 %.

In order to ensure substantial revenues for the Norwegian society, while at the same time encourage companies to carry out profitable projects, the petroleum tax is intended to be neutral. This means that if a project is profitable for an investor without taxation, it will also be profitable after. To achieve neutrality, only the company’s net profit is taxable. The tax base is calculated at company level, not per field. In that way, losses from one field, or for instance expenses related to exploration, can give deductions against the rest of the company’s revenues from the NCS. In 2018, the 23 taxable petroleum companies were accountable for 63 % of the total company tax in Norway of 147 bn NOK, while 332 000 companies contributed to the other 37 % (Norwegian Tax Authorities 2019).

The state owns 67 % of the shares in Equinor, and thus receive dividends from it. These dividends are estimated to amount to about 20.4 bn NOK in 2020. In addition, “Folketrygdfondet”, the organisation managing the Government Pension Fund, owns a 3.45 percent share, making the states total ownership in Equinor 70.5 percent. (Folketrygdfondet 2018) Up until 1985, the only holdings the state had was through its then sole ownership in Statoil (Equinor). However, with effect from January 1st, 1985, these holdings were split into two. One part remained in Statoil, while the other part became the State’s Direct Financial Interest (SDFI).

The SDFI is an arrangement where the state owns assets in several oil- and gas fields, pipelines and onshore facilities. The owner shares vary from field to field and are being determined with the awarding of production licenses. When Statoil became listed in the stock exchange in 2001, the SDFI portfolio was transferred from Statoil to a new state-owned limited company, Petoro, whose purpose is to manage the interests of the SDFI. Today, the state has direct participating interests in 208 production licenses, 34 producing fields as well as shares in 15 joint ventures holding pipelines and onshore facilities. (Norwegian Ministry of Petroleum and Energy 2020)

The area fees are intended to provide an incentive for companies to develop and produce in the areas they hold licenses for, and it has its legal base in section 4-10 of the Petroleum Act (Norwegian Ministry of Petroleum and Energy 1997). The fees are payable annually per square kilometre covered by a production license.  In fields where there are active exploration or production, there are no area fees.

Important environmental taxes from the NCS are taxes on $CO_2$ and $NO_x$. The industry is also included in the EU ETS, and the operating companies must thus buy allowances if their allocated emission allowance are exceeded. The total tax levied for 2020 from the NCS is estimated to be NOK 5.7 billion. (Norwegian Ministry of Petroleum and Energy 2020)

### 5.2.2 Investments and operational costs

From the beginning of the petroleum activities on the NCS, it has been invested in exploration, field development, production, infrastructure and onshore facilities, and the shelf now has a comprehensive network of installations and pipes connecting to onshore facilities. When new discoveries are being made, they can be phased into this infrastructure, ensuring efficient resource exploitation and a high activity level on the shelf. With high demand and higher oil and gas prices, investments in the petroleum sector have been attractive over several years, resulting in a high increase of investment- and operational costs. Following the oil price plunge in 2014, both the costs and petroleum activities fell to a more sustainable level. (Norwegian Ministry of Petroleum and Energy 2020)

In the recent years, there has been taken measures like cost control and efficiency improvements resulting in a reduction of the average bill per production well by more than 40 %. Similarly, there have also been taken several measures to reduce the operational costs, which fell by 30 % on average from 2013 to 2017. New solutions like automation and remote operation, improved use of data and more efficient operation, may result in further cost reductions, as well as increased production. (Norwegian Petroleum Directorate 2019) The NCS' total costs reached a record high in 2014 due to major investments and exploration activity. Though they have decreased in the years after, they are still at a high level historically. (Norwegian Ministry of Petroleum and Energy 2020)

Figure 5-3 below shows historic data and prognosis for investments, operational costs, explorational costs, disposal and cessation costs and other costs on the NCS. The cost predictions are based on presumptions about oil price developments, future general cost levels and the companies' investment decisions, and is therefore subject to big uncertainty, with increasing uncertainty over time.

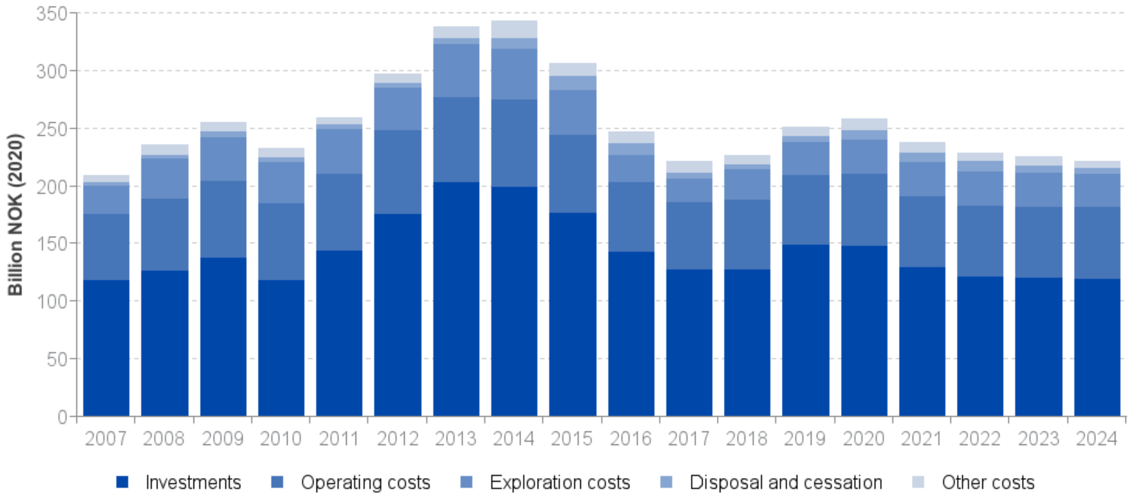



*Figure 5-3 Historic data and prognosis for total costs on the NCS, 2007 – 2024 (Norwegian Ministry of Petroleum and Energy 2020)*

In 2019, the total costs amounted to about 250 bn NOK and, as is shown in Figure 5-3, they are expected to decrease a little the coming years.

Exploration costs include expenses related to the gathering of seismic data intended to map possible petroleum deposits under the seabed and the drilling of exploration wells. These costs amounted to around 30 bn NOK in 2019, and the exploration activities in the same year led to 17 discoveries. (Norwegian Ministry of Petroleum and Energy 2020)

As well as major investments in field development, infrastructure and onshore facilities, there is also being made major investments in already existing fields, thus increasing both the recovery and lifetime of the field. The investment costs were around 150 bn NOK in 2019 and is expected to be around the same in 2020, meaning that the investments in the petroleum industry account for about one fifth of the total investments in production capital in Norway. (Norwegian Ministry of Petroleum and Energy 2020)

The majority of the operational costs are related to maintenance of platforms and wells, as well as expenses related to the day-to-day operation of installations, including salaries and salary related costs. By the end of 2019 there were 87 producing fields, and the total operational costs amounted to around 60 bn NOK. (Norwegian Ministry of Petroleum and Energy 2020)

### 5.2.3 Government's Pension Fund Global (GPFG)

The Government Pension Fund Global (GPFG) was established in 1990. The first transfer of the petroleum revenues to the fund happened in 1996, and since then the state's net cash flow from the petroleum activities has been transferred annually. As of August 2020, the fund is valued at more than 10 000 bn NOK (Norges Bank Investment Management 2020), making it the world's largest sovereign wealth fund (SWFI 2020).

Figure 5-4 and Figure 5-5 below shows the fund's historic yields (orange) since its start compared to the reference index (blue), and the historic market value of the fund.

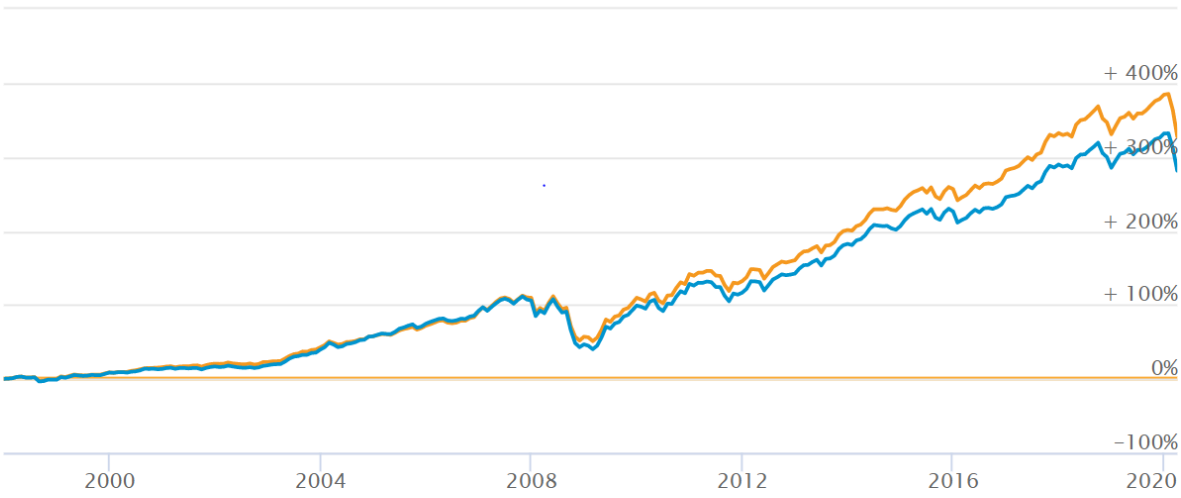



*Figure 5-4 Yearly returns from the Government's Pension Fund Global, (Folketrygdfondet 2020)*

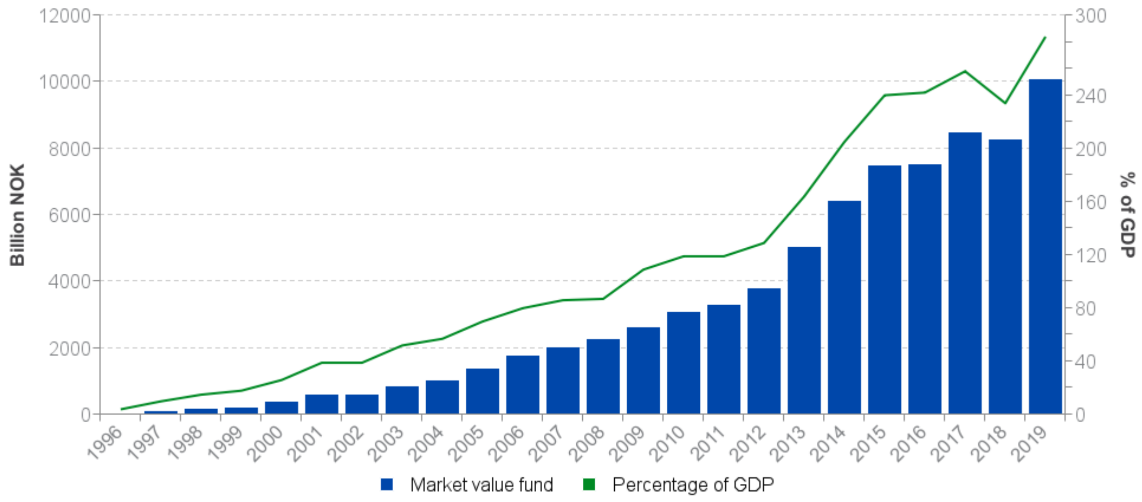



*Figure 5-5 Market value of the Government Pension Fund Global, 1996-2019 (Norwegian Ministry of Petroleum and Energy 2020)*

The fund is supposed to benefit both current and future generations, in accordance with the principle that "Norway's petroleum resources belong to the Norwegian people" (The Norwegian government (a) 2019) and that "the petroleum resources are to be managed in a long-term perspective for the common good of the Norwegian society as a whole" (Norwegian Ministry of Petroleum and Energy 1997).

### 5.2.4 Employment

The petroleum industry employs a significant portion of the Norwegian workforce. It can be challenging to estimate a precise number of people employed, especially people who are indirectly employed by the sector, meaning employment generated in other sectors due to demand from the petroleum industry, and will thus give different estimates based on different definitions and methods. For 2017, one estimate is that 225 000 people were directly or indirectly employed in the Norwegian petroleum sector (Menon Economics 2019), while another estimate from (Statistics Norway (b) 2019) says that 139,500 people were directly or indirectly employed in the sector.

Figure 5-6 below, based on data from the national budgets and Statistics Norway, shows the estimated number of employees in the Norwegian petroleum sector from 1970-2018 (Norwegian Ministry of Petroleum and Energy 2020).

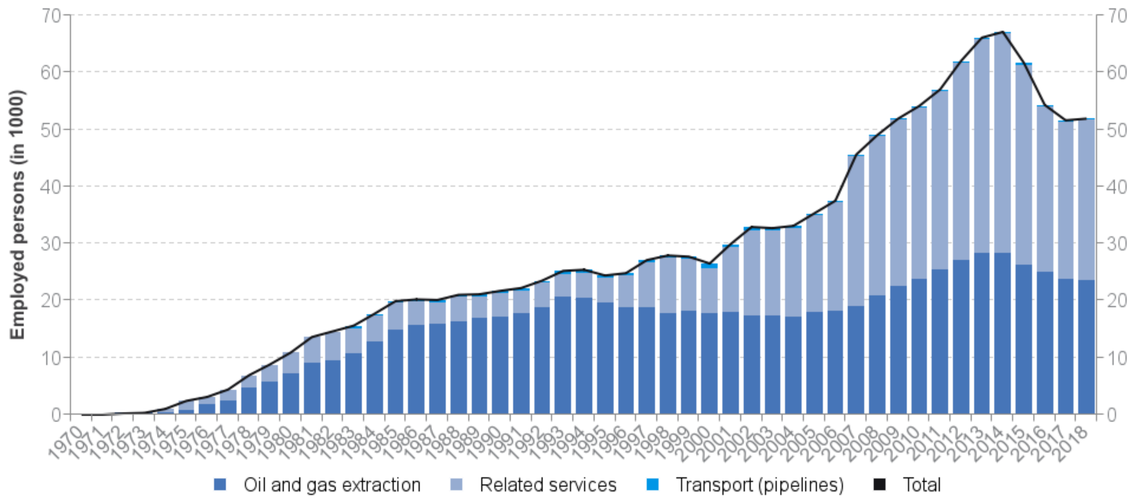



*Figure 5-6 Number of employees in the Norwegian petroleum sector, 1970-2018*

## 5.3 Research and development

“Production of the remaining resources on the Norwegian shelf will generate substantial value creation, but to realize this potential, new knowledge and technology must be developed. Research and technology is therefore an integral part of Norway's policy of the petroleum industry». (Norwegian Ministry of Petroleum and Energy 2020)

In addition to its “obvious benefits” to the petroleum activities, the innovation stemming from the petroleum industry have also given ripple effects and technological contributions to other industries in Norway, among others within maritime industries and renewable energy, as well as made the Norwegian supplier industry internationally competitive. The framework conditions and policies regarding petroleum activities on the NCS have given the companies incentives to carry out research and development in order to increase value creation from the petroleum activities and their related industries, as well as contribute to the reduction of greenhouse gas emissions from the shelf.

Today, we are facing several new challenges. The discoveries and field developments are fewer than before, and the petroleum resources remaining in the fields are more demanding to produce than they were when the productions started (Norwegian Ministry of Petroleum and Energy 2020). Consequently, it becomes harder for single projects to finance technology development. At the same time, we see an increase in the global demand for oil and other energy sources (see chapter 3.0, “Energy perspectives”).

In order to succeed with the development of new solutions and technology, a national strategy for the petroleum industry in Norway, OG21 (“Oil and Gas in the 21st century”), with its mandate from the Norwegian Ministry of Petroleum and Energy, was established in 2001, with the purpose of "contribute to efficient and environmentally friendly value creation from the Norwegian oil and gas resources through a coordinated engagement of the Norwegian petroleum cluster within education, research, development, demonstration and commercialization". (OG21 2019) Through OG21, the oil companies, research institutions, supplier industry and authorities come together to identify and strategize around technological challenges within the industry.

In 2016, OG21 identified ten technology needs – three were related to emission reduction, two were linked to subsurface understanding and recovery improvements, three had to do with improved efficiency and reduced costs, and the last two was regarding digitalization and technologies for the High North. (OG21 2016) The authorities stimulate to research and technology development mainly through legislation and direct allocations to the Research Council of Norway. Most of these allocations go to the research programs Petromaks 2 and Demo 2000, and research centres in Stavanger and Tromsø, to reach the goals defined in the OG-21 strategy. (Norwegian Ministry of Petroleum and Energy 2020)

# 6.0 Environmental effects and performance

“Environmental and climate considerations are an integral part of Norway’s policy. A range of policy instruments ensures that actors in the industry take environmental and climate considerations into account during all phases of their activities, from exploration to development, operations and field closure.” (Norwegian Ministry of Petroleum and Energy, 2020)

## 6.1 Emission to air

Emission to air from the petroleum activities mainly results from the combustion of natural gas and diesel in turbines, engines and boilers, by flaring of natural gas, ventilation and diffuse gas emission, as well as storing and loading of crude oil. The main greenhouse gases contained in these emissions are $CO_2$, $NO_x$, nmVOC, $CH_4$ and $SO_2$. (Norwegian Ministry of Petroleum and Energy, 2020)

There are several acts regulating the emission of greenhouse gases to air resulting from petroleum activities, including the climate change act (Norwegian Ministry of Climate and Environment 2017), the petroleum act (Norwegian Ministry of Petroleum and Energy, 1997), the act relating to $CO_2$ fees (Norwegian Ministry of Finance 2015), the greenhouse gas emission trading act (Norwegian ministry of climate and environment 2004) and the pollution control act (Norwegian Ministry of Climate and Environment 1983). Requirements of impact assessments and the approval of new development plans (PDO/PIO) are also central in the petroleum legislation through the planning and building act (Norwegian Ministry of Local Government and Modernisation 2008).

A shared database has been established by the trade organisation “Norsk olje og gass” (“Norwegian Oil and Gas”), where operators on the NCS report their emission data. Consequently, there is a good overview of the emissions from the shelf.

### 6.1.1 Emission of greenhouse gases (GHG)

The total emissions of GHG from Norwegian territory amounted to around 52 million tons of $CO_2$e in 2018. 13.4 million tonnes, or about one fourth, of these emissions stemmed from the petroleum industry. Compared to other petroleum producing countries, the emission stemming from activities on the NCS is low. This is largely due to energy efficiency measures like implementation of energy control systems and installations of more energy efficient equipment like compressors and pumps. (Norwegian Ministry of Petroleum and Energy, 2020)

Figure 6-1 below shows the historic and forecasted GHG emissions from petroleum activities on the NCS from 1998 – 2023.

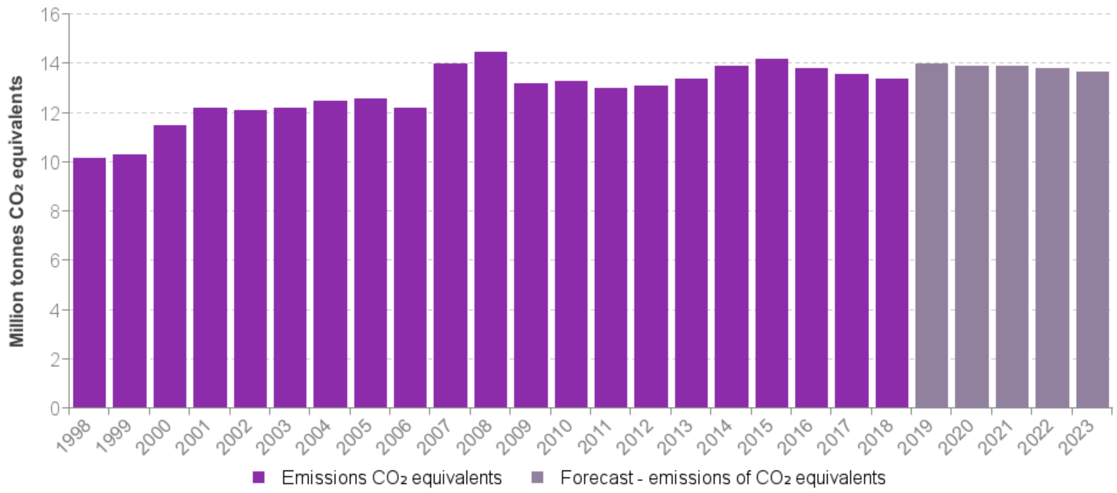



*Figure 6-1 Greenhouse gas emission from the petroleum sector (Norwegian Ministry of Petroleum and Energy, 2020)*

Figure 6-2 shows the petroleum industry's share of total emissions to air from 1990-2018.

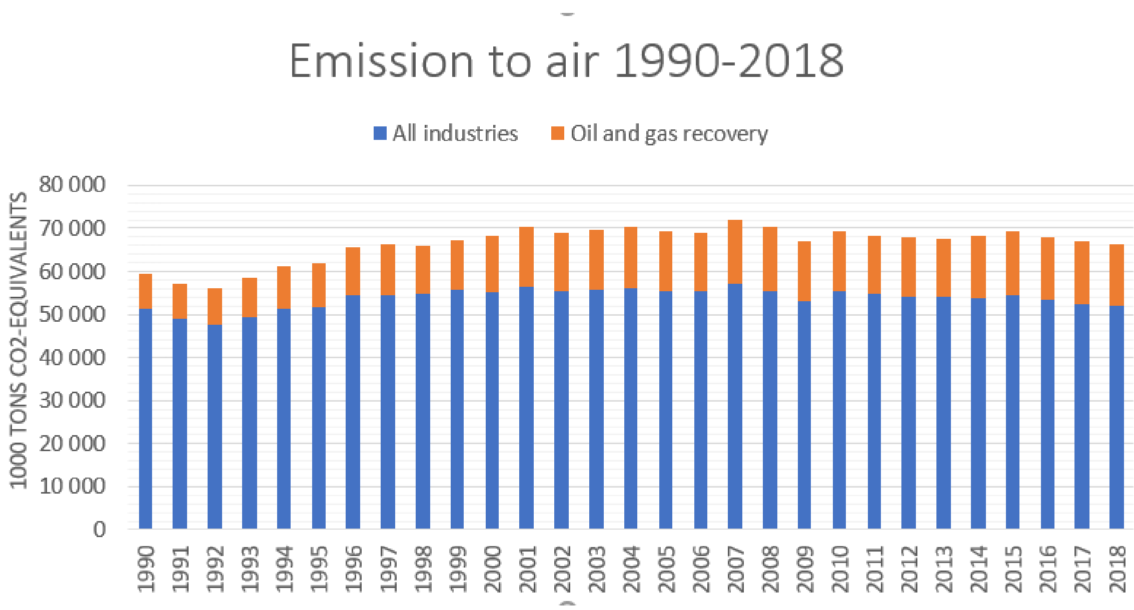



*Figure 6-2 Emission to air from Norway 1990 – 2018, based on data from (Statistics Norway 2020)*

The carbon tax and the emission trading system are measures for cost effective reduction of GHG emissions spanning across the sectors. For the petroleum sector, both of these apply, while other sectors are mainly affected by one or the other. Added together, the sum of the carbon tax and emission trading system amounts to a total of between 700 and 800 NOK per ton $CO_2$ emitted. This is significantly more than the vast majority of other industries in Norway as well as any other petroleum producing nation.

Through the (Gothenburg protocol 1999), Norway is committed to reduce the total emission of $NO_x$ by 23 % and the total emission of nmVOC by 40 % in 2020 compared to 2005 levels. Almost one third of the $NO_x$ emissions in Norway stems from the petroleum industry, and these emission levels have been at around the same level since the beginning of the 2000s. (Norwegian Ministry of Petroleum and Energy, 2020) The emission of $NO_x$ resulting from petroleum activities is directly regulated through the terms in the government approval of the PDO and through emission permits based in the pollution control act, as well as the requirements of the use of best available technologies (BAT).

### 6.1.2 HC gases

Hydrocarbon (HC) gases get reported as two emission gasses, namely methane ($CH_4$) and nmVOC (Non-Methane Volatile Organic Compounds), to meet requirements set in regulations and international agreements. When measured in a 100-year perspective, the greenhouse effect stemming from methane equal 25 $CO_2$e. Over time, methane will oxidise to $CO_2$ in the atmosphere, meaning that the greenhouse effect will reduce over time, but also that it will be higher in a short-term perspective. (Husdal, et al. 2016) Figure 6-3 and Figure 6-4 below shows the yearly emission of methane from Norway by emission source as well as the share of these emissions stemming from oil and gas recovery.

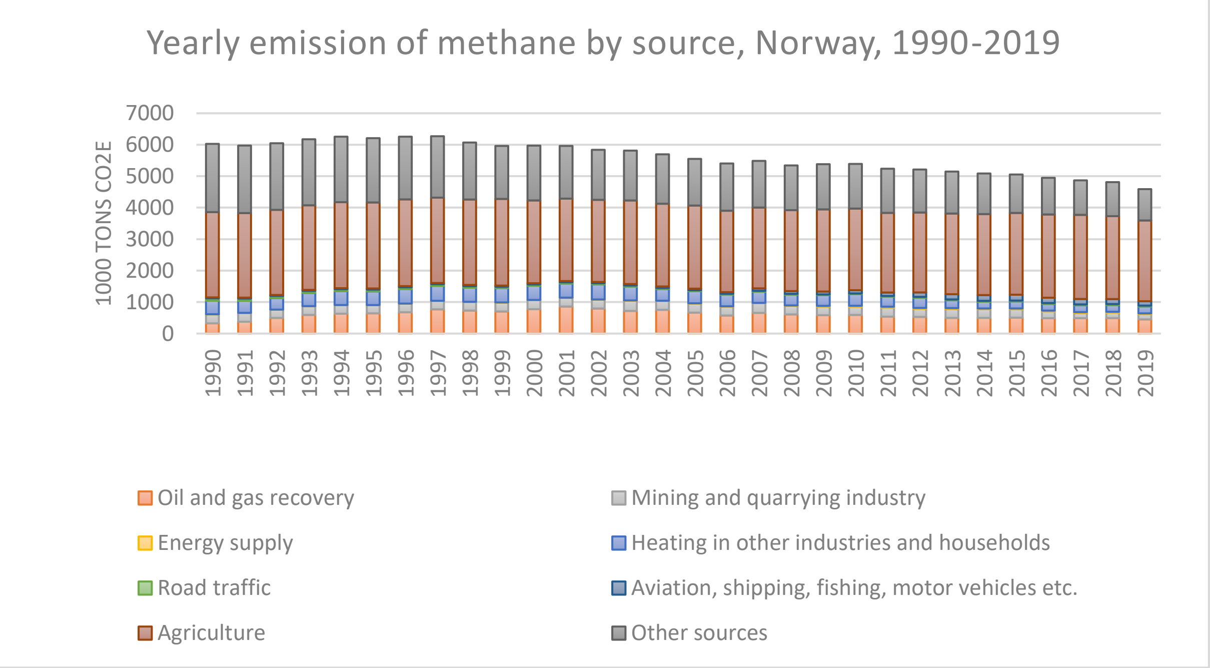



*Figure 6-3 Yearly emission of methane by source, Norway, 1990-2019, based on data from Statistics Norway*

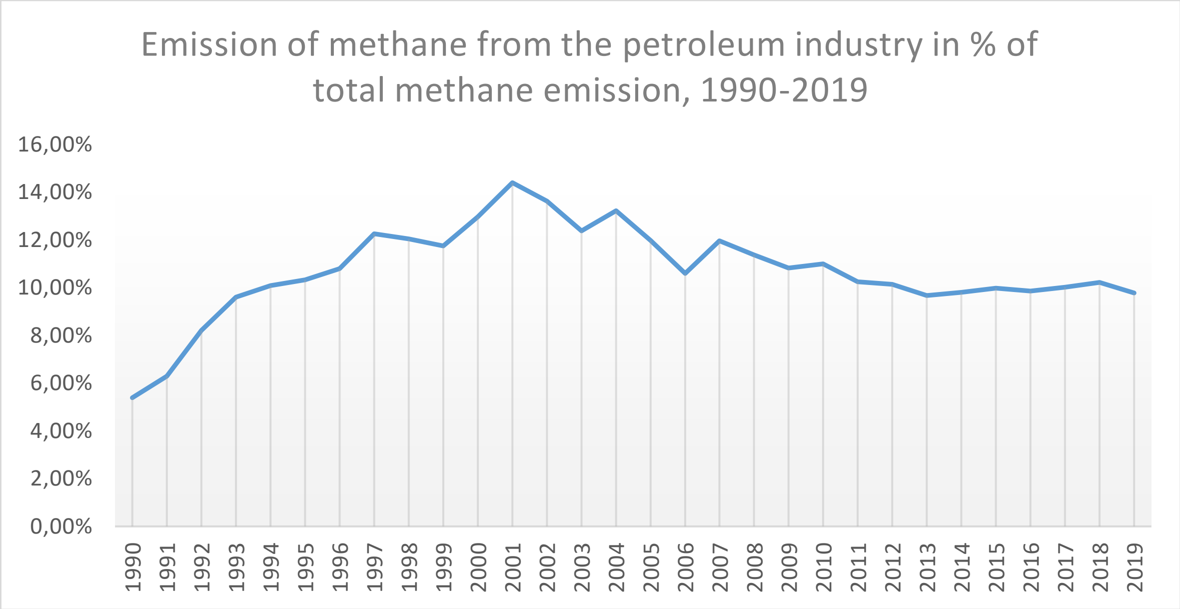



*Figure 6-4 Emission of methane from the petroleum industry in % of total methane emission, 1990-2019, based on data from Statistics Norway*

NmVOC contributes to the formation of tropospheric ozone, which has regional environmental effects, as well as having carcinogenic properties. Through the Gothenburg Protocol, Norway is committed to reducing its nmVOC emissions by 40 % from 2005 to 2020. In 2018, 173,000 tons of nmVOC were emitted, which is a reduction of 34 % from the reference year 2005, and a 48 % reduction from the year 1990 (Norwegian Environment Agency 2019). Most of the emissions of nmVOC stemming from the petroleum sector comes from storing and loading of crude oil offshore, as well as smaller emissions from the gas terminals. The total nmVOC emissions amounted to 40,500 tons in 2018. (Norwegian Ministry of Petroleum and Energy, 2020)

As shown in Figure 6-5 and Figure 6-6 below, the petroleum industry is responsible for the largest part of the nmVOC emissions. However, this part has decreased over time.

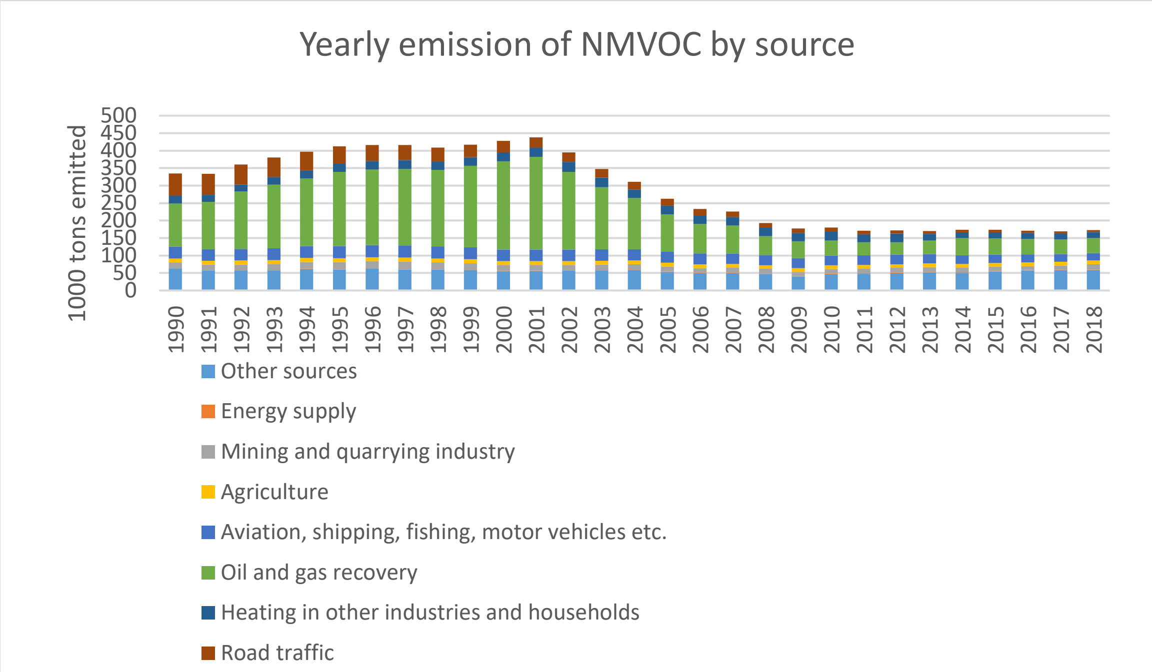



*Figure 6-5 Yearly emission of NMVOC by source, based on data from (Norwegian Environmental Agency 2019)*

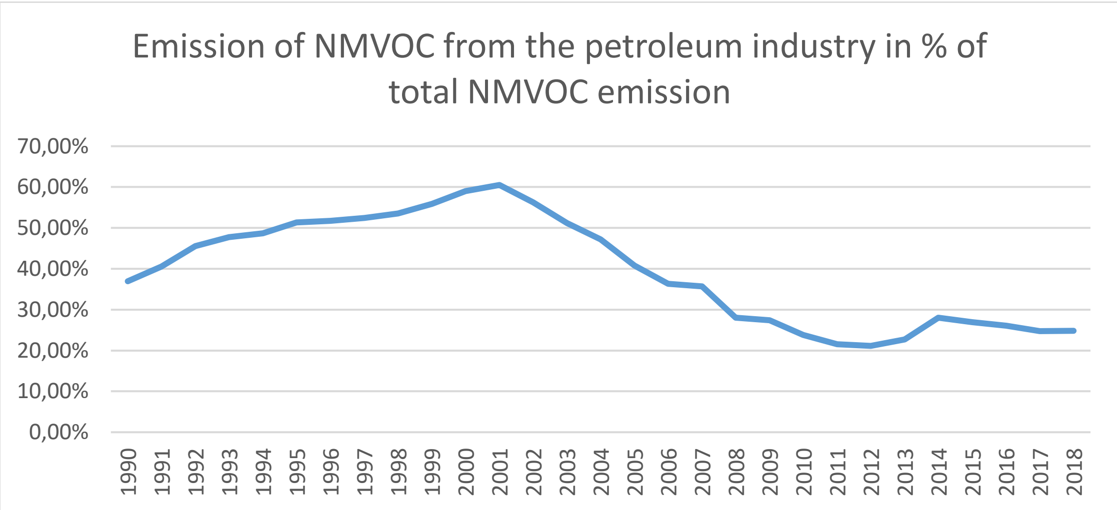



*Figure 6-6 Emission of NMVOC from the petroleum industry in % of total NMVOC emission, based on data from (Norwegian Environmental Agency 2019)*

Direct emission of HC gases can be divided into two emission categories: (1) Diffuse emission, and (2) operational emission. Diffuse emissions are leakages of natural gas directly to the atmosphere through valves and gaskets, diffusion of natural gas through hoses, flexible piping systems, evaporation from hydrocarbon liquids or from drill cuttings. Diffuse emission can never be fully eliminated, though they can be reduced through the use of correct materials, equipment and design, and through good operational procedures. These kinds of emissions can take place anywhere on the installation where HC-gases are present. (Husdal, et al. 2016)

The operational emissions (venting) are exhaust containing hydrocarbons from different processes on the installations, which is being routed through the atmosphere as a result of planned and chosen operational solutions. They usually take place through dedicated pipe systems where the natural gas is being emitted in a secure place. The reasons for these planned emissions include safety measures, high content of inert components in the exhausted gas, pressure conditions on the installation, cost-related preferences, or a combination of these. Venting can often be avoided by good design. The alternatives can be recycling or flaring of the gas. Out of these, recycling is, from an environmental perspective, the best solution, though flaring will also reduce the emissions as the greenhouse effects resulting from the flaring process is lower than those of the HC gases. (Husdal, et al. 2016)

Since nmVOC oxidises in the atmosphere, it leads to indirect emission of $CO_2$. Therefore, measures taken to reduce the emission of nmVOC, will also have an effect on the $CO_2$ emissions. As a result of the phasing in of vapour recovery units (VRU) technologies to the vessels loading and storing crude oil, and because of the reduction of oil production over the last years (the oil production was reduced by approximately 50 % from 2001 to 2018), the petroleum sector's total share of the nmVOC emissions has decreased. (Norwegian Ministry of Climate and Environment (a) 2020)

## 6.2 Discharging to sea

The discharges to sea mainly contain of produced water, drill cuttings, chemical residues, and cement from drilling operations. When water is being produced together with oil and gas, it results in dispersed oil and other organic compounds. Mitigation measures include cleaning before discharging to sea, deposition below the seabed and the treatment as hazardous waste under transportation and onshore treatment. In the whitepaper no. 58 1996-97 (Norwegian Ministry of Climate and Environment 1997) a target of zero hazardous substances released to the sea was being put forth, and regarding chemical additives, this target is considered reached. (Norwegian Ministry of Petroleum and Energy, 2020)

Drill cuttings are small rock fragments produced during drilling operations and brought to the surface with the circulated drilling mud flow. The prime contaminants in drill cuttings are petroleum hydrocarbons (THC), but there are also other contaminants such as aromatic hydrocarbons, polychlorinated biphenyls (PCB), synthetic base fluids, heavy metals, radioactivity, and endocrine disrupters. (The Norwegian Oil Industry Association 2003) These discharges affect the benthic fauna in several ways, like for instance by hypoxia, toxicity, sedimentation or change in particle properties like grain size and sharpness. (Trannum, et al. 2010) Discharge of oil-contaminated drill cuttings has been prohibited in Norway since 1993. (Orstein, et al. 2004)

On most offshore platforms, produced water – which is sea- or freshwater that has been trapped in geologic reservoirs with oil and gas for millions of years - represents the largest volume waste stream in petroleum operations and may account for 80 % of the waste and residuals stemming from the production of natural gas. The chemicals in produced water include metals, radioisotopes, inorganic salts and a variety of organic chemicals, in particular hydrocarbons. (Neff and Lee 2011)

Before being discharged to sea, the produced water on the NCS gets injected into a reservoir or cleaned. Emission of oil and chemicals from produced water is being nationally regulated through emission permits from the Norwegian Environment Agency with a legal basis in the pollution act. Internationally, they are regulated through the Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR-convention") of 1992. (Norwegian Ministry of Petroleum and Energy, 2020) Figure 6-7 shows the discharges of produced water on the NCS from 1998-2018, as well as projections made for the discharges up to 2023.

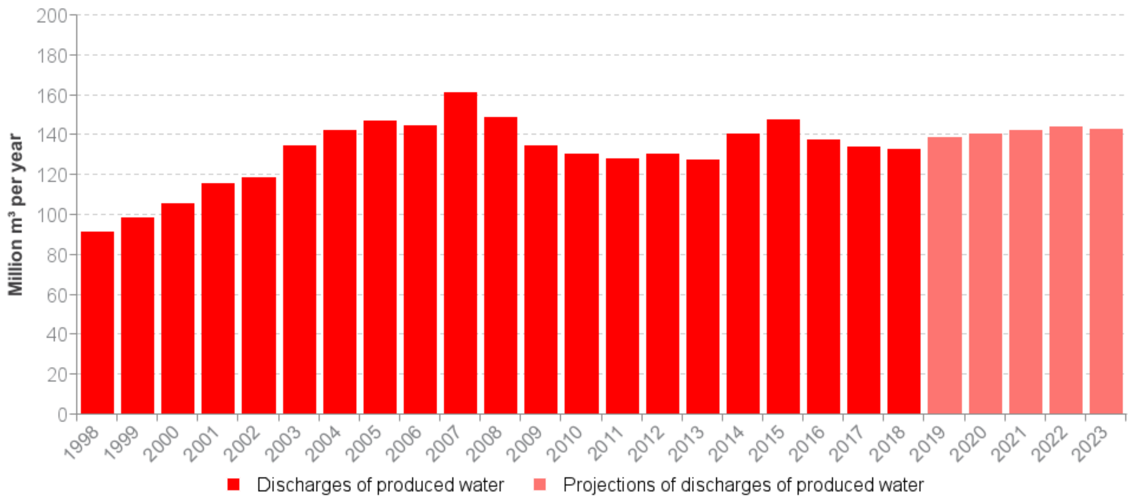



*Figure 6-7 Historical data and projections of discharges of produced water, 1998-2023 (Norwegian Ministry of Petroleum and Energy, 2020)*

## 6.3 Acute pollution, oil spill preparedness and emergency response

In Norway, most of the acute pollution has been from shipping near the shore. There has, so far, been zero major oil spills from the Norwegian petroleum industry that has led to environmental damage, and no oil spill from the industry has ever reached the shore. (Norwegian Ministry of Petroleum and Energy, 2020)

In compliance with the pollution control act, the operating companies are responsible for and have a duty to maintain a necessary level of emergency preparedness and response to handle acute pollution stemming from their activities. There are also oil spill preparedness and response services in both private, municipal and governmental sectors to limit the consequences of any acute pollution.

Nationally, the Norwegian Coastguard, under the Ministry of Transport and Communications, are responsible for the coordination of the overall oil spill response and the national preparedness against acute pollution. All acute oil spill stemming from the installations on the NCS gets reported to the Coastguard, and the causes for the incident get investigated. The requirements for the emergency preparedness in the municipalities and private companies are set by the Ministry of Climate and Environment, who also approves of the emergency preparedness plans and controls that the requirements are being followed.

The Norwegian Clean Seas Association for Operating Companies (NOFO) is an association owned by a group of companies licensed to operate on the NCS. Its function is to administrate and maintain emergency preparedness and response resources including personnel, vessels and equipment, and it holds five bases along the coast located in Stavanger, Mongstad, Kristiansund, Sandnessjøen/Træna and Hammerfest.

## 6.4 Global comparison

In comparison with the other top ten oil and gas producing nations, Norway emits the least amount of $CO_2$ and has the lowest $CO_2$ intensity, as shown in Figure 6-8 below.

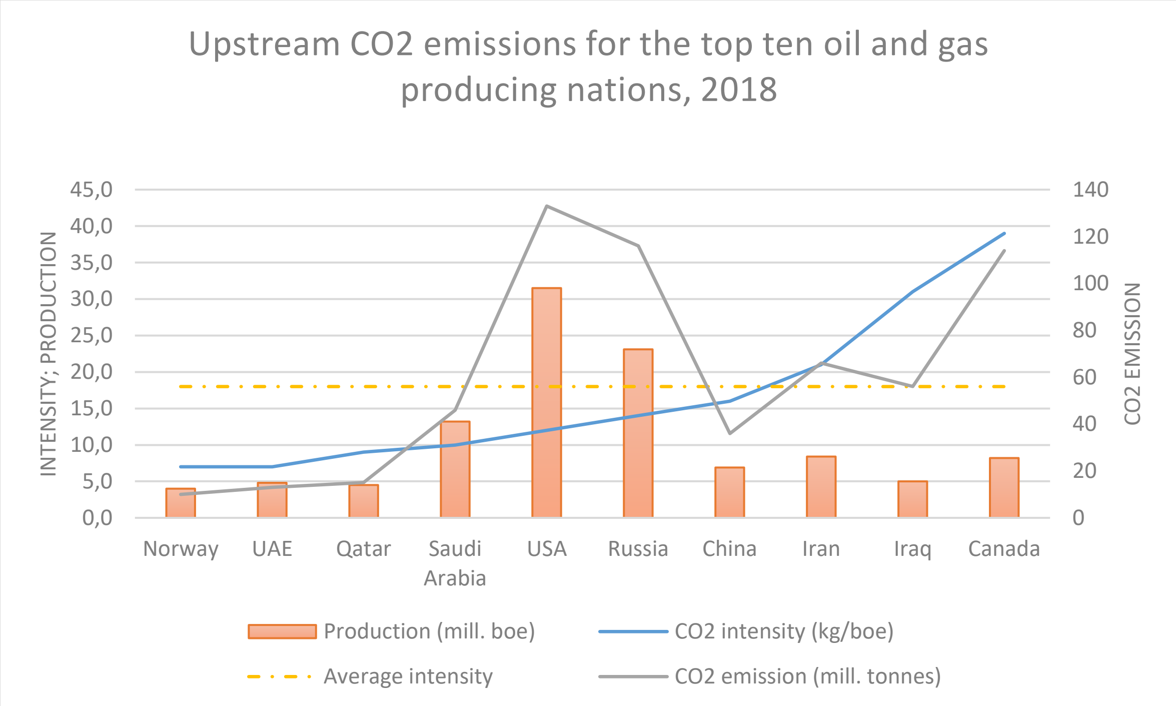



*Figure 6-8 Upstream CO2 emissions for the top ten oil and gas producing nations, 2018, adapted from (Rystad Energy 2020)*

(Rystad Energy 2020) points to the CO2 taxes implemented in 1991 and Norway's participation in the EU ETS, which gives companies incentives to reduce their emission and implementing and developing environmentally friendly technologies, as some of the reasons for Norway's low emission rates. In addition, flaring for non-safety purposes has been banned in Norway since the 1970s, resulting in a low flaring intensity.

None of the other ten countries are a part of the EU, and hence not a part of the EU ETS. There does, however, exist other ETS systems, and more are planned. In 2017, China decided to implement its own emission trading system, planned to be operative from 2020, which will then be the world's largest ETS. (International Energy Agency 2020) There are also local ETSs and other emission reducing schemes in USA and Canada. Figure 6-9 below shows the implementation of emission reduction policies by year from the top ten oil producing nations that carries them.

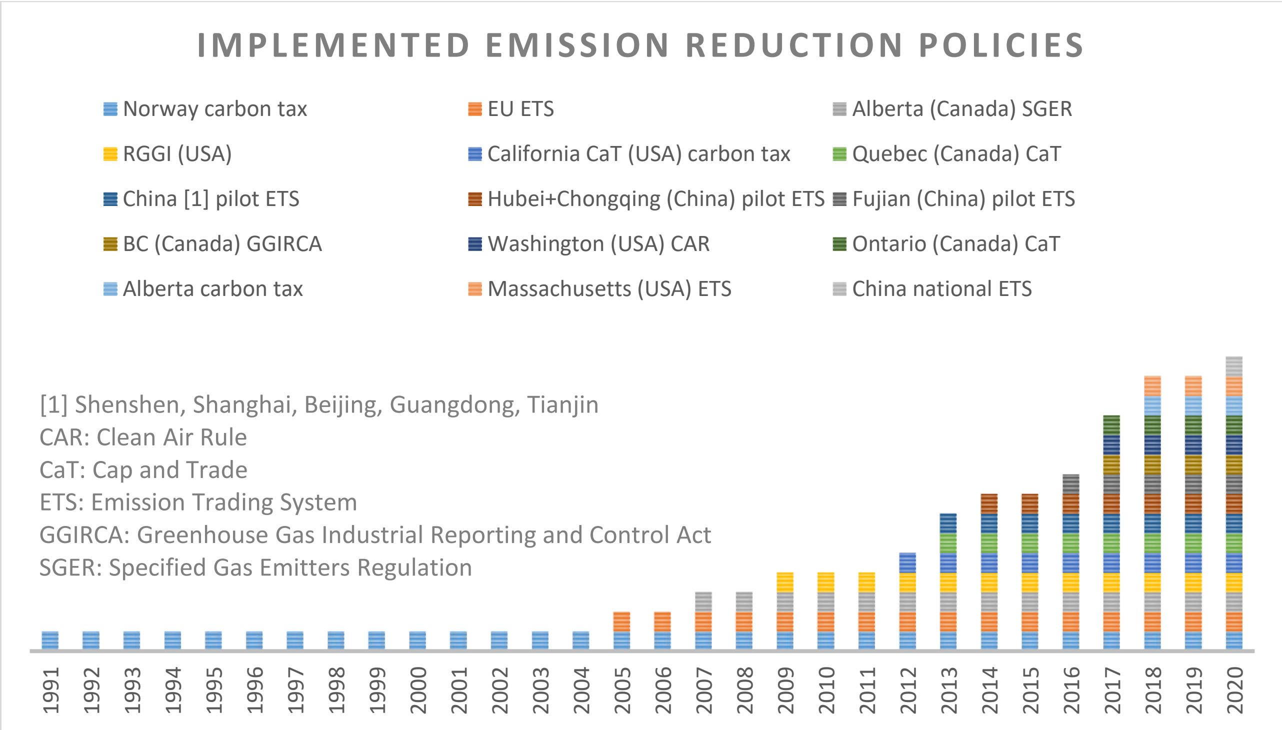



*Figure 6-9 Implemented emission reduction policies Canada, China, EU, Norway, USA, based on data from (World Bank 2018)*

The early adaptions of emission reduction policies in Norway means that companies operating in the country will have had longer time to develop emission reducing technologies due to stronger incentives to do so compared to the other ten nations, thus being able to take a lead in this field. Major offshore projects, like the electrification of Johan Sverdrup and the planned Hywind Tampen project, as well as other environment projects like the Northern Light CCUS project (see 7.1), will contribute significantly to further emission reductions

# 7.0 Equinor – "Shaping the future of energy"

Over the last decades, there has been a shift in both public opinion and the opinion of companies when it comes to dealing with climate change. Examples of this can be seen in Equinor's statements over the last 20 years regarding their role in sustainable development and the battle against climate change:

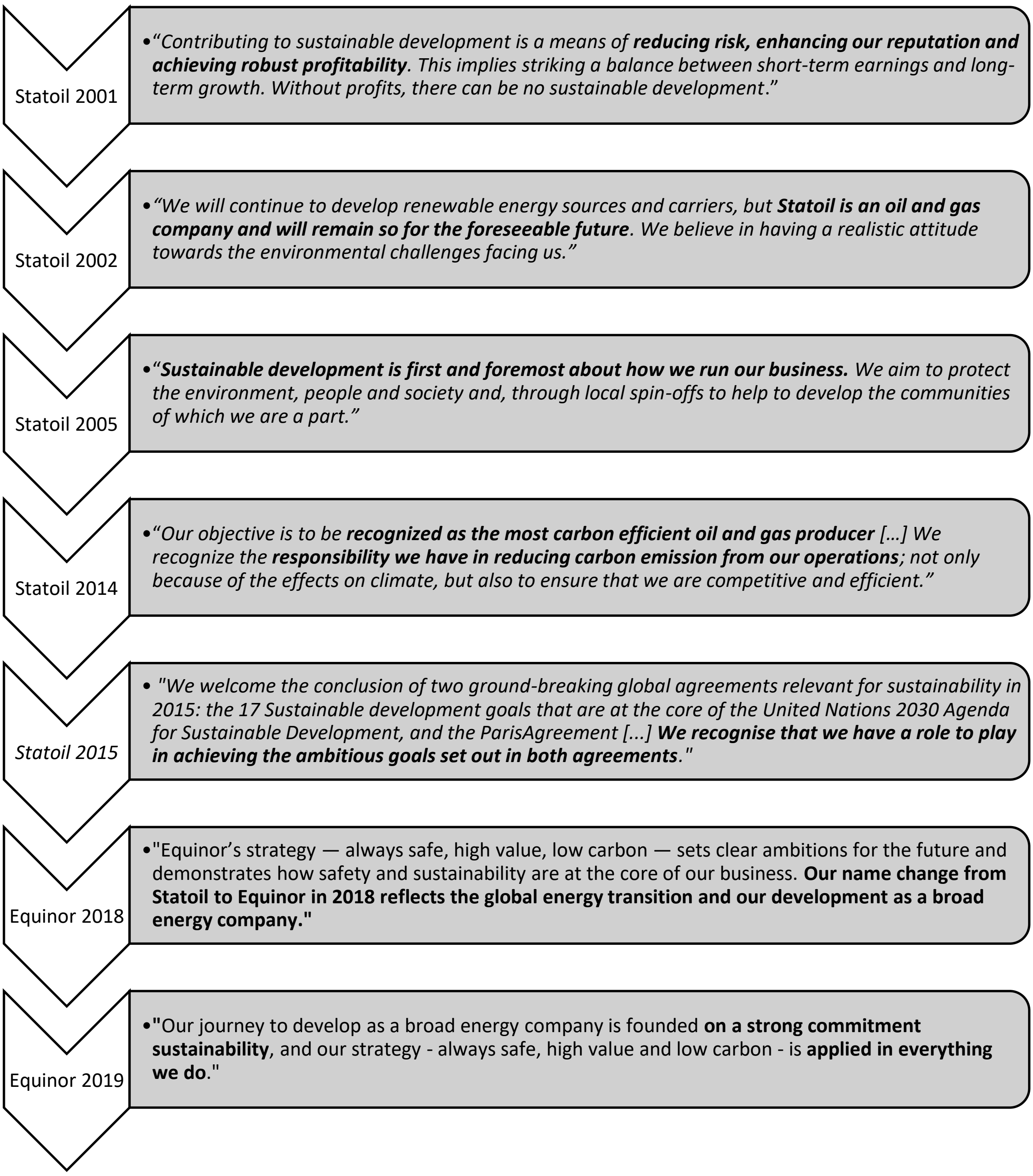



*Figure 7-1 Statements from Statoil/Equinor regarding sustainable development (Equinor 2001) (Equinor 2002) (Equinor 2005) (Equinor 2014) (Equinor 2015) (Equinor 2018) (Equinor (b) 2019)*

There is a shift from the more “profitable business” side of sustainability to more emphasis being put on the “people” and “planet” pillars. Equinor’s vision, “shaping the future of energy”, is descriptive of the company’s development from a strictly oil and gas company (Statoil) to a broader energy company, whose purpose is to “turn natural resources into energy for people and progress for society”. (Equinor (b) 2019) The UN sustainability goals are ingrained in Equinor’s values, business model, strategy and governance, spanning across the three sustainability pillars of people (“Always safe”), planet (“Low carbon”) and profit (“High value”). This is in line with Norway’s triple bottom line perspective found in its legislation and government statements, as well as the UNs 2030 Agenda (United Nations 2015), where the sustainability goals can be found.

Equinor describes its main contribution to society as “the energy we deliver, the economic value and jobs we create, the people we develop, our efforts to reduce greenhouse gas emissions, and pursuing safe and responsible operations”. There is an admittance that the company’s operations may have both positive and negative impacts on the UN sustainability goals, and the company highlight 6 goals where they believe they have the most impact, namely numbers 4 (quality education), 7 (affordable and clean energy), 8 (decent work and economic growth), 13 (climate action), 14 (life below water) and 17 (partnerships for the goals).

## 7.1 Climate ambitions, measures and technology

“*We will continue addressing our own emissions in line with the emitter pays principle. But, we can and will do much more. As part of the energy industry, we must be part of the solution to combat climate change and address decarbonisation more broadly in line with changes in society*.”(Eldar Sætre, (Equinor (a) 2020))

In January 2020, Equinor launched its “Climate Roadmap 2020” (Equinor (a) 2020) with new climate ambitions to reduce the emissions stemming from their offshore and onshore activities in Norway. The ambitions are shown in Figure 7-2. If these ambitions are met, there will be annual emission cuts of more than 5 million tonnes by 2030 – around 10 % of Norway’s total $CO_2$ emissions (Equinor (b) 2019).

| Year | Climate ambitions |
|---|---|
| 2020 | • Low carbon and energy efficiency: 25 % of research and technology expenditure |
| By 2025 | • Upstream $CO_2$ intensity below 8 kg $CO_2$ /boe |
| 2026 | • 4-6 GW installed capacity renewable energy, Equinor share |
| 2030 | • Carbon neutral global operations<br>• 40 % absolute GHG reductions in Norway<br>• No routine flaring and near zero methane emissions |
| 2035 | • 12-16 GW installed capacity renewable energy Equinor share |
| 2040 | • 70 % absolute GHG reductions in Norway |
| 2050 | • At least 50 % reduction of net carbon intensity<br>• Near zero absolute GHG emissions in Norway |

*Figure 7-2 Equinor climate ambitions by year*

Large scale industrial measures will be required in order to reach the ambitions. The sub-chapters that follow will present some of these measures.

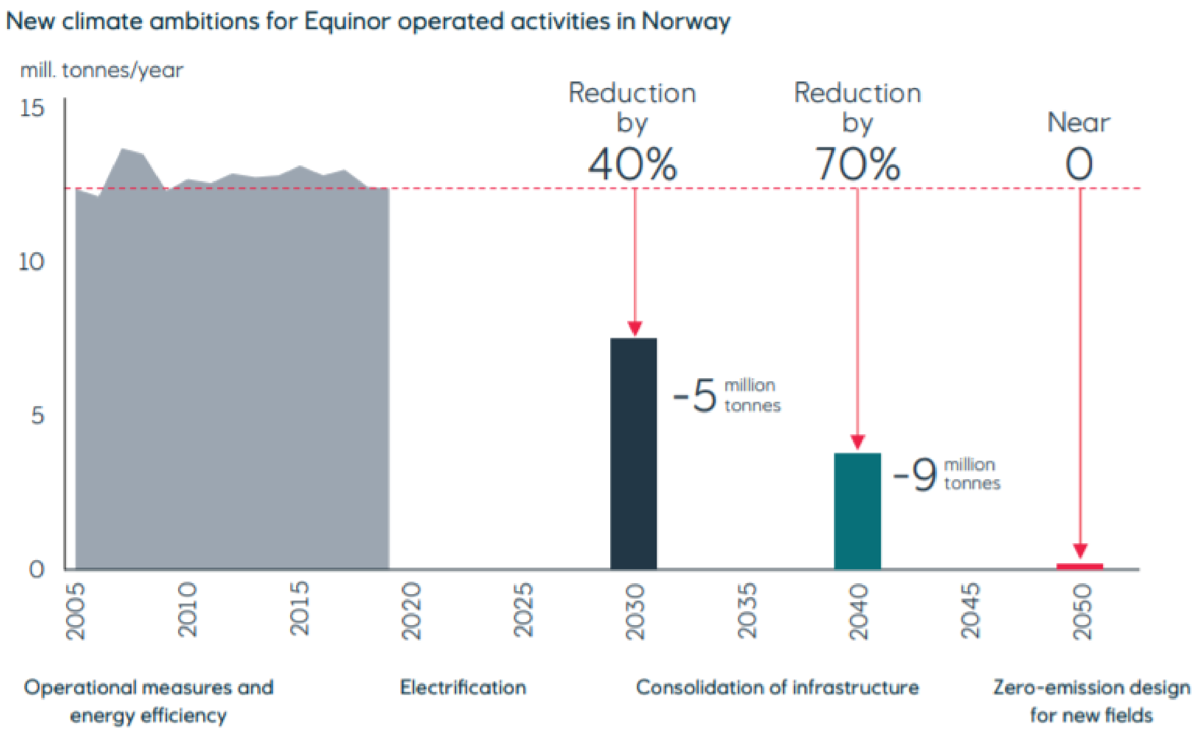



*Figure 7-3 New climate ambitions for Equinor operated activities in Norway (Equinor (a) 2020)*

### 7.1.1 Electrification of offshore assets

The Johan Sverdrup field, Norway's third largest oil field of all times, opened in 2019. The field is powered by electricity from land. In Norway, 98 % of the electricity is renewable - mainly from hydropower, but also wind and thermal power (Norwegian Ministry of Petroleum and Energy 2014) - which contribute in making Johan Sverdrup one of the most carbon-efficient fields in the world. The $CO_2$ intensity on this field will be at a record low 0.67 kg/boe (Equinor (d) 2020). Over the lifespan of the field, it is estimated that the power from shore will result in total $CO_2$ reductions of nearly 20 million tonnes, more than 460,000 tonnes annually. (Equinor (b) 2019)

Figure 7-4 below shows the plans for further electrification of the fields in the Utsira High area. The purple cable shows the shore power already in place for Johan Sverdrup. The yellow cables show power from shore to the second phase of the Johan Sverdrup development, where there will be installed a power hub allowing electrification of the fields Gina Krog, Ivar Aasen and Edvard Grieg from 2022. The orange cable shows power from shore to Sleipner and attached fields planned from the end of 2022. The black cables are existing cables between Sleipner and Gudrun. In total there will be ten fields receiving power from shore through this Utsira High solution, estimated to result in an average annual emission reduction of 1.2 million tonnes $CO_2$.

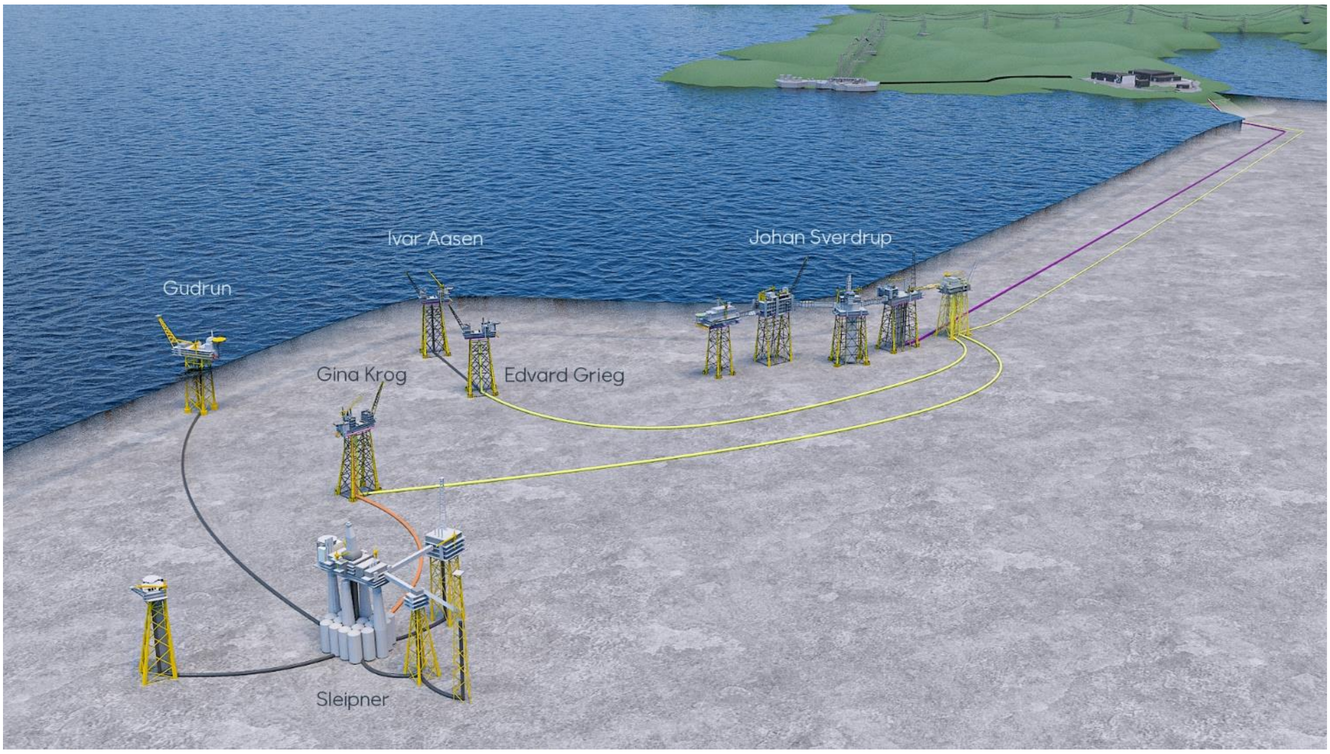



*Figure 7-4 Power from shore to the Utsira High area (Equinor (c) 2019)*

The Hywind Tampen project is another planned project within the area of offshore electrification. This project will generate renewable electricity with the use of floating wind turbines to supply the fields Snorre and Gullfaks in the Tampen area. These will be the world's first offshore fields to be powered by floating offshore wind, and the estimated annual emission reductions from Snorre and Gullfaks will be more than 200,000 tonnes $CO_2$, a reduction of around 35 %. The project is due to start up in the third quarter of 2022. (Equinor (c) 2020)

### 7.1.2 Reduced flaring

In addition to contributing to emission of $CO_2$, black carbon and other pollutants, gas flaring also wastes valuable energy that could otherwise be used to advance sustainable development. In 2015, the "Zero Routine Flaring by 2030" initiative were introduced by the World Bank, bringing together governments, oil companies and development institution with a shared goal of eliminating routine flaring by 2030. 27 governments (including Norway), 34 oil companies (including Equinor) and 15 development institutions endorsed this target. (World Bank 2015)

In addition to the "zero routine flaring by 2030" target, Equinor also aims to reduce the upstream flaring intensity to 0.2 % by 2020, well below the industry average of 1.1 % (Equinor (b) 2019). In 2019, Equinor's flaring intensity was at 0.25 % (see Figure 7-9). There is currently flaring from the field Mariner in the British part of the North Sea. This is because the need for power generation in the early production phase is exceeded by the gas production. Equinor is expecting Mariner to meet their 2030 zero routine flaring commitment after a few years when all the field's associated gas will be used for energy production.

Due to gas infrastructure challenges in Bakken, North Dakota, there is still routine flaring taking place there. The midstream pipeline capacity is exceeded by the production growth in this area, resulting in gas being flared rather than sold. Equinor has identified several measures to reduce flaring from Bakken, but further improvement actions are needed to achieve zero routine flaring in this area. (Equinor (b) 2019)
There is no routine flaring in Equinor's operations at the NCS.

### 7.1.3 Energy efficiency

Over the last decade, the annual emissions from Equinor has been reduced by around 2 million tonnes $CO_2$ as a consequence of several energy efficiency measures implemented on the NCS, the onshore facilities and within the logistics operations. (Equinor (e) 2020) For instance, in 2019, Equinor modified the compressor system on the field Gullfaks C, reducing $CO_2$ emissions by 35,000 tonnes annually, and increased efficiency of ten turbines over nine platforms for an annual emission reduction of 17,000 tonnes $CO_2$ (Equinor (b) 2019), as well as reducing the number of gas turbines from five to four on the LNG facilities in Hammerfest, contributing to about 160,000 tonnes $CO_2$ emission reduction in 2017 and 2018. There are also plans for further efficiency measures, like for instance the development of an air filter program expected to reduce annual $CO_2$ emissions from turbines on the NCS by 250,000 tonnes from 2022. (Equinor (e) 2020)

Figure 7-5 below shows examples of these energy efficiency improvement.

**Sources of energy efficiency improvements**

| Area of the economy | Measures |
|---|---|
| Buildings | Retrofit insulation, new windows, heat pumps, LED lighting, modern appliances, smart meters |
| Consumers | Reduced consumption of goods and services, recycling and reuse, public transport |
| Industry | New equipment, automation, waste reduction, electrification |
| Transport | Fuel efficiency, electrification, optimised logistics |
| Power/ heating | Co-generation, decommissioning of old thermal plants, shift to renewables |

*Figure 7-5 Sources of energy efficiency improvements (Equinor (a) 2019)*

### 7.1.4 Carbon Capture, Utilisation and Storage (CCUS)

CCUS is a part of the solution to reach the renewal scenario presented in chapter 3.3, though currently it is lacking a clear business case. Its only "revenue source" is its $CO_2$ emission reducing effect, while it adds costs to industrial processes and electricity generation. However, most scenarios showing ways to reach the 1.5°C and 2°C targets, rely quite heavily on CCUS (see Figure 7-7). It will therefore have to rely on incentives and strong policy support in order for it to be sufficiently attractive for companies. (Equinor (a) 2019)

With the Norwegian government, who has an ambition of developing a full-scale CCUS value chain in Norway by 2024, as a key partner, Equinor is working on building a European value chain where $CO_2$ from industrial plants, like cement producers and waste management facilities where $CO_2$ is a by-product, will be captured and stored. (Equinor (b) 2019) A part of the Norwegian government's CCUS value chain developing is "The Northern Lights project", which is about the transporting and permanent storing of $CO_2$ in a safe reservoir in the North Sea. Equinor is executing the project, with Shell and Total as equal partners.

Figure 7-6 below shows the planned value chain of the Northern Lights project.

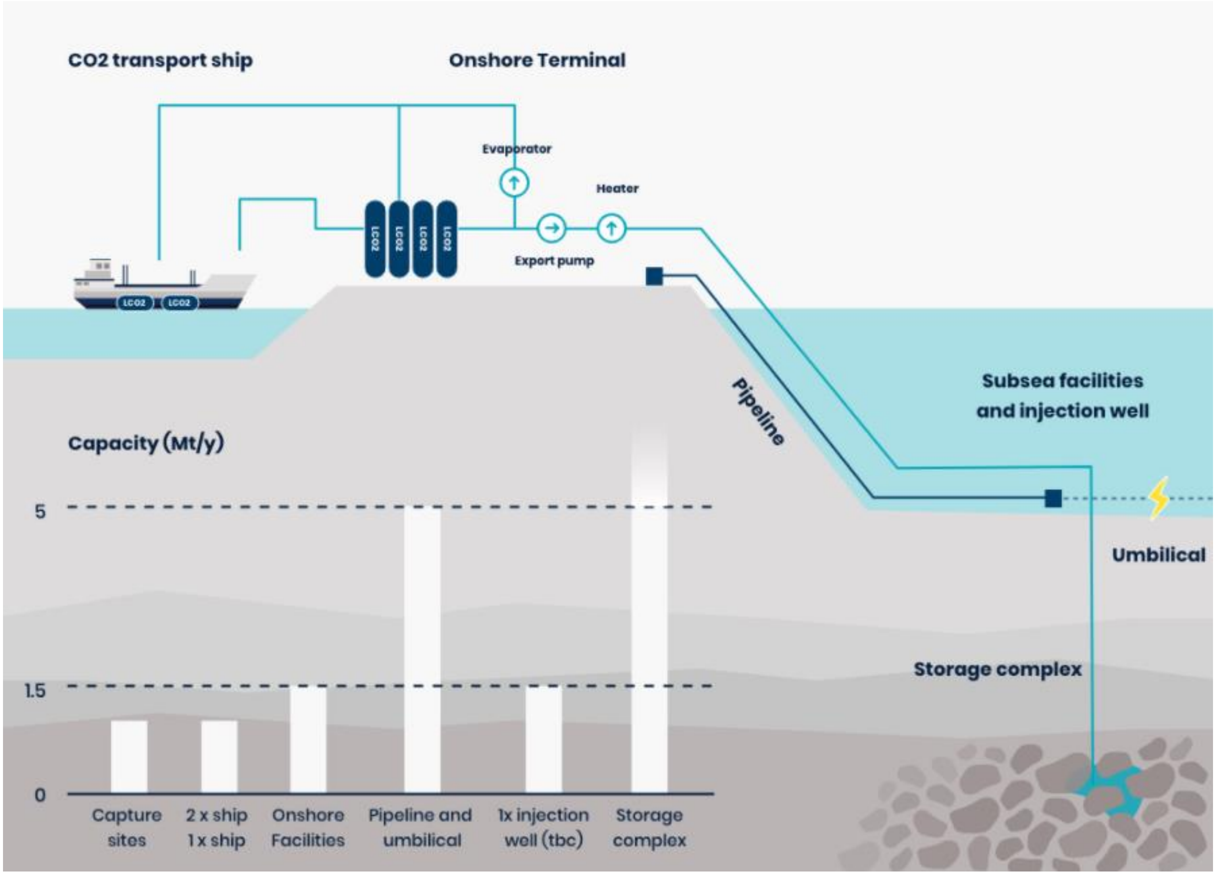



*Figure 7-6 The Northern Lights Value Chain (Northern Lights Project 2020)*

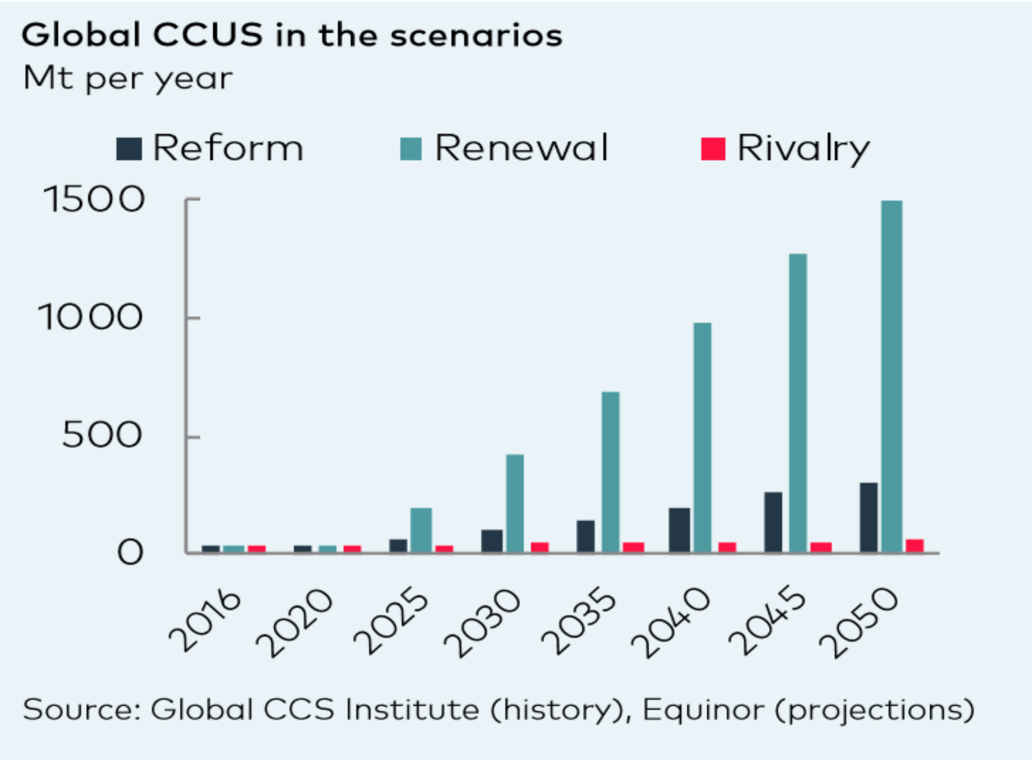



*Figure 7-7 Global CCUS in the energy perspective scenarios (Equinor (a) 2019)*

### 7.1.5 New energy

As can be seen in Figure 7-2, Equinor has a target of increasing their equity share of installed capacity from renewable projects to 4-6 GW by 2026, around ten times higher than today's capacity (see Figure 7-16), and to 12-16 GW by 2035. They estimate that by 2030, the wind and solar energy capacities will need to double, and the battery production need to increase more than 20-fold. (Equinor (a) 2019)

Equinor is increasing its offshore wind portfolio, e.g. with the recent additions of Dogger Bank in the UK, with a total installed capacity of 3.6 GW (Equinor (f) 2020), and Empire Wind in the US, which will provide enough renewable energy to serve around one million homes in New York City (Equinor (b) 2019).

In addition to these projects, and Johan Sverdrup and Hywind Tampen mentioned in 7.1.1, Equinor also has a 50 % share in the 150 MW Cañadón León wind farm in Argentina, 162 MW Apodi solar production asset in Brazil as well as in the 117 MW Guanizul IIA solar project in Argentina currently under construction. Equinor is also involved in several pilots and projects within hydrogen, like e.g. the Zero Carbon Humber (UK) that explores the way in which hydrogen can help to decarbonize the country's largest industrial cluster. (Equinor (b) 2019).

## 7.2 Environmental Performance

### 7.2.1 About the data

The data presented in 7.2 is, unless otherwise specified, collected from Equinor's own sustainability reports and their online "sustainability data hub" (Equinor (b) 2020). The reported data will sometimes be divided between operational control and equity basis. The equity basis is based on Equinor's ownership percentage in their consolidated entities and other equity accounted entities. The data from these entities, and the way in which $CO_2$ emission is quantified, comes directly from the respective entities, and may therefore vary with regards to Equinor's ability to quality assure the data. The data under operational control gets reported on a 100 % basis for Equinor's own operated assets, facilities, and vessels. This includes the operations and subsidiaries where Equinor is the technical service provider, as well as contracted floatels and drilling rigs.

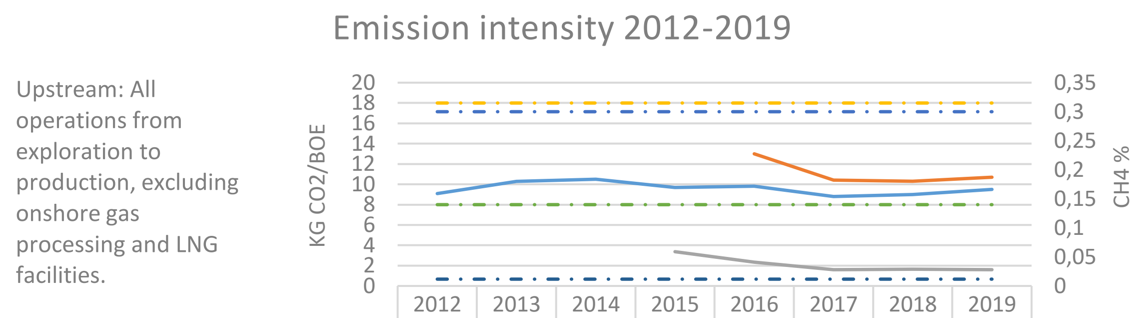
### 7.2.2 Emission to air

#### Emission intensity

The emission intensity of $CO_2$ is here reported as total scope 1 emission (direct emission) of carbon dioxide (kg $CO_2$) divided by total production (boe), and the methane ($CH_4$) intensity is given as the total $CH_4$ emissions from up- and midstream activities divided by the marketed gas, on a 100 % operated basis.

As can be seen in Figure 7-8, the upstream $CO_2$ intensity has, after a rather rapid decline from 2016, increased slightly from 2017. The increase from 2018-2019 is explained by Equinor as mainly being caused by sustained low gas prices leading to lower gas export from the Norwegian Continental Shelf (Equinor (b) 2019). The $CH_4$ intensity has remained relatively stable over the last three years. Both the $CO_2$ and the $CH_4$ intensity is on a considerably lower level than the industry average of 2018 (Equinor (b) 2019) (OGCI 2018).

From 2020, after the electrified Johan Sverdrup has been operative for a full year, the $CO_2$ intensity is expected to decrease. As a consequence, the intensity target set in Equinor’s 2018 Sustainability Report (Equinor 2018) of a $CO_2$ intensity of 8 kg/boe by 2030 has been moved forward to 2025 in the 2019 Sustainability Report (Equinor (b) 2019).




| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| CO2 intensity upstream, operated | 9,1 | 10,3 | 10,5 | 9,7 | 9,8 | 8,8 | 9 | 9,5 |
| CO2 intensity upstream, equity | | | | | 13 | 10,4 | 10,3 | 10,7 |
| Industry average CO2 intensity (2018) | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| Equinor intensity target 2025 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Johan Sverdrup intensity | 0,67 | 0,67 | 0,67 | 0,67 | 0,67 | 0,67 | 0,67 | 0,67 |
| CH4 intensity upstream, operated (%) | | | | 0,059 | 0,041 | 0,028 | 0,029 | 0,028 |
| Industry average CH4 intensity (2018) | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 |

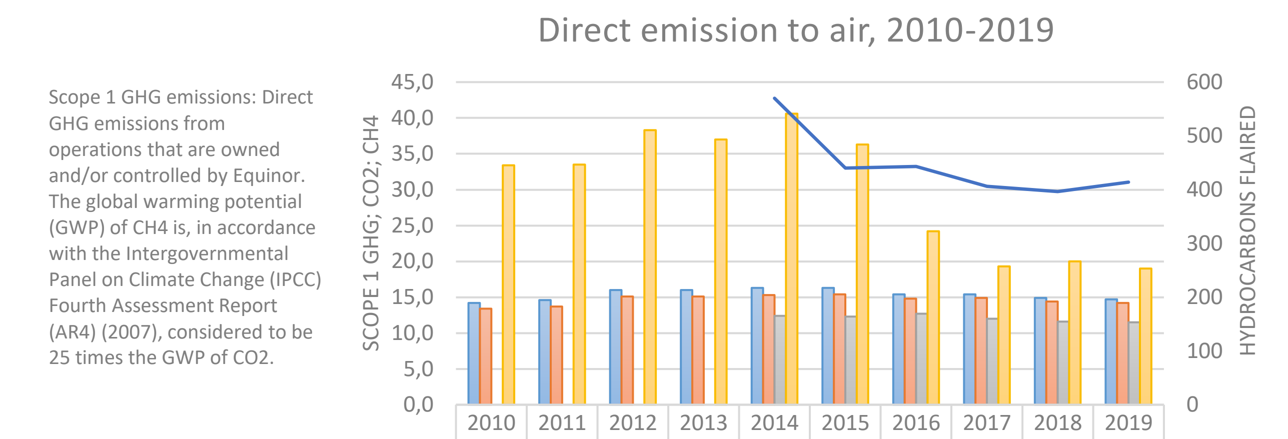
*Figure 7-8 Emission intensity 2012-2019,, Equinor and industry average*

### 7.2.2.1 Greenhouse gas emission to air

The gases included in the greenhouse gases (GHG) reported by Equinor are $CO_2$ and $CH_4$. I have chosen to include the emission of hydrocarbons from flaring in this sub-chapter. Emission of other gases ($SO_x$, $NO_x$, nmVOC) are presented in 7.2.2.2.

In the Sustainability report from 2017 (Equinor 2017), an emission reduction target of 3 million tonnes of annual $CO_2$ emission reduction by 2030 was set. As of 2019, around 0,9 million of this has been met (Equinor (b) 2019). The scope 1 GHG emission reduction from 2018-2019 is described by Equinor to mainly stem from turnaround activities in the midstream segment and energy efficiency projects.

Though the hydrocarbons emitted from flaring has been considerably lower the past years since 2014, the first year of data on this, it increased from 397 to 414 million tonnes from 2018-2019. The operated, upstream flaring intensity increased from 0.24 to 0.25 % in the same period, which is significantly lower than the industry average of 1.1 %, though slightly above the 2020 target of 0.2 %. The main reason for the increase is stated by Equinor to be due to an increase in flaring at Bakken “due to lack of infrastructure capacity to offtake associated gas, as well as flaring at Mariner”. The 2020 goal still stands, as well as an ambition of zero routine flaring by 2030. (Equinor (b) 2019)




| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scope 1 GHG emissions (million tonnes CO2e) | 14,2 | 14,6 | 16,0 | 16,0 | 16,3 | 16,3 | 15,4 | 15,4 | 14,9 | 14,7 |
| CO2 emissions Statoil/Equinor operated (million tonnes) | 13,4 | 13,7 | 15,1 | 15,1 | 15,3 | 15,4 | 14,8 | 14,9 | 14,4 | 14,2 |
| CO2 emissions equity basis (million tonnes) | | | | | 12,4 | 12,3 | 12,7 | 12,0 | 11,6 | 11,5 |
| CH4 emission (thousand tonnes) | 33,4 | 33,5 | 38,3 | 37,0 | 40,6 | 36,3 | 24,2 | 19,3 | 20,0 | 19,0 |
| Hydrocarbons flaired (million tonnes) | | | | | 570 | 440 | 443 | 406 | 396,5 | 413,7 |

*Figure 7-9 Direct emission to air, 2010-2019, Equinor*

It is worth noting, however, that the highest emission levels (more than 85 % of the total (Equinor (b) 2019)) resulting from the petroleum industry come from scope 3 emissions, meaning emissions that occur as a consequence of the operations of the organisation, but are not directly controlled or owned by the company, such as use of sold products, e.g. the use of fuels for transportation, heating etc. Due to export, these emissions may take place anywhere, and will show in the emission levels of the countries where the products are being used. This will also be the case of other nations’ petroleum export and can be challenging to calculate.

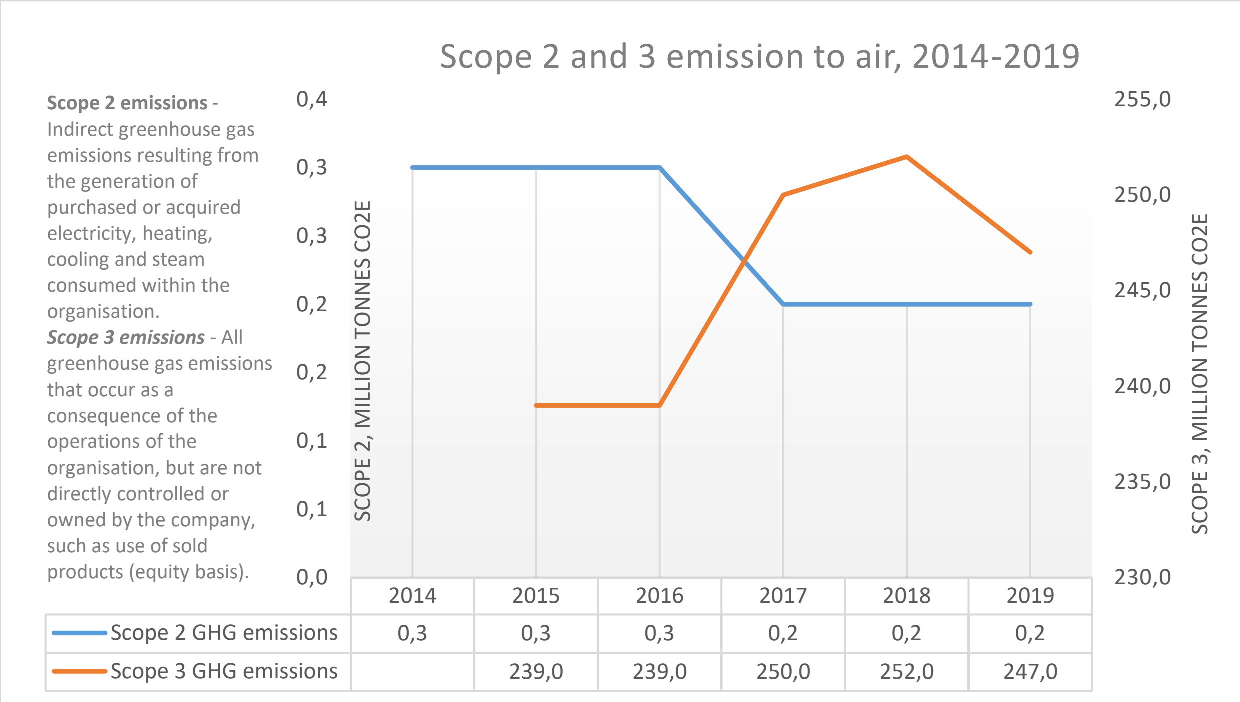
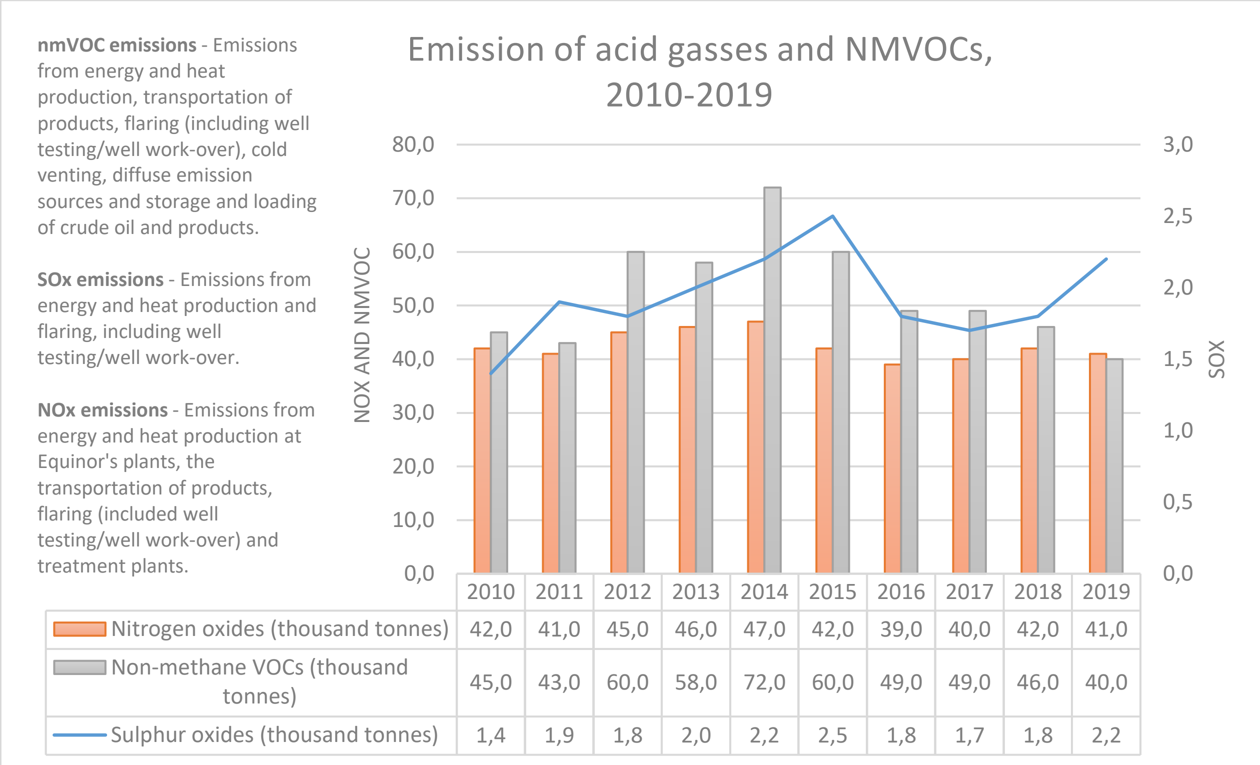



*Figure 7-10 Scope 2 and 3 emission to air, 2014-2019, Equinor*

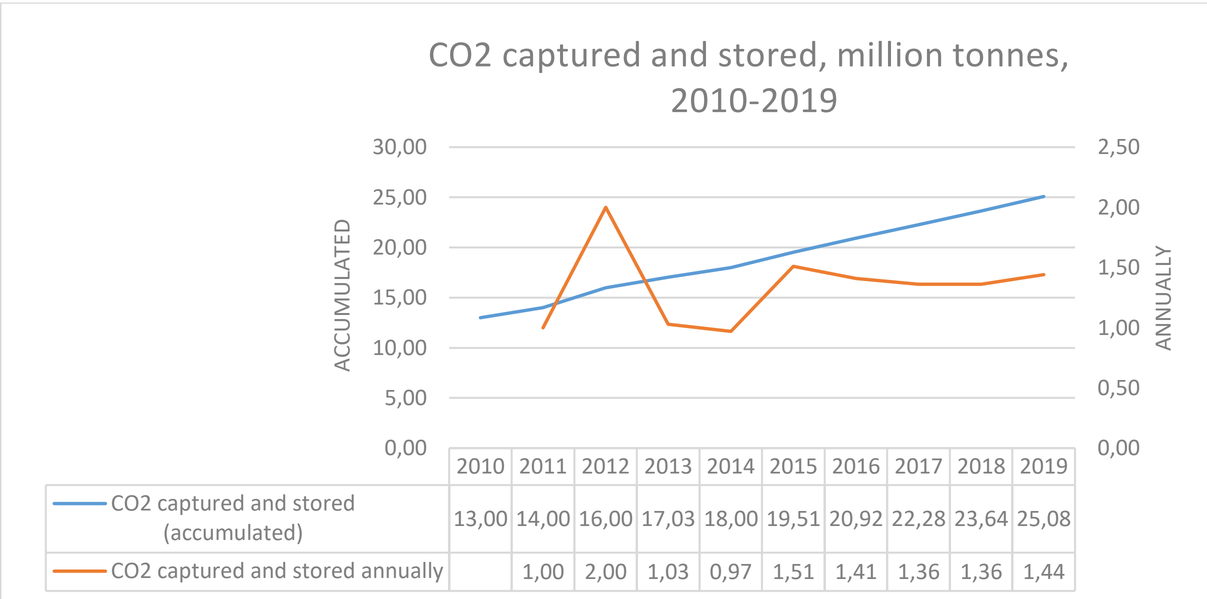
#### 7.2.2.2 Emission of acid gasses and NMVOCs

From 2018-2019 there was a decrease in the emitted $NO_x$ and nmVOC, and an increase in the emitted $SO_x$, as shown in Figure 7-11. The decreases are being explained by Equinor as, for $NO_x$ stemming from reduced drilling activities in the tight oil segment and, for nmVOC, mainly being a result of a decrease in oil loading volumes on the NCS. (Equinor (b) 2019) The high increase in emitted $SO_x$ of 22 % was in large part a consequence of a downtime of the sulphur treatment unit at Mongstad refinery during a planned turnaround. The emissions of $SO_x$ was within the permit level and are expected to return to normal. (Equinor (b) 2019)




| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen oxides (thousand tonnes) | 42,0 | 41,0 | 45,0 | 46,0 | 47,0 | 42,0 | 39,0 | 40,0 | 42,0 | 41,0 |
| Non-methane VOCs (thousand tonnes) | 45,0 | 43,0 | 60,0 | 58,0 | 72,0 | 60,0 | 49,0 | 49,0 | 46,0 | 40,0 |
| Sulphur oxides (thousand tonnes) | 1,4 | 1,9 | 1,8 | 2,0 | 2,2 | 2,5 | 1,8 | 1,7 | 1,8 | 2,2 |

*Figure 7-11 Emission of acid gases and nmVOCs, 2010-2019, Equinor*

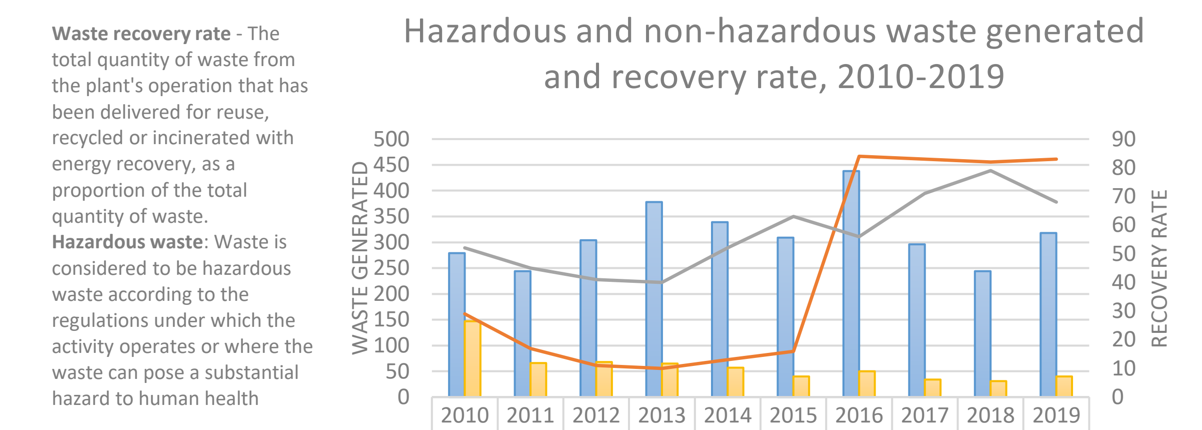



| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO2 captured and stored (accumulated) | 13,00 | 14,00 | 16,00 | 17,03 | 18,00 | 19,51 | 20,92 | 22,28 | 23,64 | 25,08 |
| CO2 captured and stored annually | | 1,00 | 2,00 | 1,03 | 0,97 | 1,51 | 1,41 | 1,36 | 1,36 | 1,44 |

*Figure 7-12 CO2 captured and stored, 2010-2019, Equino*

### 7.2.3 Waste and discharges to sea

In 2018, large volumes of process water from Troll were being dispatched to shore through pipelines and shipped to external contractors rather than being remediated at Equinor's facilities, thus increasing the amount of hazardous waste by 30 % from 2018-2019,  after seeing steady declines in the amount of generated waste, both hazardous and non-hazardous, since 2016 (see Figure 7-13). There was also a 29 % increase in non-hazardous waste in the same period, mainly caused by high amounts of polluted soil from groundwork and tank cleaning at Kalundborg refinery.



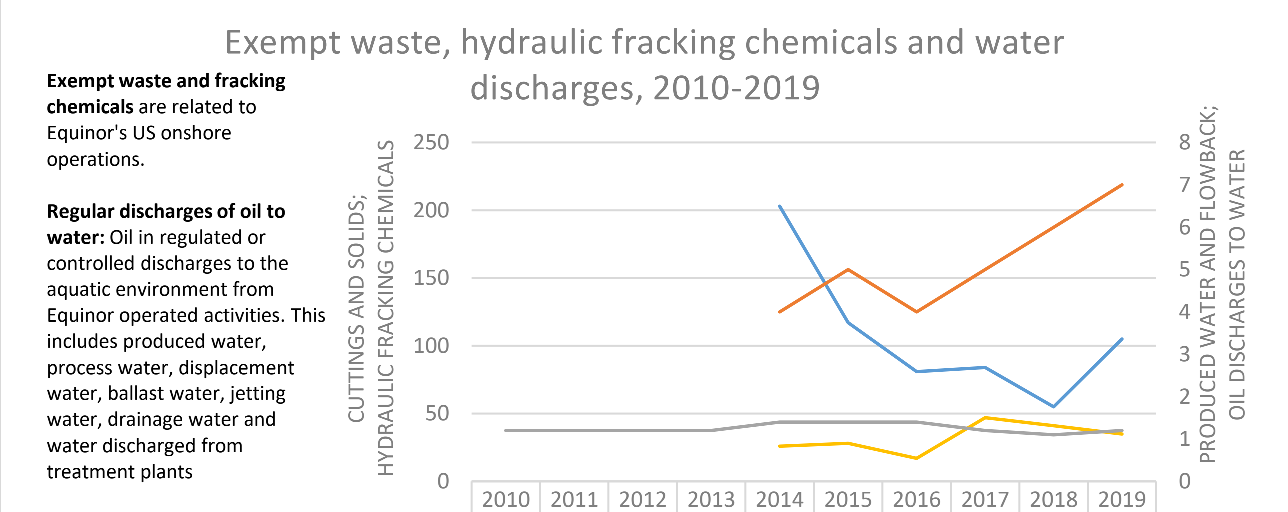

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Hazardous waste generated (thousand tonnes) | 279 | 244 | 304 | 378 | 339 | 309 | 438 | 296 | 244 | 318 |
| Non-hazardous waste generated (thousand tonnes) | 147 | 66 | 68 | 65 | 57 | 40 | 50 | 34 | 31 | 40 |
| Hazardous waste recovery rate (%) [1] | 29 | 17 | 11 | 10 | 13 | 16 | 84 | 83 | 82 | 83 |
| Non-hazardous waste recovery rate (%) | 52 | 45 | 41 | 40 | 52 | 63 | 56 | 71 | 79 | 68 |

*Figure 7-13 Hazardous and non-hazardous waste generated and waste recovery rate, 2010-2019, Equinor*

Waste exempted from being classified as hazardous waste includes drill cuttings and solids, as well as produced water and flowback, from Equinor's onshore operations in the US. They are exempt from the hazardous waste regulations, and I have therefore chosen to show them in a separate figure, along with regular discharges of oil to water and hydraulic chemicals from flaring, seen in Figure 7-14.

There was a significant increase of 53 % in the volume of drill cuttings from US onshore operations from 2018-2019. Equinor explains this increase as resulting from the transporting of cuttings as waste to landfill sites, were the waste management varies with location, causing variations from year to year in solid exempt waste. There was also a higher amount of produced water from wells in the same period, causing an increase of 17 % in produced water and flowback, as well as an increase of 9 % in oil discharges to water. Due to reduced activities at Eagle Ford and Bakken in 2019, the use of fracking chemicals saw a decrease of 15 % from 2018-2019, continuing the declining trend since

2017. The reduced fracking activities also led to a decrease of 8 % in freshwater consumption. (Equinor (b) 2019)




| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Exempt waste generated: cuttings and solids, (thousand tonnes) | | | | | 203 | 117 | 81 | 84 | 55 | 105 |
| Hydraulic fracking chemicals (thousand tonnes) | | | | | 26 | 28 | 17 | 47 | 41 | 35 |
| Exempt waste generated: produced water and flowback (million m3) | | | | | 4 | 5 | 4 | 5 | 6 | 7 |
| Regular discharges of oil to water (thousand tonnes) | 1,2 | 1,2 | 1,2 | 1,2 | 1,4 | 1,4 | 1,4 | 1,2 | 1,1 | 1,2 |

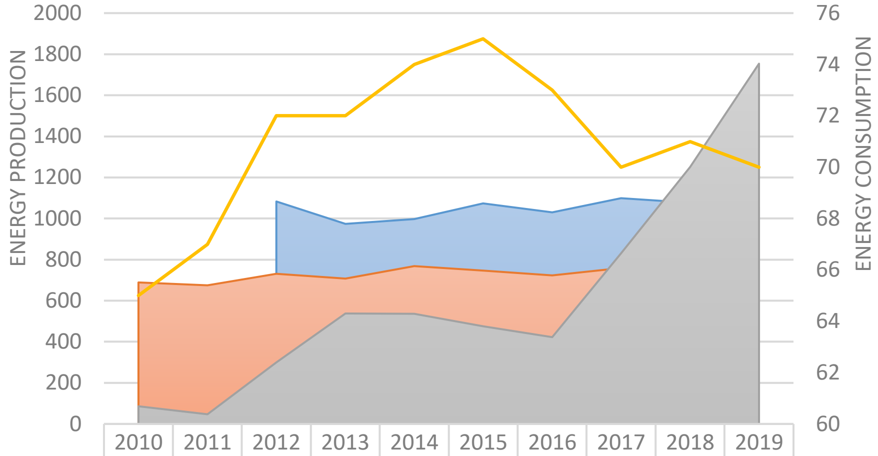
*Figure 7-14 Exempt waste, hydraulic fracking chemicals and water discharges, 2010-2019, Equinor*

## 7.2.4 New energy solutions and energy efficiency

As shown in Figure 7-15, the production of renewable energy has had a rapid increase since 2016, with annual increases of 96 % in 2017, 51 % in 2018 and 40 % in 2019. The increases are due to a growing portfolio in the area of renewable energy production, like for instance the wind farm Arkona in Germany, which opened in 2019.

## Energy production and consumption, 2010-2019

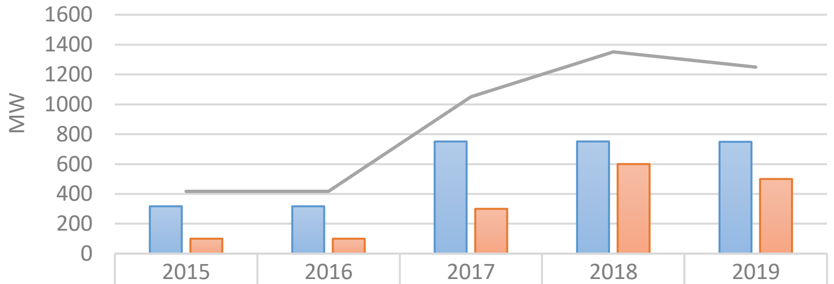
**Energy consumption**: Energy used for power generation and heat production in combustion processes, unused energy from flaring (including well testing/work-over and venting), energy sold/delivered to third parties and gross energy (heat and electricity) purchased.




| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Operated production (mboe) | | | 1083 | 974 | 997 | 1073 | 1030 | 1099 | 1077 | 1055 |
| Equity production (mboe) | 689 | 675 | 731 | 708 | 768 | 747 | 723 | 759 | 770 | 757 |
| Equity renewable energy production (GWh) | 86 | 47 | 300 | 538 | 536 | 475 | 423 | 830 | 1251 | 1754 |
| Energy consumption TWh | 65 | 67 | 72 | 72 | 74 | 75 | 73 | 70 | 71 | 70 |

*Figure 7-15 Energy production and consumption, 2010-2019, Equinor*

## Renewable energy, installed capacity, 2015-2019

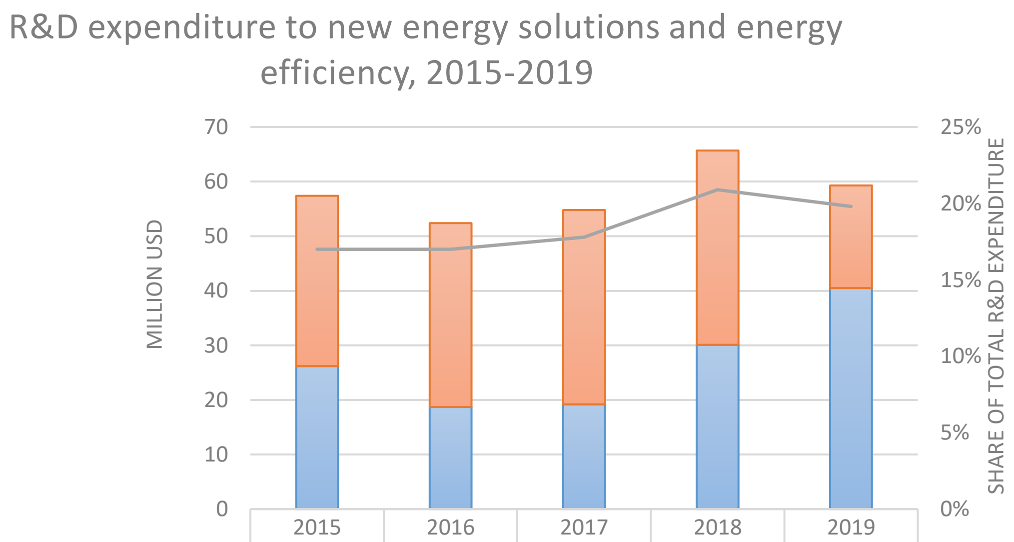



| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| Renewable installed capacity, operational control | 317 | 317 | 751 | 751,3 | 749 |
| Renewable installed capacity, equity basis | 100 | 100 | 300 | 600 | 500 |
| Total renewable installed capacity | 417,00 | 417,00 | 1051,00 | 1351,30 | 1249,00 |

*Figure 7-16 Renewable energy, installed capacity, 2015-2019, Equinor*

### 7.2.5 Investing in low-carbon research and technology

Figure 7-15 show the expenditure on new energy solutions and energy efficiency, an area expected to grow over the coming years in line with Equinor's strategic direction of growing in renewables. The decrease from 2018-2019 is explained by several new projects in the area of low-carbon technology starting late in 2019, meant to replace projects that are exiting the portfolio. These will show up in the 2020 numbers.




| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| Energy efficiency and methane reduction | 31,2 | 33,7 | 35,6 | 35,6 | 18,8 |
| Carbon capture, utilisation and storage (CCUS) and renewables | 26,2 | 18,7 | 19,2 | 30,1 | 40,5 |
| R&D expenditure to new energy solutions and energy efficiency (% of total R&D expenditure) | 17% | 17% | 18% | 21% | 20% |

*Figure 7-17 R&D expenditure to new energy solutions and energy efficiency, Equinor, 2015-2019*

# 8.0 Discussion

The petroleum industry is considered both as a large contributor to the environmental problems we see today as well as an obstacle to implementing the changes needed to reach the 2°C goal. In order to reach this goal, we will have to phase out the non-renewable energy sources in favour of renewable ones. Therefore, I questioned in my introduction how Norway can balance its significant petroleum industry with its ambitious climate targets, and whether these can coexist.

Due to factors such as global population growth and developing countries becoming more developed, the demand for energy is increasing. In Energy Perspectives 2019, Equinor states that “more of global electricity demand will be met from renewables, relying relatively less on coal for meeting growing demand. However, it is not yet clear whether the growth of renewables is causing a decline in the use of fossil fuels or just representing a new addition. So far, most signs point to the latter one. Despite record growth in solar and wind capacity installations, the world is still increasing its use of fossil fuels.” In all three of the scenarios presented in chapter 3.0, there is estimated a continued need for fossil fuels in 2050, with 75 % of the total primary energy demand in the rivalry scenario, a 67 % share of total demand in reform, and a reduction of 50 % for oil and 20 % for gas in the renewal scenario. (Equinor (a) 2019)

There might be questioned whether a company like Equinor, who is a large producer of oil and gas, could be biased when it comes to future fossil fuel demand. The International Energy Agency (IEA) published its first ‘World Energy Outlook’ (WEO) report in 1977, and they have been published annually since 1998. Like Equinor’s ‘Energy Perspective’ reports, the WEOs are not forecasts, but a presentation of possible scenarios for how the future “energy picture” might look. IEA’s ‘stated policies scenario’ is comparable with Equinor’s rivalry scenario, while the ‘sustainable development scenario’ can be compared with Equinor’s renewal scenario. Figure 8-1 and Figure 8-2 shows IEA’s future scenarios for the oil and gas demand comparable to those of Equinor.

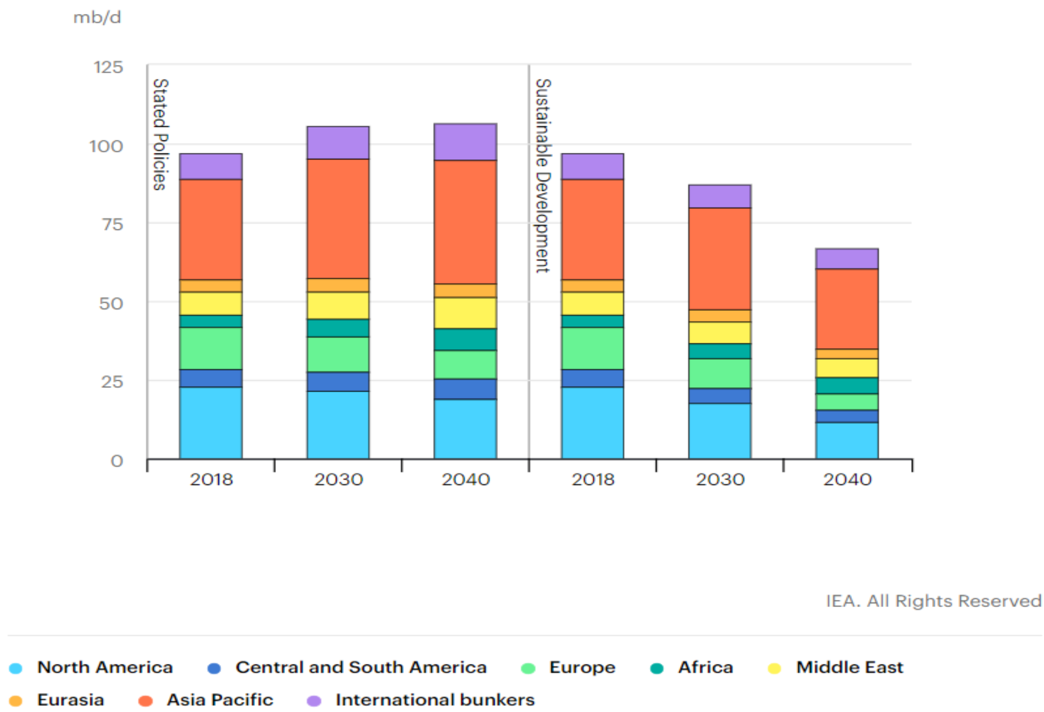



*Figure 8-1 Oil demand by region and scenario (International Energy Agency (b) 2019)*

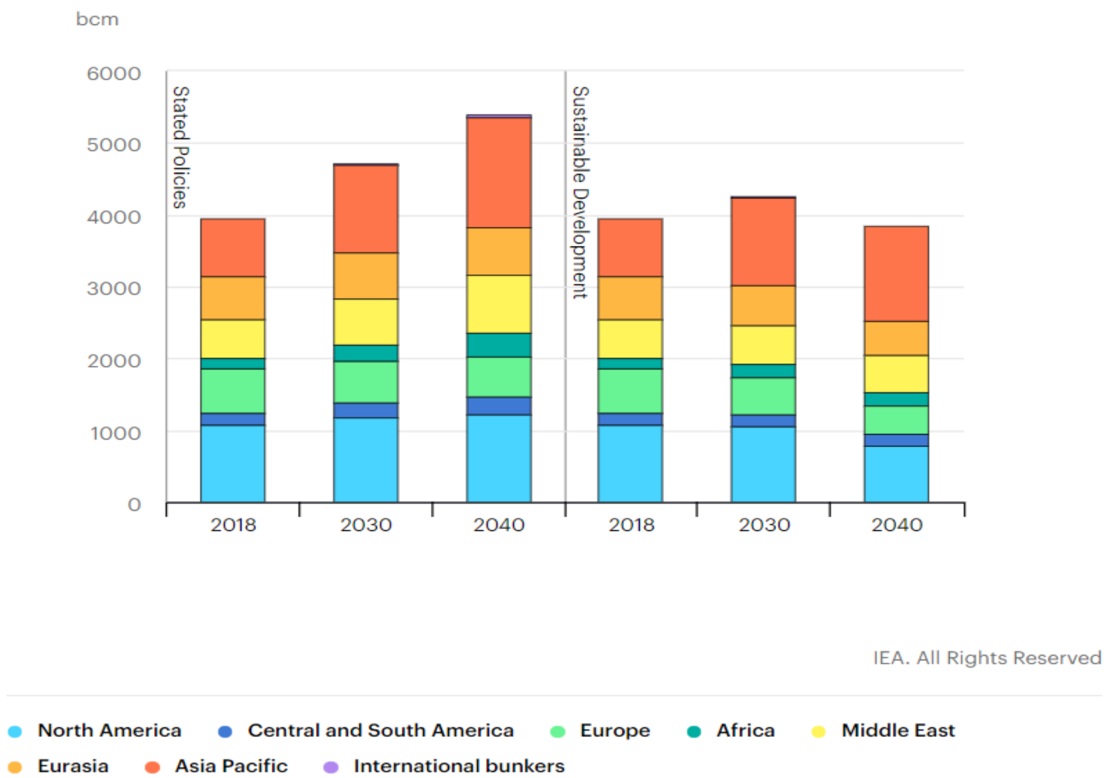



*Figure 8-2 Gas demand by region and scenario (International Energy Agency (c) 2019)*

It is evident that there exists a political will in Norway to combat the climate changes. In its whitepaper No. 34 to the parliament in 2007, the Norwegian Ministry of Climate and Environment wrote that "the emission of greenhouse gases have the same environmentally harmful effects no matter where the emissions take place. However, the developed countries have a particular responsibility to contribute to the emission reductions, both because it is the developed countries who have contributed to the highest emission levels, and because the developed countries are financially better off. On account of this, Norway should take particular responsibility to contribute to global emission reductions", further stating that one of the aims in Norway's climate policy is for Norway to "be at the forefront of international efforts to develop knowledge in and about the High North" in the context of carbon monitoring (Norwegian Ministry of Climate and Environment 2007), and in the "Granavolden-platform" of 2019, the government proclaims that they want Norway to "continue being a pioneering country in renewable energy" (The Norwegian government (a) 2019). The question remains, however, how these climate ambitions can coexist with the petroleum industry.

Even though a switch to renewable energy sources - among other measures like improved energy efficiency, CCUS etc. - are needed to reach the 2°C goal, there is and still will be a demand for oil and gas in the future. There are uncertainties to the level of this demand, but even in the "best case" scenarios where the global temperature will stay below the 2°C mark, like Equinor's "renewal" and IEA's "sustainable development scenario", the demand for fossil fuels will still be at a relatively high level. Natural gas will also be important in the out-phasing of coal.

The Norwegian petroleum industry is among the cleanest in the world, evident in the levels of emission and emission intensity, and with more projects being planned and developed, like projects in the areas of offshore wind, energy efficiency and CCUS, these emission levels are expected to decrease further. Projects like these are supported and regulated through government measures like environmental taxes, emission allowances and subsidies, which have made possible and given incentives to develop knowledge and technologies for more environmentally friendly operations. The fact that Norway's electricity mix is made up of 98 % renewables, also contributes to the low emission rates, particularly in the field of electrification of offshore assets.

The petroleum industry will inevitably have to transition to a broader energy industry focusing on renewable energies, and the industry has started the transition. There are being made major investments in renewable energy production, energy efficiency and CCUS (see for instance Figure 7-17), and Equinor's "Climate roadmap 2020" presented ambitious climate targets on areas like R&D expenditure on low carbon and energy efficiency, emission intensity reduction, renewable energy production, carbon neutral operations, no routine flaring, near zero methane emission, and absolute GHG reduction (see 7.1).

Sustainability is comprised of the three pillars of people, planet and profit. So far I have argued from a “planet” perspective, but the petroleum industry is also important for the other two. The industry employs a large part of the Norwegian workforce (as described in 5.2.4). The revenues generated from the industry are significant, funding the nation’s national and international obligations as well as projects in other countries complying with the 17 goals of sustainable development, fulfilling UN’s determinations to “ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment” and “ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature”. (United Nations 2015)

In addition to the strictly environmental benefits, there is a strong business case for the greening of companies. The implemented economic measures, such as environmental taxes and emission allowances, gives a strong economic incentive to reduce emission through implementation of environmentally friendly technologies and solutions, and due to accumulated knowledge and increasingly cheaper technologies and solutions, more companies, such as in the supplier industry, will have the means to transit to “greener” operations. New innovations can be incorporated into the existing infrastructure, making implementation less costly. There is also pressure from both authorities, through regulations and requirements, and consumers through higher demand for environmentally friendly products and solutions – both private customers, who might have idealistic reasons for raising the demands, and B2B customers who themselves have a business case for products that help them comply with regulations or reduce their footprints, or they themselves might have customers with higher environmental demands.

In summary, the Norwegian petroleum industry is an integral part of the country’s efforts to reduce its environmental footprints in the transition to a low-emission society. The industry is responsible for the highest emissions, and one could argue that it should therefore be proactive and a strong participant in the endeavors to battle climate change.

There seems to exist a will for this in the industry. The early implementation of policies such as the carbon tax and EU ETS has laid a foundation and a framework that facilitates for this, and the industry's innovation and development of emission reducing solutions and projects shows that it is a significant contributor in helping the country reach its climate targets.

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