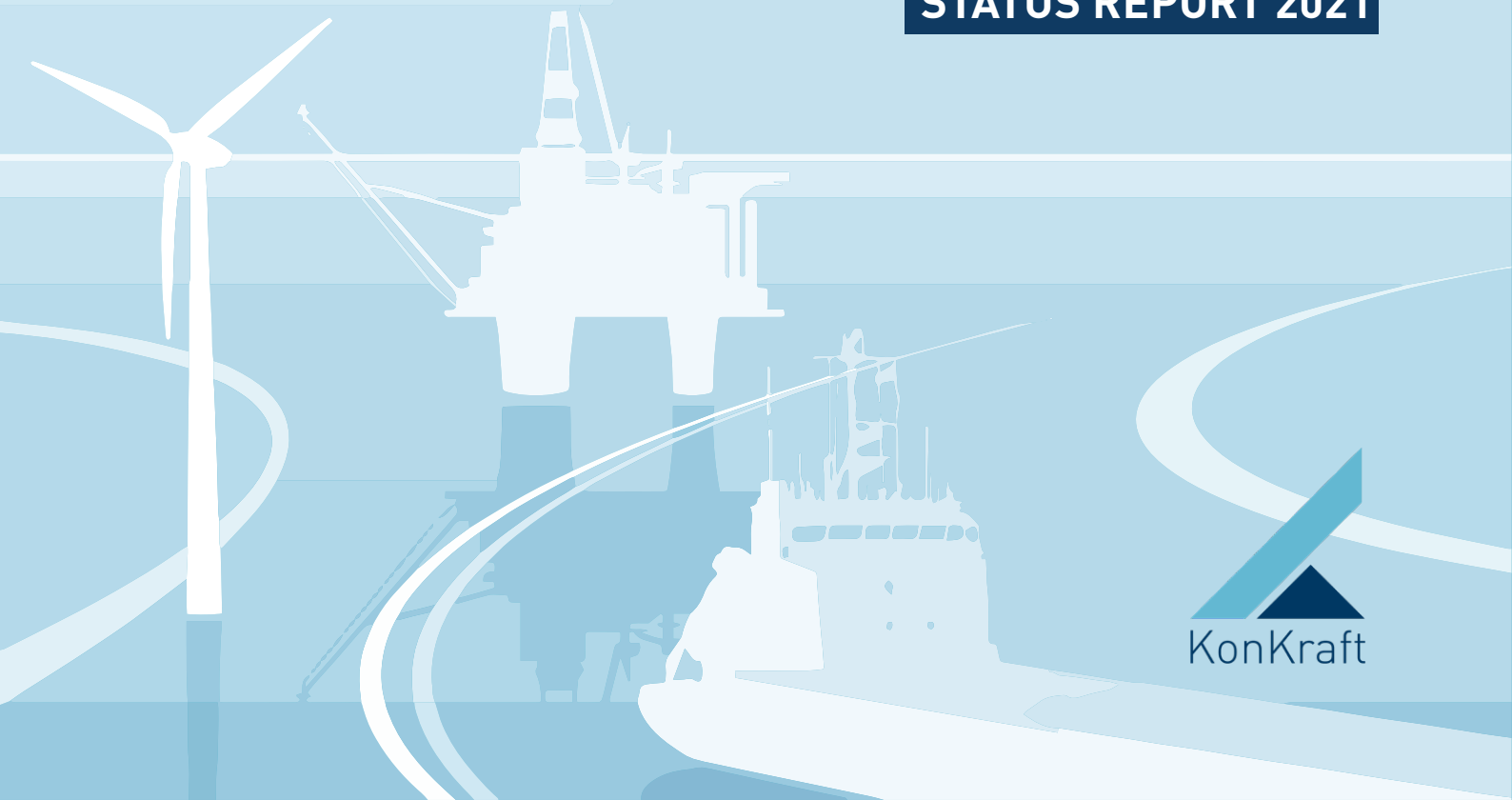
THE ENERGY INDUSTRY OF TOMORROW ON THE NORWEGIAN CONTINENTAL SHELF

CLIMATE STRATEGY TOWARDS 2030 AND 2050

STATUS REPORT 2021



KonKraft

ABOUT KONKRAFT

KonKraft is a collaboration arena for the Norwegian Oil and Gas Association, the Federation of Norwegian Industries (NI), the Norwegian Shipowners Association (RF), the Confederation of Norwegian Enterprise (NHO) and the Norwegian Confederation of Trade Unions (LO), together with two LO members – the United Federation of Trade Unions and the Norwegian Union of Industry and Energy Workers (Industry Energy).

Its role is to be an agenda-setter on national strategies for Norway's petroleum sector and to work on maintaining the competitiveness of the Norwegian continental shelf (NCS), so that the country remains an attractive investment target for the domestic and international oil and gas sector, including supplier companies and the maritime industry.

The council is KonKraft's topmost body. In addition, it has an executive committee and a secretariat, which is responsible for ongoing activities and day-to-day operations.

Norsk olje&gass Norsk Industri Norges Rederiforbund Norwegian Shipowners' Association NHO Fellesforbundet INDUSTRI ENERGI

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SUMMARY

Ambitious climate targets

The Norwegian oil and gas industry launched ambitious climate goals in January 2020 which called for greenhouse gas (GHG) emissions to be reduced to near zero in 2050. The target for 2030 is to reduce these emissions by 40 per cent compared with 2005. When approving temporary changes to the Petroleum Tax Act, the Storting (parliament) requested the government to produce a plan together with the industry for cutting GHG emissions by 50 per cent in 2030 compared with 2005. This work is under way, and the government expects to present the plan during the spring of 2021 in its promised White Paper concerning long-term value creation from Norwegian energy resources.

All operator companies on the NCS and at the onshore plants have set climate targets and are working actively to assess and implement climate measures. For a more detailed description of goals and ambitions, see also KonKraft's report on *The energy industry of tomorrow on the Norwegian continental shelf. Climate strategy towards 2030 and 2050*.

Opportunity space

An important part of the work on this status report has involved updating the opportunity space for reducing GHG emissions, which shows how we can reach the climate target for 2030 on the NCS. The updated opportunity space reflects the potential at December 2020, and sums up the effects of the most important measures decided upon in the licences as well as projects and feasibility studies. As described in the climate strategy, the opportunity space will be updated annually and this report will account for progress towards 2030.

The opportunity space at December 2020 shows an overall potential for reducing GHG emissions in 2030 by almost 50 per cent compared with the 2005 level. A large part of this potential includes very uncertain measures in an extremely early phase. Experience indicates that the opportunity space changes over time – many measures are implemented, some drop out for various reasons, and new opportunities are assessed and pursued. The overall potential has increased over the past year, and clearly shows that the oil and gas industry is working systematically and purposefully to find and implement emission-reducing measures. Reviews with the operators demonstrate that it could be technically feasible to reach a goal of reducing GHG emissions by 50 per cent in 2030, but that this will both be considerably more complicated in technical terms and demand significantly higher investment than reaching the 40 per cent goal set by the industry itself for 2030.

This opportunity space was established before the presentation of the Norwegian government's climate plan for 2021-30, which announced a graduated rise in the CO_2 tax. That would raise the overall CO_2 price in 2030 (tax plus emission allowance price) to NOK 2 000 per tonne. The corresponding price paid by the companies today is about NOK 850 per tonne.

Power from shore

Power from shore is an absolutely key measure for reaching the ambitious climate goals set by the oil and gas sector. Assessments of developing resources on the NCS and implementing climate measures must be made from a holistic perspective, where the need for electricity supplies and competitive power costs is taken into account for both onshore and offshore industries.

Industry policy parameters

The NHO has initiated work on a new energy and industry policy platform, with participation from the relevant employer associations and unions as well as a large number of companies. KonKraft has been invited to take part as an observer. The goal is to develop a unified industry policy position concerning which measures best realise various potentials and requirements for an energy transition in Norway, how critical infrastructure should be further developed, and what industry policy parameters are needed to realise the potential. This is an important job for taking care of and agreeing on the conditions which must be put in place to secure a successful transition.

50 per cent reduction in maritime offshore

During the autumn of 2020, the KonKraft partners worked to develop the base data for concretising a 50 per cent reduction in GHG emissions by 2030 compared with 2008 for the maritime segment of the petroleum sector. Efforts are under way to produce indicators for following up this goal.

Long-term perspectives

Achieving the climate goals requires that the companies have a long-term perspective on their activities in Norway. Competitive operating parameters which ensure profitable operation and production on the NCS, and which encourage technology development and innovation, will be crucial for ensuring the industry's future competitiveness. Realising GHG-reducing measures will be demanding if the basic production and operation parameters are weakened or significantly altered. Strengthening and further developing government support programmes will be important for reaching the 2030 and 2050 targets.

Parameters for offshore wind farms

A lot has happened since the climate strategy was presented in January 2020. The Storting has approved investment in the Longship project to support the implementation of carbon capture, transport and storage in Norway. Several industry players, including NorSea, Equinor, Wilhelmsen and BKK, have launched a plan to establish a maritime value chain for hydrogen in western Norway. In addition, the government has opened two areas of the NCS for applications to develop both fixed and floating offshore wind farms. Norway's supplier industry has a big potential to secure a substantial share of a floating offshore wind power market, both nationally and internationally. This potential can best be realised if provision is made to establish a domestic market on terms which ensure the development of large-scale floating wind farms on the NCS.

> The supplier industry has a big potential to secure a substantial share of a floating offshore wind power market

White Paper

The government is due to present a White Paper in the spring of 2021 on long-term value creation from Norwegian energy resources. In this context, the KonKraft partners have emphasised the importance of maintaining the competitiveness of the NCS so that Norway remains an attractive area for investment by the domestic and international petroleum industry, including supplier companies and the maritime segment, if the country is to succeed in developing a new and forward-looking offshore energy industry.

2

BACKGROUND

2.1 Climate work is important

Climate change is one of the biggest challenges of our time. As Norway's largest industry, the petroleum sector has a social responsibility. It will do its part of the job in ensuring that the world can reach the goal of net zero emissions by the mid-21st century. Emissions are to be reduced at the same time as the industry produces energy and sustains value creation, jobs and revenues for the welfare state. Reaching the world's climate goals while maintaining high value creation from the NCS is fully possible.

Norwegian oil and gas production has one of the lowest carbon footprints in the world, and it will be reduced even further with the new climate goals. A united petroleum sector has set itself ambitious targets on cutting emissions to near zero by 2050. That is historic. Competitive operating parameters will be crucial for implementing commitments to low- and zero-emission technologies, such as carbon capture and storage (CCS), hydrogen and offshore wind power. Expertise and technological innovativeness in the industry is part of the solution to the global challenges, and will help to reach the goals set in the Paris agreement.

The petroleum industry is working to ensure that the world's energy consumption from this source has the lowest possible emissions. To manage to limit global warming in line with the Paris agreement, we must develop and adopt low- and zero-emission technologies. Exporting Norwegian solutions of this kind will be an important contribution to reaching global climate goals.

2.2 KonKraft's climate goals

Norway's oil and gas industry set ambitious goals for emission reductions in *The energy industry of tomorrow on the Norwegian continental shelf. Climate strategy towards 2030 and 2050.*

- The Norwegian petroleum sector will reduce its absolute GHG emissions in 2030 by 40 per cent compared with 2005, and continue cutting them to near zero in 2050.

- Together with shipping companies and rig owners, the Norwegian petroleum sector will be a driver for vessels involved in offshore maritime activities to make an active contribution to achieving the goal set in the government's action plan on green shipping, which involves a 50 per cent emission reduction by 2030 in domestic maritime transport and fishing.

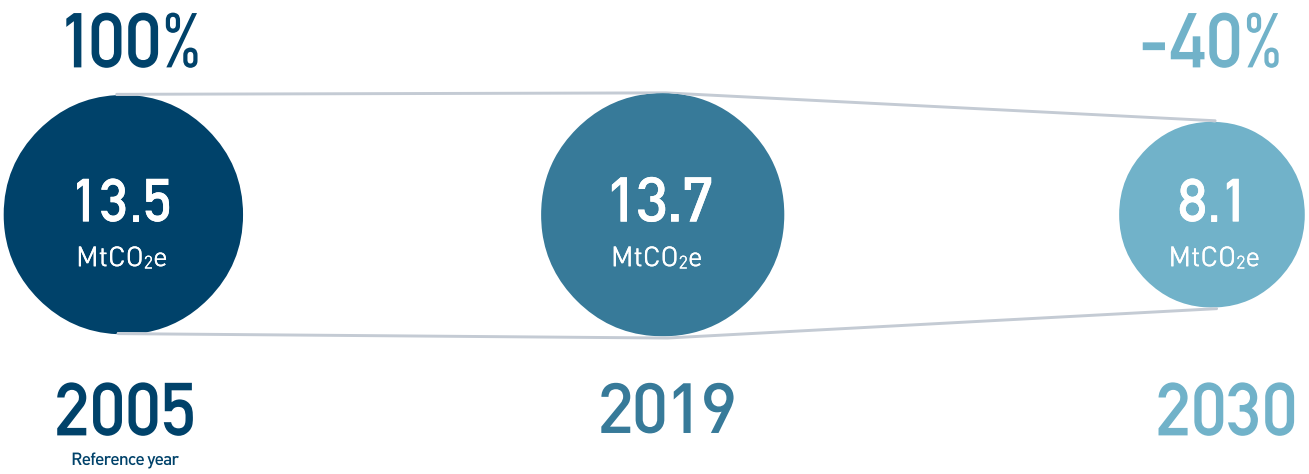
In order to realise these goals, the industry will work to foster a culture where good ideas are welcomed, picked up and adopted. Oil and gas produced with a low climate footprint in Norway will provide a future competitive edge, and its ambitious climate goals will help the petroleum sector to continue creating substantial value for Norwegian society.

In addition to cutting emissions from its own operations and from associated offshore maritime activities, Norway's oil and gas sector has ambitions of gradually creating a new and forward-looking energy industry on the NCS. This includes offshore

wind power, hydrogen and CCS projects which facilitate major emission reductions in Norway, Europe and the rest of the world. A more detailed description of goals and ambitions is provided in *The energy industry of tomorrow on the Norwegian continental shelf. Climate strategy towards 2030 and 2050.*

This status report describes progress made in the various areas.

FIGURE 01 THE NORWEGIAN OIL AND GAS INDUSTRY'S GOAL OF A 40% EMISSION REDUCTION BY 2030



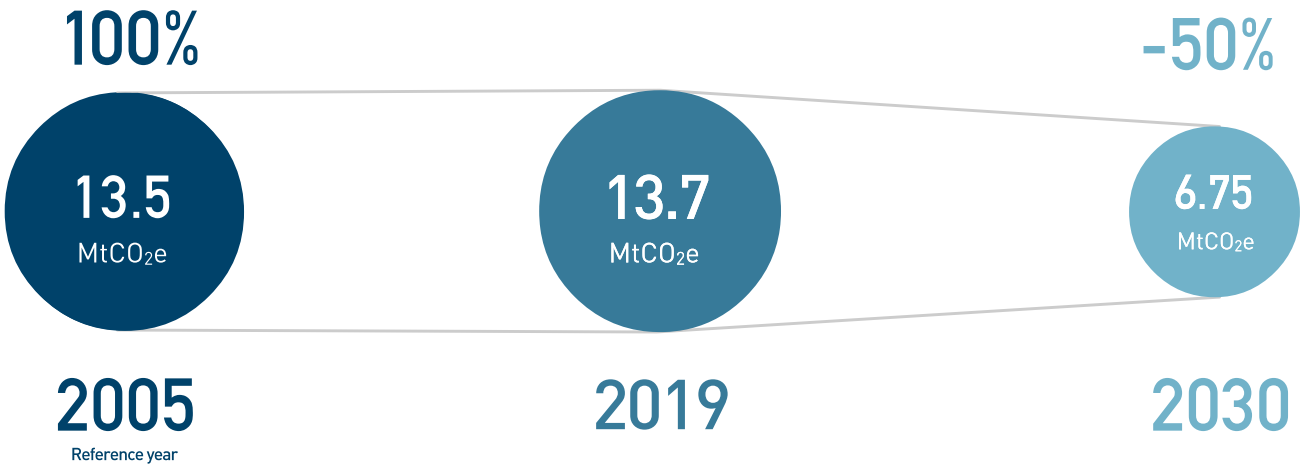
2.3 Storting petition to raise the climate goal on the NCS to 50 per cent

When the Storting approved temporary tax changes for oil and gas companies during 2020, it signalled a desire for tougher climate goals in 2030. A petition resolution requested that the government presents a plan together with the industry which shows how emissions from petroleum production on the NCS can be reduced by 50 per cent in 2030. These cuts must be achieved within existing government support programmes. The plan must also take account of the need for cost-effective emission reductions. That includes further adoption of power from shore on existing fields and in new developments, along with low- and zero-emission technology, while paying regard to the electricity generating system on land. This work must be completed during 2021. The Storting also asked the government to present proposals which ensure low- and zero-emission solutions for offshore vessels in the oil and gas sector.

The background for this decision is that Norway in February 2020 reported a more ambitious target under the Paris agreement, involving an emission reduction of 50-55 per cent compared with the 1990 level. The Storting noted that the government will help to make provision for applying the instruments in the national climate strategy, but that its goals could be even more ambitious than those KonKraft had already adopted in its own climate strategy.

Work has already begun in the industry on mapping and assessing measures, costs and consequences of meeting the Storting's request, and on collaborating with the government to present a plan during 2021. This status report is a first important step in this effort.

FIGURE 02 EMISSION REDUCTIONS PURSUANT TO THE STORTING'S PETITION RESOLUTION ON REDUCING EMISSIONS FROM OIL AND GAS PRODUCTION ON THE NCS BY 50 PER CENT IN 2030



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STATUS REPORTING FOR THE CLIMATE STRATEGY

Emissions from Norway's oil and gas industry amounted in 2019 to 13.7 million tonnes of CO_2 equivalent ($mtCO_2e$), or just over a quarter of total Norwegian emissions. This figure includes total emissions from operations on the NCS as well as from the processing plants at Kårstø, Kollsnes, Nyhamna, Melkøya and Sture. In addition come amounts released by mobile rigs and ships beyond the scope of the Norwegian Petroleum Tax Act.

From 2018 to 2019, emissions fell by a little over one per cent. Final figures for 2020 emissions are not yet available, but this was a special year with Covid-19, production cuts, a temporary shutdown at Melkøya and the implementation of energy efficiency measures which will probably lead to larger emission reductions than the year before. Given sanctioned activities and stabilisation of the position during 2021, amounts released are expected to show a short-term bounce-back to a slightly higher level in 2022 before being substantially reduced up to 2030. Because it will take time to mature the major power-from-shore projects, the big emission reductions will emerge gradually and a little later in the period.

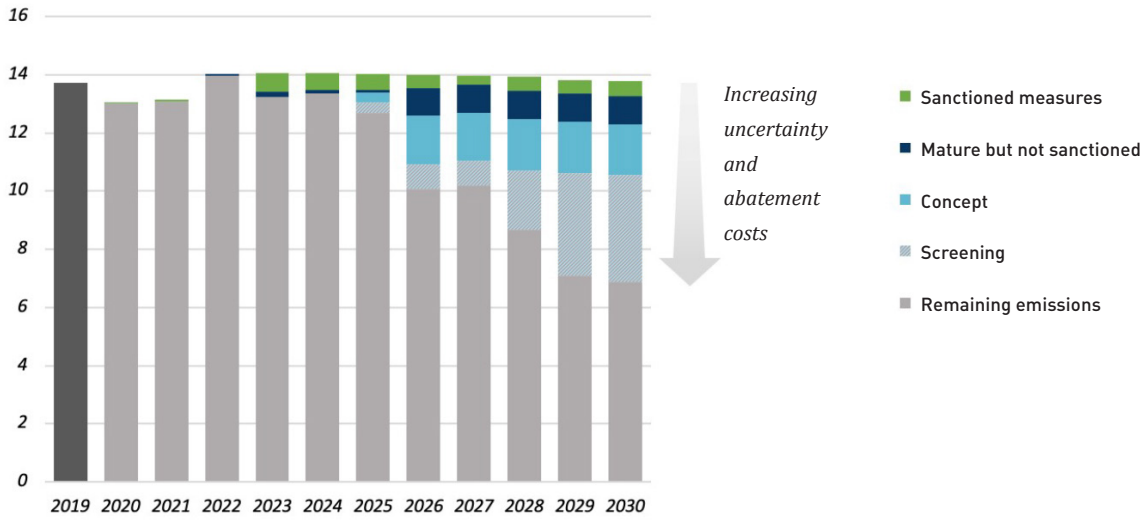
3.1 Updated opportunity space

An important part of the work on this status report has involved updating the opportunity space which shows that the 2030 climate goal for the NCS and the onshore plants can be reached. This update reflects the potential at December 2020 and sums the effects of the most important sanctioned and non-sanctioned measures as well as feasibility studies at various stages of maturity in the companies. Annual updating of the opportunity space will provide a gradually improving overview of progress towards achieving the reduction target.

All the operator companies on the NCS and at the onshore plants have established climate goals and are working actively to assess and implement climate measures towards 2030. In December 2020, Endrava provided Norwegian Oil and Gas with an updated opportunity space and an overview of the effects of sanctioned and non-sanctioned measures for reducing GHG emissions up to 2030. This analysis is based on reviews conducted by Norwegian Oil and Gas with all the operators on the NCS. The figure below illustrates the combined effect of sanctioned and larger non-sanctioned measures. These are categorised in various stages of maturity, from "screening" with very considerable uncertainty to "sanctioned measure" for the most mature. The projections also include planned new field developments and updated assumptions about residual service life.

Measures with a low abatement cost and limited complexity are given first priority, and many of these are therefore already sanctioned or mature. Measures in the screening phase are often more complex and have a higher abatement cost. Preliminary analyses indicate that raising the level of ambition for emission cuts from 40 to 50 per cent in 2030 could increase the necessary investment by up to 50 per cent.

FIGURE 03 UPDATED OPPORTUNITY SPACE, DECEMBER 2020
(MILLION TONNES EMISSIONS OF CO_2E/YEAR)



The updated opportunity space in December 2020 with projections for emissions and the estimated effect of major sanctioned climate measures and action under assessment. Note that emission figures for 2020 are based on a rough analysis, and final figures will be published later in 2021. The projections also include planned new field developments, which means that the total effect of emission-reducing measures at the different levels of maturity will vary a little over time.

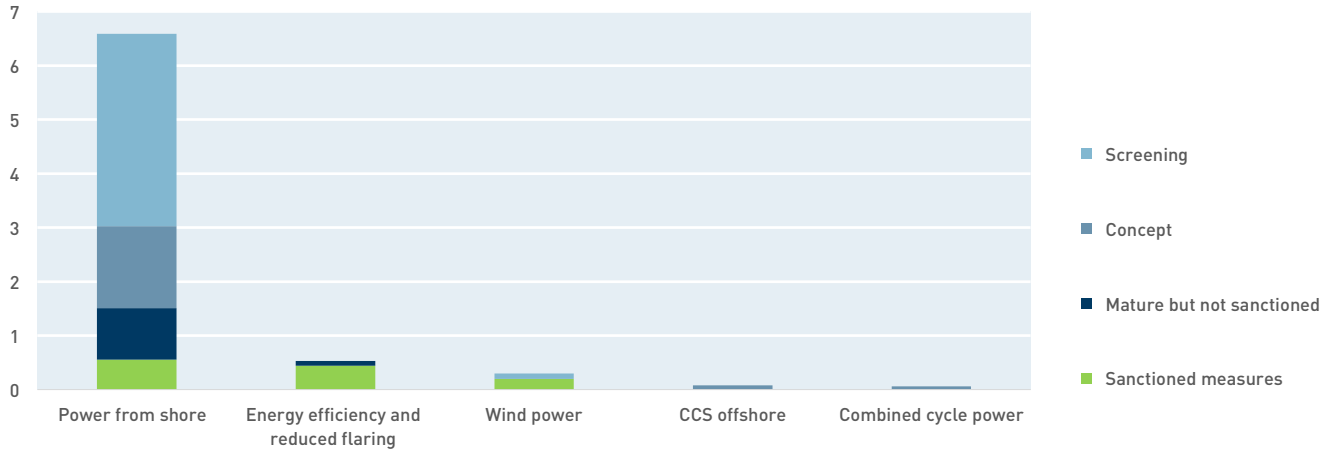
The updated opportunity space at January 2021 shows a total reduction potential of 49 per cent in 2030 compared with 2005. This updating was conducted before the government presented its climate plan for 2021-30 to the Storting on 18 January 2021. In the time to come, the companies will review possible measures in the light of the proposed increases in CO_2 prices up to 2030.

Gas turbines are the main source of GHG emissions from the NCS, accounting for 84 per cent of the total. Power from shore is the measure with the biggest effect in the opportunity space up to 2030, and a large proportion of the projects are in the screening phase. Energy-efficiency improvements and power from offshore wind turbines also contribute additional emission cuts. Some operators are assessing combined cycle power generation and offshore CCS at the concept and feasibility level. Other measures, such as closed flaring or reductions to cold venting and fugitive emissions, have a more limited effect up to 2030 since they account for only a small part of the total GHG emitted.

Experience shows that the companies continuously implement many operational steps which enhance energy efficiency. A lot of these measures are not quantified in the opportunity space, but they add up to a significant future effect. The proposed increase in the CO_2 price will also mean that even more such energy efficiency improvements will become profitable.

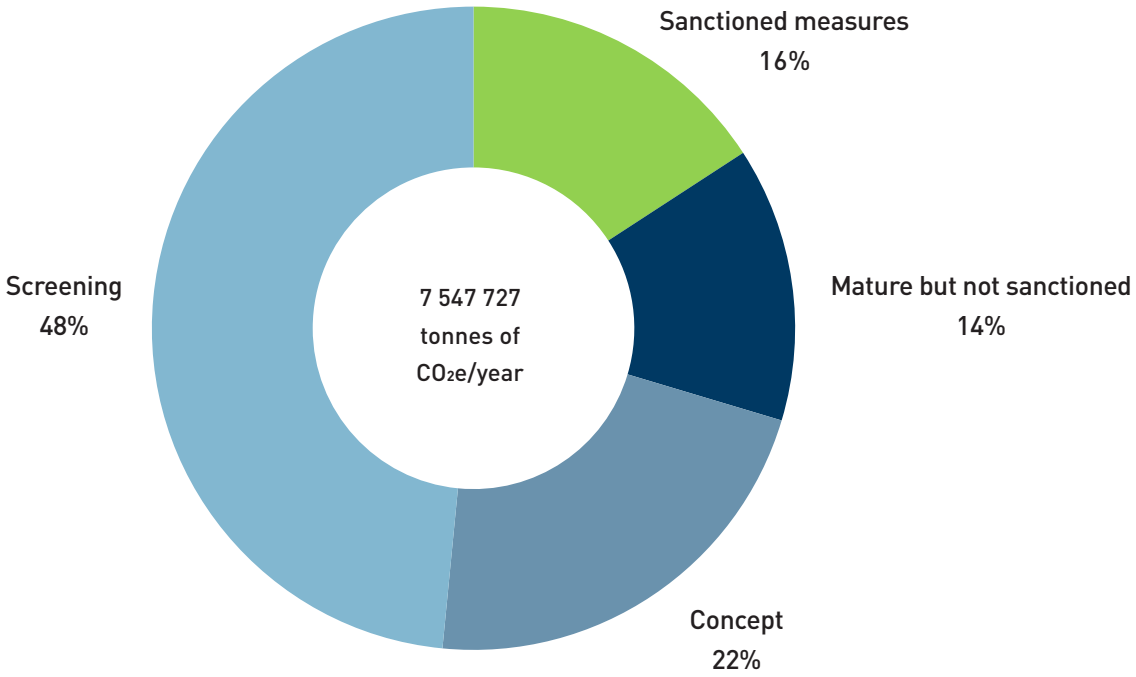
The projections cover only sanctioned climate measures and ones being assessed. More measures will be identified in the future. Experience shows that a large proportion of the measures get implemented, some drop out for various reasons, and new steps are assessed and adopted. The overview clearly shows that the oil and gas industry is working systematically to identify and implement the necessary emission reductions. The Low Emission Centre and other research initiatives will also play a key role in continued development of technologies and in expanding the opportunity space for emission cuts towards 2030.

FIGURE 04 ABATEMENT EFFECT IN 2030
(MILLION TONNES OF CO_2E/YEAR)



Categorisation of sanctioned climate measures and measures under assessment, with expected effect up to 2030.

FIGURE 05 TOTAL ABATEMENT EFFECT IN 2030



3.2 Power from shore and electricity demand

Demand for power in Norway will rise because society needs to make more extensive use of electricity to reach the national climate goals.

Utilising power from shore on new and existing oil and gas facilities is absolutely essential for reducing emissions in order to reach the ambitious climate goals set by the industry for 2030 and 2050. According to government guidance, power from shore and/or offshore wind power must be assessed for all new developments and major modifications on the NCS.

It is important that assessments related to developing NCS resources and implementing climate measures are made from a holistic perspective, where the power requirements of onshore and offshore industries and the need for competitive electricity prices are taken into account.

The NHO has initiated work on a new energy and industry policy platform, with participation from the relevant employer associations and unions as well as a large number of companies. KonKraft has been invited to take part as an observer. The work includes studying and periodising power needs related to using electricity from land in the petroleum sector, both offshore and onshore, together with the requirements of other sectors. The goal is to develop a unified industry policy position concerning which measures best realise various potentials and requirements for an energy transition in Norway, how critical infrastructure should be further developed and which industry policy parameters are necessary for realising the potential. This is an important job for taking care of and agreeing on the conditions which must be put in place to secure a successful transition.

At present, 16 NCS fields have adopted or are due to adopt power from shore. All these solutions are due to be in operation from 2023-24. Fields with power from shore will then account for 45 per cent of total NCS oil and gas production. Emissions avoided as a result of these solutions are estimated at 3.2 million

FIGURE 06 BASE FORECAST FOR POWER CONSUMPTION ON THE NCS 2020-40 (GIGAWATT-HOURS)

Source: Norwegian Oil and Gas

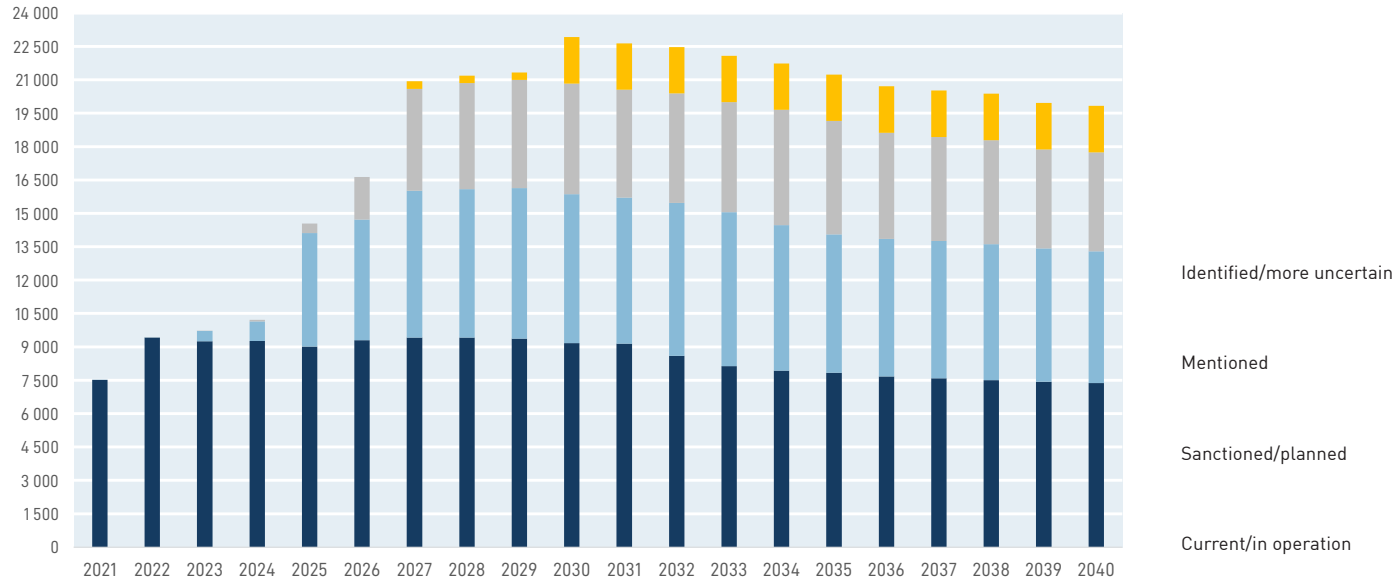


FIGURE 07 STRENGTHENING LONG-TERM POWER-GRID PLANNING

Source: Statnett

tonnes of CO_2 per annum by 2023. (*Power from shore to the NCS 2020*).

Facilities where power from shore has already been sanctioned for adoption over the next two-three years are supplemented by a number of projects where this is considered a possible solution. According to the Norwegian Petroleum Directorate (NPD) in 2020, this involves the following projects: Troll B and C, Oseberg Field Centre, Oseberg South, Sleipner East, the Halten area and Draugen. In addition comes grid power for the Melkøya gas liquefaction plant.

Norwegian Oil and Gas published a forecast at the end of January 2021 for future power-from-shore consumption on NCS oil and gas facilities. This has been prepared on the basis of detailed analyses of the gas network, updated analyses from the field operators for delivery requirements to power-from-shore projects being matured, and the expected development of Norwegian gas exports.

The forecast is based on expected power consumption by facilities which are 1) on stream today, 2) sanctioned/planned, 3) mentioned and 4) identified/more uncertain. The gas processing plants at Melkøya, Kårstø and Kollsnes are included, but not the petrochemical plants/oil refineries at Tjeldbergodden, Mongstad and Slagentangen. As with all forecasts, uncertainty increases with time and particularly after 2030.

Looking only at the first three categories, the forecast shows that power consumption is expected to increase gradually to around 20 TWh in 2030.

Grid operator Statnett's base prediction for the development of consumption in the petroleum sector shows a corresponding figure for 2030. This also includes other petroleum activities, such as Tjeldbergodden, Mongstad and Slagentangen at around one TWh.

Power from shore provides real emission cuts, which are crucially important for meeting the climate goals. The bulk of emissions from oil and gas are included in the EU emission trading system (EU ETS). A market stabilisation reserve (MSR) was introduced to the system in 2019 to delete surplus allowances. This mechanism works by removing available allowances for sale and placing them in the MSR when the surplus goes over a certain level. If allowances in the MSR exceeds the number being auctioned, the surplus will be permanently removed from 2023. The MSR thereby helps to reduce the allowance ceiling and raise the price, which gives an added incentive within the ETS to cut emissions even further. When the petroleum sector reduces the amount it emits, the result is real emission reductions beyond the national targets because the industry is part of the ETS.

Norwegian gas exported to Europe is utilised far more efficiently than by burning it on the NCS. About 30 per cent of gas used in the EU and the UK provides fuel for power stations, which are more efficient than gas turbines on the NCS. While the latter basically have an efficiency of 25-35 per cent, depending on type, age and how the facility is operated, the figure for gas-fired power stations – particularly combined-cycle plants in Europe – lies at around 50-60 per cent. Direct use in households and commercial buildings accounts for about 40 per cent of European and British gas consumption, where this commodity is again used over 80 per cent more efficiently than in offshore gas turbines. In total, this makes gas consumption on the continent substantially more efficient than on NCS facilities.

> Norwegian gas exported to Europe is used far more efficiently than by burning it on the Norwegian continental shelf

3.3 Maritime goals

Extensive measures to reduce GHG emissions have already been initiated in petroleum-related maritime activities.

According to the government's action plan for green shipping, domestic maritime transport and fishing are to cut emissions by 50 per cent up to 2030. That includes offshore-related operations. Equinor presented its specific climate ambitions for this segment in the spring of 2020, and intends to halve GHG emissions related to the maritime part of its business in Norway by 2030 compared with 2005. The Norwegian Shipowners Association (RF) also launched its climate goals for 2030 and 2050 earlier this year (*Climate targets for Norwegian shipping*).

The KonKraft partners worked during the autumn of 2020 on the base data for concretising the goal of reducing maritime emissions in the petroleum sector by 50 per cent compared with 2008, the reference year adopted by the International Maritime Organisation.

DNV GL has conducted a study for the RF and Norwegian Oil and Gas to establish base data for 2008 covering maritime operations on the whole NCS. Statistics from various sources use different calculation methods, and the quality of the input varies. Good base data are essential for quantifying what a 50 per cent reduction compared with the reference year in maritime emissions from the offshore sector represents in tonnes of CO_2. According to the recent DNV GL analysis, domestic maritime emissions from the petroleum sector totalled about 2.1 million tonnes in 2008. This estimate may vary a little as a result of methodological changes, scope and future reporting guidelines. Some uncertainty also prevails about calculating emissions from automatic information system (AIS) data and how information on emissions and activity is correlated. Given this uncertainty, the estimate must be regarded as a preliminary figure with room for improvement through more detailed calculations.

Many ships have a long remaining service life, which means modifications must be made to the existing fleet along with developing new vessel solutions. That could mean changes to charterparties between shipping companies and operators. Examples include more longer-term charters, mechanisms for risk-sharing, common industry requirements and environmental standards for procurement. Furthermore, collaboration is required on logistics/digitalisation as well as to international cooperation on harmonising climate measures so that vessels do not end up confined to the NCS. At the same time, being well in the forefront of technological developments in this area could be a competitive advantage for the Norwegian supplier sector.

Indicators will be developed in connection with following up the climate goal of a 50 per cent reduction for maritime emissions in the petroleum industry by 2030 compared with 2008.

3.4 Government's climate plan for 2021-30

A five per cent annual increase in CO_2 tax was agreed as part of the 2019 Granavolden policy platform for Norway's current non-socialist coalition. In January 2021, this government presented a White Paper on its policy for reducing GHG emissions during 2021-30 in line with Norway's climate targets and in collaboration with the EU. This plan shows how Norway will fulfil its climate target while also creating green growth. The main emphasis is on non-ETS emissions, but it also deals with the ETS – which covers the bulk of emissions from petroleum and other industries.

The government has announced a gradual stepping-up of the CO_2 price from about NOK 850 per tonne for the oil and gas sector at January 2021 to NOK 2 000 in 2030. Today's price includes the Norwegian CO_2 tax of NOK 543 per tonne and the EU ETS price, which was above EUR 30 per tonne at January 2021.

Under these proposals, CO_2 tax on emissions from oil and gas production subject to the EU ETS will rise

in line with the tax paid by non-ETS emissions, so that the overall carbon price (CO_2 tax plus the cost of allowances) in 2030 will be about NOK 2 000 per tonne of CO_2 in 2020 value.

KonKraft proposes that the increased government revenues from the significant rise in CO_2 tax should be earmarked for measures which contribute to a faster reduction in GHG emissions. Establishing an action fund to dispense revenues raised by the higher CO_2 tax, on the model of Norway's Business Fund for Nitrogen Oxides, could help to reduce emissions from the sector subject to the EU ETS while also supporting the development of new low- and zero-emission technologies such as CCS, hydrogen and offshore wind power.

The proposed tax hike will mean a substantial rise in costs on the NCS and could weaken Norwegian competitiveness. Norway's petroleum sector is among the industries which currently pay the highest overall CO_2 price globally though a combination of tax and allowances. It is important to avoid the NCS being outcompeted by special Norwegian charges, so that investment moves elsewhere. A higher CO_2 price could also have an effect on fields in the tail production phase, and lead to lower resource utilisation through their earlier shutdown. In that event, companies and the government would lose revenues from the oil and gas left in place.

A positive aspect is that the climate White Paper affirms that the main aim of petroleum policy is to make provision for profitable production of oil and gas in a long-term perspective, and that climate policy will made it profitable to develop and adopt technologies and solutions which reduce emissions. Furthermore, it notes that the petroleum sector has been a cornerstone of the Norwegian economy for several decades and will continue to play an important role in the years to come. That depends not only on competitive operating parameters for the NCS, but also on good collaboration between industry and government on instruments for reaching the climate goals.

3.5 New energy and industry policy platform

Norway reported a more ambitious climate target to the UN in February, which involves cutting GHG emissions by at least 50 per cent and up towards 55 per cent in 2030. At the same time as the country cuts emissions, it must create industrial growth and jobs based on the energy shift. A number of sectors will utilise more electricity, and power supply will be a key to success. The NHO's roadmap for future industry and green electricity value chains identify the green transition as one of the growth areas with the biggest potential in coming decades. Success calls for a successful transfer of technology and expertise between industries and companies.

It also requires larger supplies of green power and access to acreage for developing more energy and other industrial commitments.

Against that background, the NHO has taken the initiative on a process which aims to bring together industry interests in establishing a common energy policy platform. Providing a starting point for contributions to relevant political processes, this will be based on established climate goals and an aggressive industrial commitment, which will require greater use of electricity in a number of sectors.

The relevant employer associations and unions as well as large number of companies from several sectors are taking part. KonKraft has been invited to participate as an observer. The goal is to develop a unified industry policy position concerning which measures best realise various potentials and requirements for a Norwegian energy transition, how critical infrastructure should be further developed, and which industry policy parameters are necessary for realising the potential. This is important work for taking care of and agreeing on the conditions which must be put in place to secure a successful transition.

3.6 Support programmes

Achieving the climate goals requires that the companies have a long-term perspective on their activities in Norway. Competitive operating parameters which ensure profitable production on the NCS as well as technological development and innovation will be crucial for ensuring the industry's future competitiveness. This is very important in providing the assurance required for making long-term climate and technology investments related to recovering oil and gas, installing CCS and producing hydrogen from natural gas and offshore wind power.

The government's support programmes will be important when the industry is to reach ambitious goals for a 50 per cent emission reduction by 2030 and near zero in 2050. Strengthening this backing will be even more significant in achieving further emission cuts over and above KonKraft's climate targets. The industry would highlight the arrangements below as particularly important for further progress with low- and zero-emission solutions.

- Earmarking the increase in CO_2 tax for a fund, on the model of the Business Fund for Nitrogen Oxides, to support measures which can contribute to faster and further reductions in GHG emissions.
- Ensuring sufficient electricity generation to meet increased demand, given considerations of national security of supply as well as the industry's power costs and value creation.
- Strengthening Enova so that it can support the implementation of measures based on existing technology for ETS emissions. This will reduce risk and help to cost cuts for technologies with transfer potential. The support will thereby help to ensure wider implementation of technologies which have completed the qualification process but cost too much for individual companies.
- Ensure the continuation of the Business Fund for Nitrogen Oxides beyond 2025.
- Ensure further development of technology for and the roll-out of CCS in order to cut costs.
- Ensure further development of technology and demonstration projects for hydrogen, including early establishment/encouragement of markets through public procurement as well as quantified targets.
- Strengthen R&D funding through the Research Council of Norway's programmes for low- and zero-emission technology and fuels.
- Make provision for good support schemes and instruments for investment in developing, producing and implementing technologies for low- and zero-emission vessels.

> Strengthening government support programmes will be important when the industry is to reach ambitious climate goals

4

NEW VALUE CHAINS

4.1 Introduction

A lot has happened since the climate strategy was published in January 2020.

In June 2020, it was decided that the Utsira North and Southern North Sea II areas of the NCS would be opened for applications to develop renewable energy offshore. This makes it possible to seek licences for large offshore wind power projects on the NCS.

Utsira North must be developed with floating wind turbines, which is the most interesting technology with the largest market opportunities globally from a Norwegian perspective. The area is relatively large, making it possible to balance several interests and to locate wind farms close to established infrastructure. Southern North Sea II lies close to the boundary with the Danish sector, and offers opportunities for both fixed and floating turbines. It is particularly attractive for exporting power to continental Europe.

Taken together, the two areas offer opportunities for developing up to 4 500 MW of wind power with both fixed and floating technology. That corresponds to the power requirements of more than a million Norwegian households.

In September, the government presented a White Paper on the Longship project to realise carbon capture, transport and storage in Norway. The government proposed to begin by realising a capture facility at Norcem's cement mill in Brevik, but also made provision to support carbon capture from Fortum Oslo Varme's waste incineration facility on condition that the project secures external financing.

The climate strategy lays the basis for the way petroleum technology and expertise are helping to create a new and forward-looking energy industry on the NCS. Producing and utilising hydrogen will contribute to major emission cuts in both Norway and continental Europe. Examples of projects related to establishing new value chains for hydrogen and CCS which stand on the shoulders of the petroleum sector are described below.

> Petroleum technology and expertise are helping to create a new and forward-looking energy industry

4.2 CCS projects

4.2.1 Longship

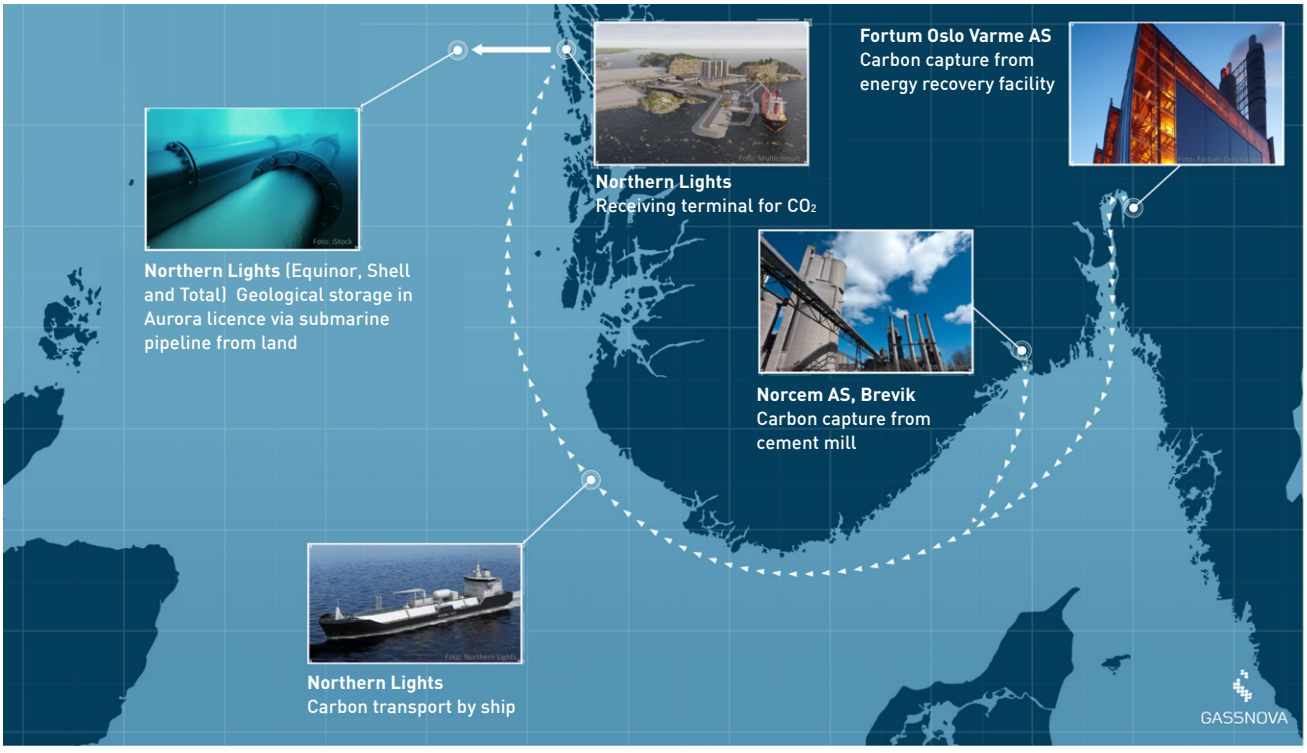
CCS is a key technology for reducing emissions from energy production and industrial processes based on fossil fuels. The UN's intergovernmental panel on climate change (IPCC) has noted that the amount of CO_2 captured and stored annually must increase a hundredfold by 2050 to reach climate targets. That will require much greater political attention and commitments, including from industry, to realise the CCS developments required to reach the climate and sustainability goals.

The Norwegian authorities have long been a global driver for developing CCS solutions, supporting technology advances and international collaboration in a number of arenas. It is therefore gratifying that the government has resolved to appropriate funds for realising an integrated CCS value chain in Norway. That shows it is working long-term and seriously to find climate solutions, and Longship is extremely important for Norwegian industry.

This government proposal to realise carbon capture, transport and storage in Norway was approved by the Storting in December 2020. NOK 16.8 billion of public money will help to establish a capture facility at Norcem's Brevik cement mill and a value chain for carbon transport and storage. This includes operating costs for 10 years. The Ministry of Petroleum and Energy (MPE) has entered into agreements with the Northern Lights partners and will formally approve the plans for development and operation and installation and operation (PDO/PIO) after the Storting's final approval in January 2021. The government is also prepared to provide NOK 3 billion for carbon capture from Fortum Oslo Varme's waste incineration facility on condition that the project secures external financing. Fortum Oslo Varme has applied to the EU's innovation fund for support to realise the capture plant.

FIGURE 08 LONGSHIP

Source: Gassnova



Financed by revenues from emission allowance sales, the EU innovation fund comprises EUR 10 billion for 2020-30. It will support low-emission technologies related to renewable energy production, low-carbon solutions for energy-intensive industries, CCS, carbon capture and utilisation (CCU) and energy storage.

Initial project evaluation is due to be completed in the first quarter of 2021, and applications continuing from this round will be informed if they are accepted in the fourth quarter. The KonKraft partners are pleased that the government is supporting Norcem's full-scale plant and the Northern Lights transport and storage collaboration between Equinor, Shell and Total. Even though Fortum Oslo Varme failed to receive full financing now, it is positive that the government wants to make a substantial contribution to the project.

This CCS investment lays the basis for an industrial infrastructure which will safeguard existing jobs and export earnings while creating new industries and revenues for Norway in the future.

Two capture plants are important for the industry, and will provide a better basis for success. Support for both would create more new jobs and strengthen Norwegian expertise and ability to build such facilities, while making the whole project more robust and cheaper per tonne of CO_2 stored. The two plants would provide a GHG cut corresponding to annual emissions by 400 000 cars, while the reduction from a single facility would equal the output from 200 000 cars per year.

These capture facilities also relate to two industries which cannot be decarbonised by other means, and have a substantial transfer potential for both waste incineration and cement output worldwide. Carbon transport by sea will give the Norwegian maritime sector an important new segment and an additional cornerstone in demanding times.

The KonKraft partners accordingly wanted a solution where both capture plants received full state support in order to secure benefits for Norway by establishing new value chains which provide value creation and jobs, as well as exports of technology and solutions, while allowing climate commitments to be reached. Europe has roughly 500 similar waste incineration plants which could benefit from lessons learnt with Fortum Oslo Varme. In addition, other facilities of this type in Norway will need to reduce their GHG emissions with the aid of CCS. The KonKraft partners would therefore urge the government to cover the difference if sufficient support fails to materialise from the EU.

In addition to the positive investment decision for Longship, the project has advanced further by attracting new partners. The Northern Lights trio already have letters of intent with seven European companies, which were supplemented in October 2020 by a similar agreement with Microsoft to see how the latter can support the venture as a technology partner. Microsoft is interested in and engages with promising CCS projects. The aim is not only to contribute technology and specialist expertise, but also to explore how new solutions such as Northern Lights can help the company reach its own goal of becoming carbon neutral by 2030. In addition, the partners will study and establish a process to promote policies which speed up the role of CCS in reaching Europe's climate goals.

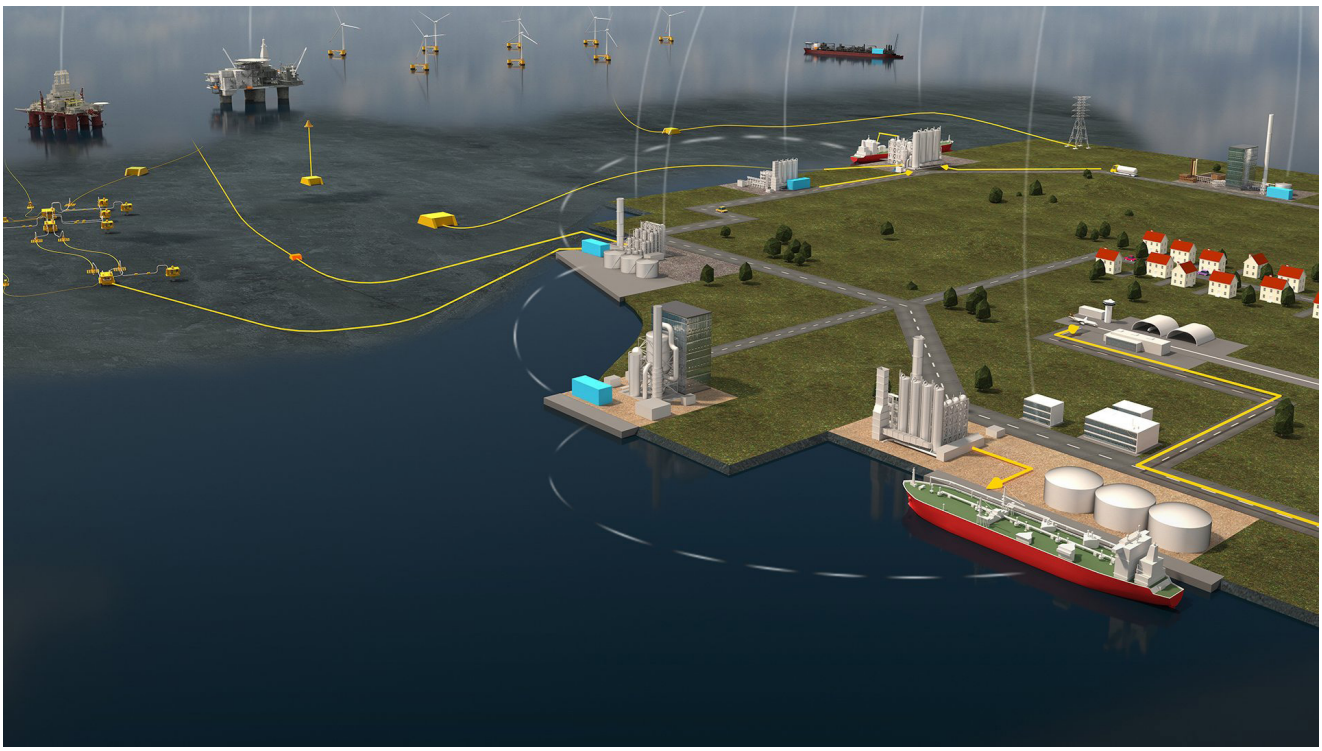


Illustration: Aker Carbon Capture

4.2.2 Carbon capture plants – Norway in the driving seat

Aker Carbon Capture pursued more than 20 projects in 2020 related to both large and medium-sized capture plants. The high point was signing an engineering, procurement and construction (EPC) contract for carbon capture, liquefaction and intermediate storage at Brevik (Longship/Heidelberg Cement Norcem). A number of projects are under way to investigate the feasibility of installing compact capture plants – JustCatch™ – with several customer projects in Norway, Denmark, Sweden and Switzerland. During 2020, Aker Carbon Capture tried out its mobile test unit (MTU) at the Preem refinery in Lysekil (carbon capture from a hydrogen production facility).

An extensive R&D programme is also underway with the aim of reducing costs in the solutions by up to 50 per cent in the middle of the next decade, in addition to further improvements and innovations.

The company's MTU has been used for more than 50 000 hours at various locations in the USA, the UK and continental Europe to test with various types of flue gases. Results from these tests provide important information for the projects and help to reduce risk when scaling up to full-sized plants.

Interest in carbon capture solutions as a long-term alternative to increased use of electricity is also being shown by the traditional oil and gas market. Extensive studies have been conducted both on the NCS and for international operators of floating production, storage and offloading (FPSO) units, and JustCatch™ has been developed to operate on FPSOs. Feasibility studies have been carried out for such a solution as one of several options for oil company Okea's Draugen platform.

FIGURE 09 CLUSTER PROJECTS IN NORTHERN EUROPE

Source: Northern Lights/Equinor

An overview of known cluster projects in northern Europe. Stand-alone projects are not included. Mature schemes such as Northern Lights, Porthos and Acorn show the potential for phases 1 and 2, whilst others are listed with the potential claimed for the various projects.

4.3 Hydrogen

The EU presented its hydrogen strategy in the summer of 2020, and has ambitions to increase the share of this gas in its energy mix from two to 14 per cent by 2050. While the strategy prioritises green hydrogen, it recognises the need for the blue variant – particularly while building up a market. Hydrogen produced on an industrial scale from natural gas with CCS will be part of the solution, particularly in sectors which are difficult to decarbonise. This provides a basis for Norwegian involvement in developing and delivering solutions for both green and blue hydrogen which Europe will come to need.

Norway's oil and gas sector is participating in several large industrial projects in Europe to develop value chains for hydrogen. The industry has also defined specific ambitions for introducing hydrogen produced from Norwegian natural gas with CCS as a fuel in shipping, for gas-fired power stations in Europe and at European manufacturers.

A condition for success with export ambitions for hydrogen from Norway is utilising gas resources on the NCS, including in the Barents Sea, and securing necessary infrastructure solutions which lay the basis for continued sales to the EU and the UK. This calls for competitive operational parameters which encourage development and innovation on the NCS.

Equinor has initiated a feasibility study which includes an assessment of what would justify the construction of a new hydrogen pipeline to Europe, able to meet a considerable share of European demand. Large-scale hydrogen production for export would require the construction of a high-capacity gas reforming plant. Using hydrogen in Norway should therefore be viewed in relation to exporting this gas through a new pipeline to continental Europe. A hydrogen production facility must be large enough to create synergies between different sectors, to permit cost-effective output, to facilitate increased industrialisation in Norway and to avoid reducing capacity for greater electricity use in society as a whole.

Norway joined the important project of common European interest (IPCEI) on hydrogen in late December 2020. The KonKraft partners take a very positive view of this collaboration, and believe it could help to speed up hydrogen-related developments and enable Norway to remain a stable energy supplier to Europe.

4.3.1 Establishing a hydrogen value chain for the maritime sector in western Norway

A consortium of BKK, Air Liquide and Equinor was established in 2019 with the goal of creating a hydrogen value chain along the west Norwegian coast. Aiming to make liquefied hydrogen available for commercial shipping in 2024, this has received substantial support through the Pilot-E programme. The Mongstad industrial park, which lies close to Equinor's Mongstad refinery, has been chosen as the possible location for a hydrogen production and liquefaction plant. Its first customer could be Wilhelmsen, which is planning to build two hydrogen-fuelled cargo ships with its Topeka concept to run every weekday between Stavanger and Mongstad (with the possibility of including Kristiansund and eastern Norway at weekends). This includes moving equipment between offshore bases in western Norway. The vessels would also carry hydrogen to filling stations along their route to supply local ferries and other ships. They can sail for up to 750 kilometres without emissions thanks to 1 000-kW batteries and three-MW fuel cells driven by hydrogen. The Topeka concept has received support from both the EU and Enova.

4.3.2 Hydrogen technologies offshore

Tomorrow's energy systems are about renewable energy sources combined with solutions for storing and distributing surplus energy. Hydrogen will be a key part of the solution. TechnipFMC is a global leader in system integration of infrastructure for producing and further processing of petroleum. Large-scale plants for hydrogen production from natural gas rank today as an important part of its portfolio, and work is underway on offshore production of hydrogen from renewable sources through the Deep Purple initiative. Supported by Innovation Norway in collaboration with Vattenfall, Repsol, NEL, ABB, Umoe and Slåttland, its pilot project aims to develop technologies and solutions for large-scale production of green hydrogen at sea from offshore wind power. The hydrogen produced will be piped to land or stored locally to supply stable and renewable power to off-grid users. In its present phase, the project involves piloting the system on land. Preparations are also under way for full-scale offshore piloting of the Deep Purple technology.

FIGURE 10 THE STELLA MARIS PROJECT

4.3.3 Stella Maris

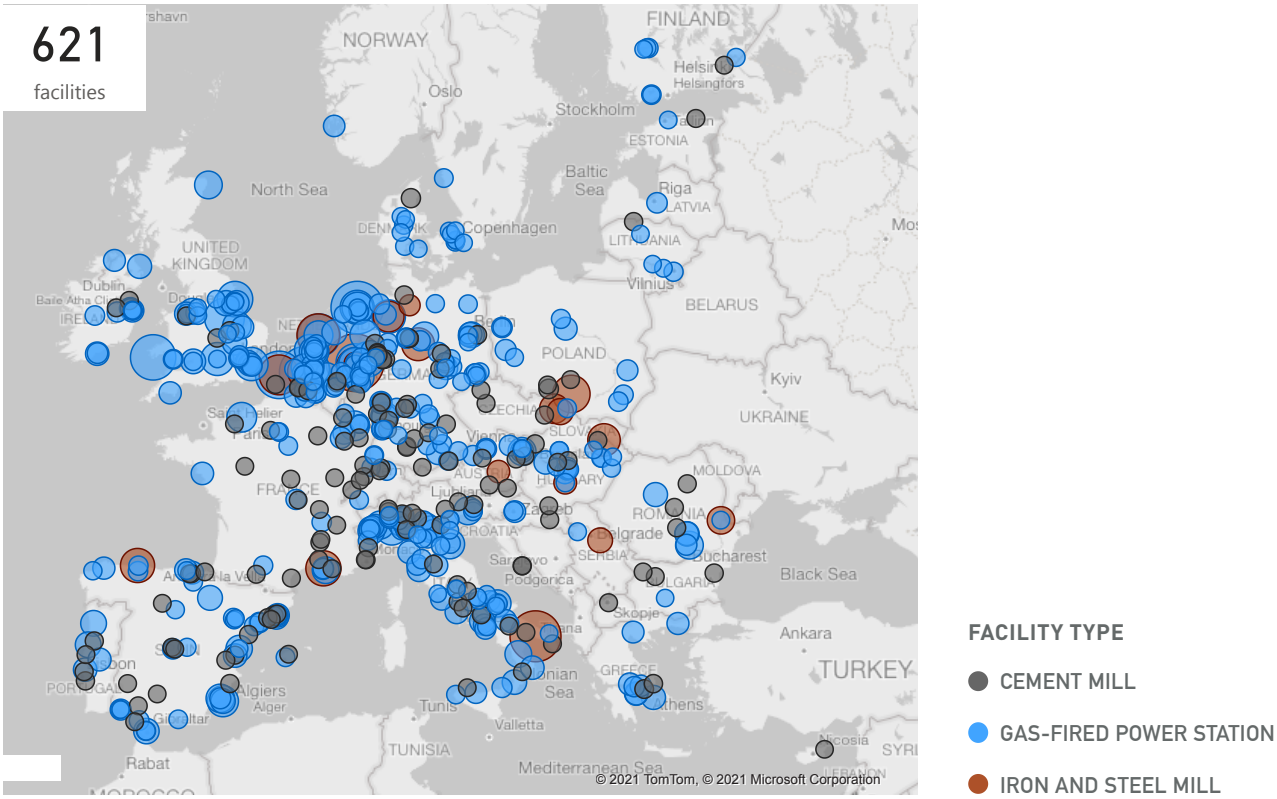
Altera Infrastructure conducted this study with participation from Gassnova, Sintef, TGE Marine Gas Engineering GmbH, Moss Maritime, Sevan SSP, DNV GL and APL Norway. Backed by NOK 4 million from Gassnova, it looked at how the oil flow could be reversed to transport CO_2 back to the oil fields for transfer to an installation and injection into an abandoned hydrocarbon-free reservoir.

Through this project, Altera Infrastructure and its partners sought to develop and scale up technology for shipping large quantities of CO_2 from various European sources to a floating reception and injection facility in the North Sea. This should be dimensioned to handle ships capable of loading 50 000 cubic metres of CO_2 under pressure and injecting up to 10 million tonnes of it per annum.

> Hydrogen will be a key component in tomorrow's energy systems

FIGURE 11 ENDRAVA HAS IDENTIFIED 621 PLANTS WITHIN 10 KM OF A NATURAL GAS PIPELINE

Source: Endrava



4.3.4 Potential for using hydrogen in Europe

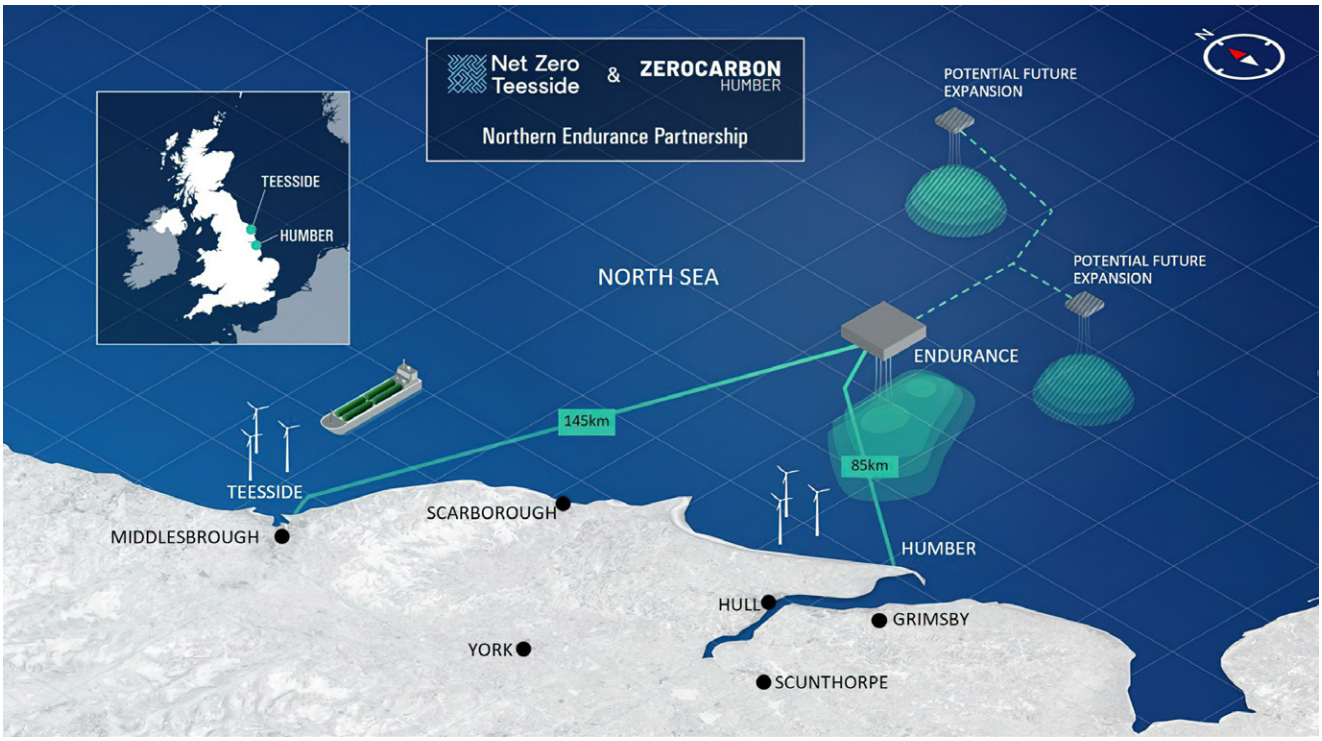
Endrava has been commissioned by Norwegian Oil and Gas to map and quantify current hydrogen production in Europe and to identify possible users at facility level. Attention was concentrated on iron/steel, cement and gas-fired power. Given substantial phasing-in as an emission-reduction measure in these sectors, future hydrogen demand could be substantially larger than present consumption. However, it competes with other reduction measures such as greater use of electricity, CCS (synergy effect) and bioenergy.

The Endrava analysis shows a future annual hydrogen potential of 13-46 million tonnes in Europe. Producing this by electrolysis would require 24-85 per cent of European electricity output in 2019. Using natural gas instead would correspond to 11-40 per cent of all gas consumption in Europe. Should the potential for using hydrogen in European industrial production be fully utilised, CO_2 emissions would be reduced by 100-260 million tonnes per annum. That is on top of the roughly 10 million tonnes of hydrogen already used annually today.

A geographical analysis utilising available data on the European gas network shows that most of the possible future hydrogen consumers are close to this infrastructure. Endrava has identified 621 plants within 10 kilometres of a natural gas pipeline, which represent 76 per cent of the iron/steel works, cement mills and gas-fired power stations identified as well as an annual hydrogen demand of 11-38 million tonnes.

FIGURE 12 THE NORTHERN ENDURANCE PARTNERSHIP (NEP)

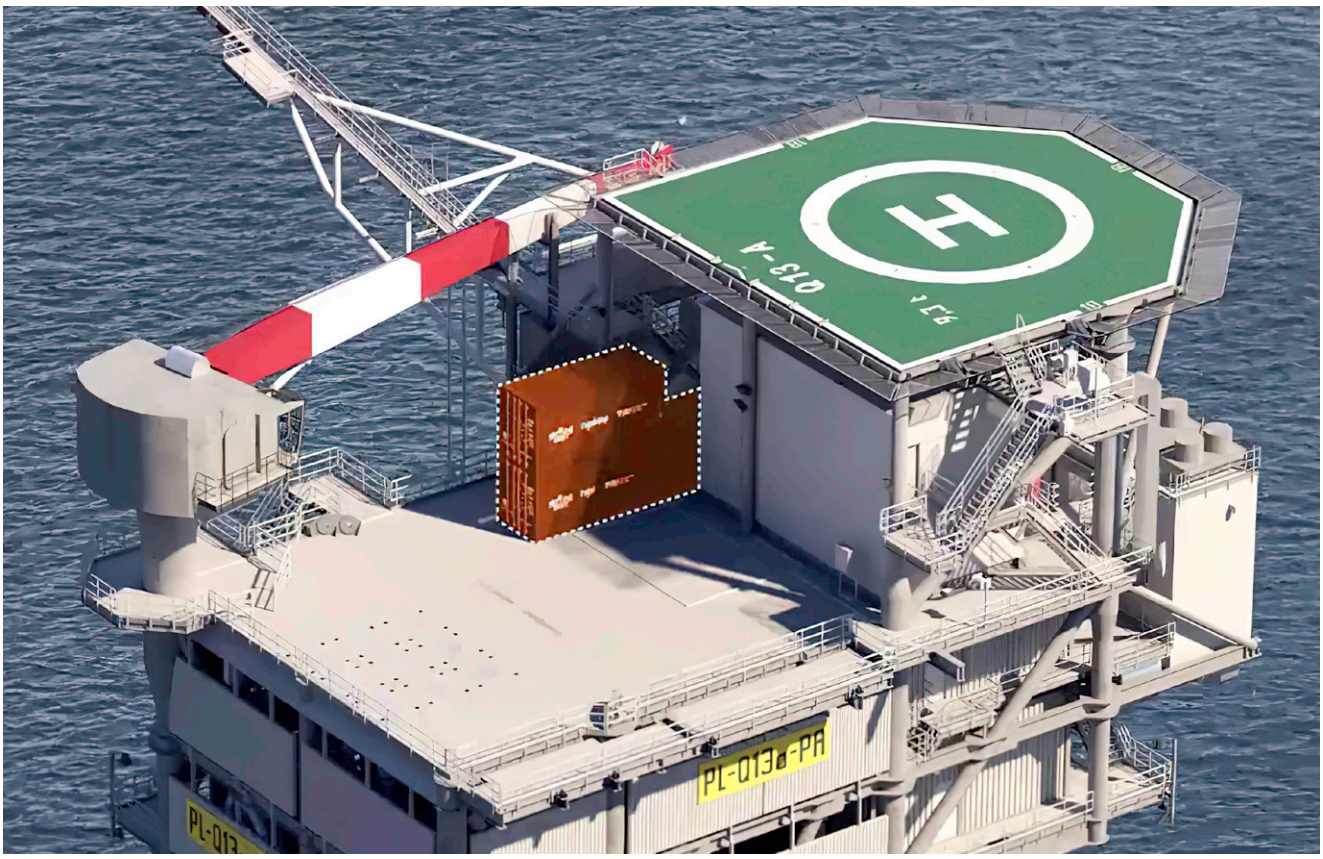
Source: Equinor



4.3.5 The Northern Endurance Partnership

BP, Equinor, Eni, the UK National Grid, Shell and Total established the Northern Endurance Partnership (NEP) in 2020 to develop offshore carbon transport and storage infrastructure in the UK North Sea, with BP as operator. This project is based on the Endurance storage licence held by Equinor, the National Grid and BP. A carbon transport and storage network will be linked to the Teesside and Humber industrial clusters to enable realisation of the decarbonisation projects established by the Net Zero Teesside (NZT) and Zero Carbon Humber (ZCH) partnerships.

NZT and NCH have plans to deliver on the UK government's ambitions for storing 10 million tonnes of CO_2 per annum by 2030, and to create a net zero cluster by 2040. As a first step, "anchor" projects are being developed. Equinor is leading the one for ZCH, known as Hydrogen to Humber (H2H) Saltend. This will develop the world's largest hydrogen facility with CCS, and permit a fuel shift for power generation and industry. BP leads the NZT anchor project to develop a gas-fired power station with CCS for large-scale clean electricity generation. Both projects are due to be realised by 2026.

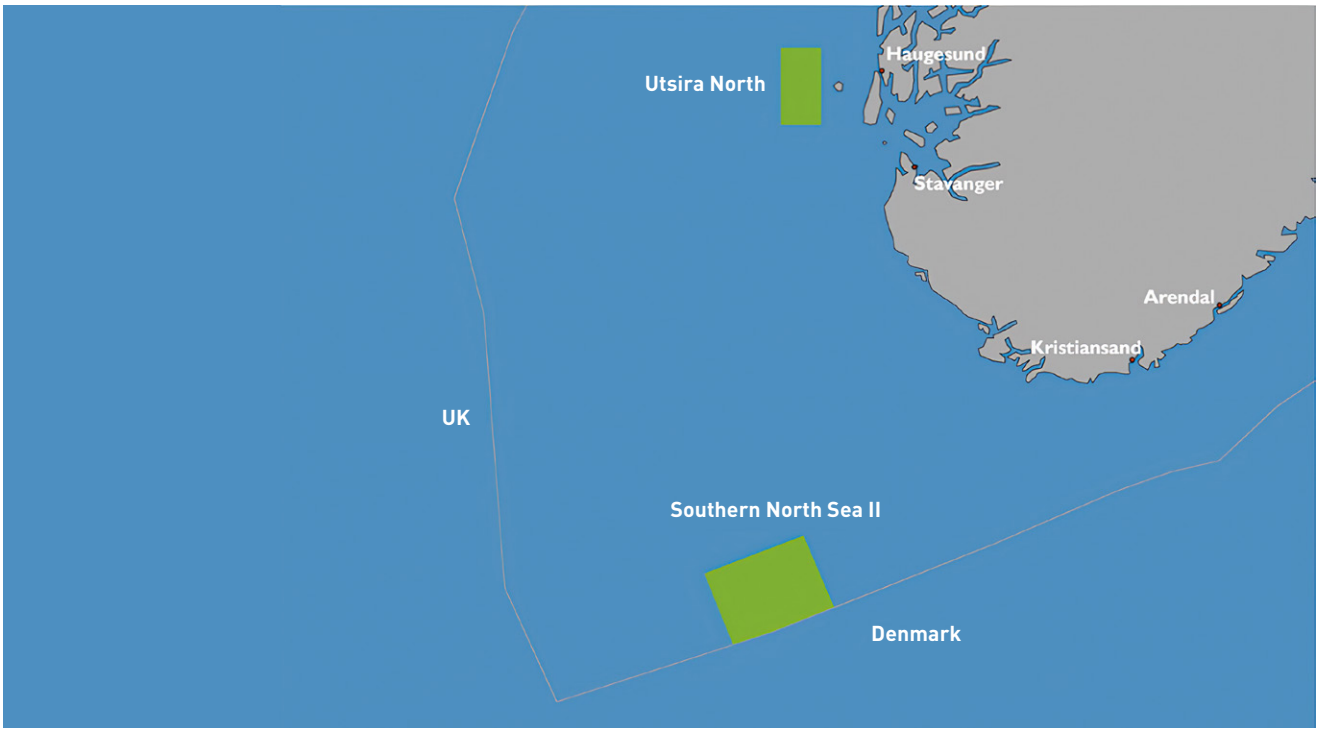


4.3.6 PosHYdon hydrogen pilot

Neptune Energy is playing a key role in implementing a Dutch pilot project which aims to use electricity from the Luchterduinen offshore wind farm to produce hydrogen on the Q13-a platform, and transport it to market on land via the existing gas infrastructure. Q13-a is the first all-electric platform in the Dutch North Sea. The aim of the pilot is to gain experience with integrating functioning offshore energy systems and producing hydrogen from wind power at sea.

FIGURE 13 OFFSHORE WIND POWER AREAS ON THE NCS

Source: Norwegian government



4.4 Offshore wind power – natural step forward for NCS as an energy area

Power from offshore wind farms will become a substantial part of the energy mix in Europe and globally over coming decades. The ambition in the EU's strategy for offshore renewable energy is to move from 12 GW of wind power today to 60 GW in 2030 and 300 GW by 2050. Britain's objective is to supply all households with offshore wind power from 2030 and develop 100 GW by 2050. The International Energy Agency (IEA) estimates that NOK 10 000 billion is to be invested in such developments up to 2040. That opens big new opportunities for the NCS and the Norwegian supplier industry. The overall goal of developing an offshore wind power sector in Norway must therefore be to establish this as a profitable and competitive industry which is attractive to national and international investors. It must create jobs in the development and generation phases on the NCS as well as in exporting offshore wind power technology. Coexistence with the fishing sector must be ensured, and synergies created between commercial interests in the ocean space. An offshore wind power industry in Norway must also help to reduce GHG emissions nationally and globally.

4.4.1 Ambitions for offshore wind power

Norway needs a long-term ambition for generating and exporting offshore wind power. KonKraft believes that the ambition for 2030 must be to have established up to 1 500 MW of floating capacity at Utsira North and fixed-turbine export projects for up to 2 100 MW in Southern North Sea II. Furthermore, at least another three GW should have been licensed by 2030 in new areas opened for wind turbines. The long-term ambition must be to develop 30 GW of offshore wind power on the NCS by 2050.

Another ambition should be that Norway's supplier industry has around 10 per cent of the global

offshore wind power market and an annual turnover of EUR 9 billion. A quantified and timetabled ambition sets a direction. This is important for calibrating government support and for ensuring long-term investment on the NCS.

4.4.2 Offshore wind power opens new opportunities

Since Norway currently has a power surplus, developing wind farms on the NCS cannot be based solely on national demand for electricity. The long-term goal must be to export it to the European market. This requires that an infrastructure for supplying offshore wind power to Europe is put in place, and that developing NCS wind farms is commercially and socio-economically profitable. A future potential could also be offered by "power to X" projects which offer opportunities for green hydrogen production based on future offshore wind farms.

In the short term, installing wind farms on the NCS will relate to industrial development and opportunities for supplying electricity to petroleum installations. Industrial projects related to offshore wind power will ensure that technology and expertise built up around the oil and gas sector continue to create jobs and value even as petroleum activities on the NCS gradually decline. Norway's competitive advantages include maritime operations, risk management, project execution, knowledge and expertise. The NHO's work on green electric value chains assesses the potential turnover for offshore wind power as up to NOK 100 billion in 2050. Sintef has calculated that this sector could provide almost 50 000 full-time equivalent jobs per annum in the same year. Calculations by Menon Economics show that developing a 500 MW wind park could yield 6 000 jobs and more than NOK 6.5 billion in value creation.

Where industrial development is concerned, distinguishing between fixed and floating offshore wind turbines will also be important. Floating turbines are the only feasible solution for Utsira North, while fixed units will probably be the technological choice for Southern North Sea II. While floating wind power is not competitive today, costs are expected to fall substantially in coming years as several large-scale farms are installed offshore. The Norwegian supplier industry has the potential to take a substantial share of both a national and a global floating wind power market. This potential can best be realised if the basis is laid for establishing a domestic market with operating parameters which ensure the development of large-scale floating wind farms on the NCS. In March, the project on developing Norwegian delivery models for offshore wind power is due to present its results related to technology and products (including mapping results), supplier chains, marine operations, international delivery models, and ports, fabrication yards and construction sites.

4.4.3 Hywind Tampen

Equinor's Hywind Tampen project is a floating wind farm with a capacity of 88 MW intended to supply electricity to the Snorre and Gullfaks fields in the North Sea. This will yield a substantial reduction in CO_2 emissions, estimated at 200 000 tonnes per year (about 35 per cent of the total from these two fields or from 100 000 cars). Scheduled to be the world's first floating wind farm to deliver power to offshore petroleum facilities, Hywind Tampen is due to become operational in the third quarter of 2022. This will also be the world's first floating wind farm and an important step forward in efforts to industrialise solutions and cut costs related to future offshore wind power projects.

Offshore wind power could acquire a bigger role in supplying electricity to oil and gas facilities over the next decade, providing the necessary operating parameters are in place.

4.5 Energy efficiency and low-emission technology

4.5.1 Low-carbon strategy is delivering

Operators on the NCS have worked systematically for many years on implementing energy efficiency measures both large and small, which has helped to put Norway in the lead globally for low emissions per unit produced.

Equinor had some 70 projects offshore in 2020, including operational measures, process improvements, production, drilling and well optimisation, and reduced flaring. While eight were modifications, the rest involved operational adjustments identified and implemented during the year.

Over the past six years, Equinor has pursued CO_2 reduction programmes which have eliminated emissions averaging 200 000 tonnes per annum. That adds up to 1 125 000 tonnes in yearly avoided emissions.

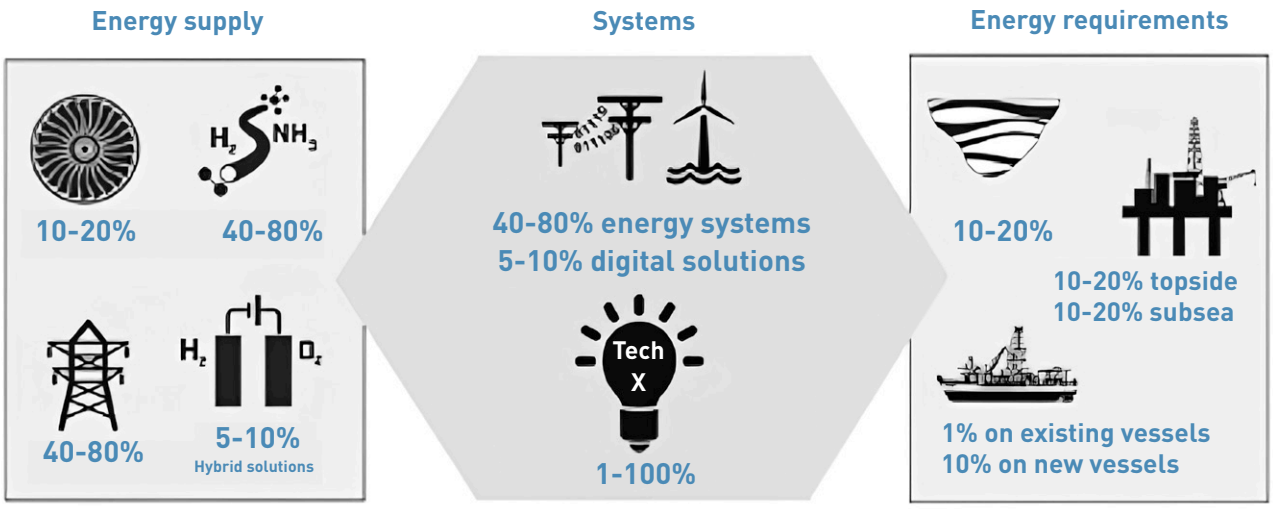
The company has adopted 83 measures at the onshore plants – including Hammerfest LNG – which have reduced CO_2 emissions by 540 000 tonnes. Operational improvements have been important. Value chain optimisation has included lowering inlet pressure in the gas pipelines entering the Kårstø gas processing plant, thereby reducing counterpressure offshore as well as energy requirements, with the associated release of CO_2.

ConocoPhillips implemented energy efficiency measures in 1999-2020 which added up to 160 000 tonnes of avoided CO_2 emissions per annum.

> Operators in the NCS have worked systematically for many years to implement energy efficiency improvements both large and small

FIGURE 14 TECHNOLOGY CATEGORIES BEING PURSUED BY THE LOW EMISSION CENTRE AND POSSIBLE BARRIERS TO IMPLEMENTATION (ESTIMATED BY RESEARCHERS AND WEIGHTED FOR FEASIBILITY)

Source: Research Council to MPE



4.5.2 Petrocentre – Low Emission Centre

The Low Emission Centre works purposefully to help cut GHG emission from and increase energy efficiency in petroleum operations on the NCS. Partners in the centre include a large number of representatives for operator companies, the supplier industry, Sintef and the NTNU, government agencies and associated research facilities abroad. The centre will share its knowledge with scientists, industry, society, politicians and the general public, and thereby help decision-making and the shaping of emission policy in Norway's petroleum sector.

The centre's activities and work packages cover a wide breadth of technological and knowledge areas. Its nine work packages can be categorised as heat and power generation, system integration and reduced energy consumption/requirements. They span different technologies and methods, which also differ in terms of maturity and which can contribute to both short- and long-term emission reductions.

Several of the technology categories could potentially contribute positively to emission cuts by 2030. Several barriers to implementation exist, as well as challenges related to research and technology development. Cost is the most important barrier.

Digitalisation plays a key role in tying the various opportunities together. Replacing gas turbines with renewable or emission-free power and heat sources represents the largest single contribution to reducing GHG emissions, but achieving it faces many challenges.

Viewed overall, the whole Research Council project portfolio embraces a great many new technologies/methods which could be closely integrated with operations on the NCS and which have the potential to cut GHG emissions in both short and long terms (from the Research Council's report of January 2021 to the MPE on reducing GHG emissions by 2030).

4.5.3 Compact steam turbines - Compacts2

The goal of Sintef's Compacts2 project is to assess a method for developing more compact, more robust and lighter steam bottoming cycles, with the aim of introducing this technology to petroleum production on the NCS. On the offshore facilities where it is being installed, the technology could potentially increase energy efficiency and reduce fuel consumption/CO_2 emissions by up to 25 per cent. Work in the project includes case studies on a fixed platform and an FPSO to assess whether the technology meets the objectives. If Compacts2 succeeds, it could be one contribution to reducing CO_2 emissions by 2030 from facilities where power from shore is not relevant.

ConocoPhillips installed a heat recovery plant with a steam turbine in 1999 and upgraded this substantially in 2015. That yielded CO_2 emission cuts in the order of 45-50 000 tonnes per annum, and has contributed useful operating experience to Compacts2.

4.5.4 Digital twin at Nyhamna

Kongsberg Gruppen delivered a dynamic digital twin in 2019-20 to Norske Shell's big Nyhamna gas plant. This digital model of/platform for the Nyhamna facility is continuously updated with data and status reports from the physical plant. That makes it possible to monitor the various parts of the facility continuously, test various scenarios and identify opportunities to improve operation. Virtual sensors can also be added to supplement those physically present in the plant. These systems can be used to increase production, manage energy consumption and reduce emissions as well as to create a simpler and more efficient working environment which cuts costs and improves health, safety and environmental aspects. Kongsberg Digital signed a global frame agreement in 2020 on a worldwide roll-out across Shell.

4.5.5 Reusing production tubulars

Repsol is devoting great attention to the circular economy as a tool for reducing raw materials consumption and emissions throughout the value chain, and has implemented more than 200 such projects globally. In connection with shutting down the Gyda field, Repsol Norge AS has ensured that casing and tubing retrieved from the wells are sold for reuse rather than being scrapped.

Reusing these products – as piling in construction projects, for example – avoids emissions from producing new tubular goods and resmelting used items. For Gyda alone, this is estimated to avoid 10 000 tonnes in CO_2 emissions.

Repsol Norge is now working for this to become best practice in dealing with redundant tubular goods in Norway.

5

VALUE CREATION ON THE WAY TO A LOW-EMISSION SOCIETY

Norwegian gas exports to Europe illustrate the significance of the assets on the NCS. In 2019, these sales totalled 114 billion standard cubic metres (scm) worth more than NOK 171 billion. Gas from Norway meets about 22 per of EU and British demand, and roughly two-thirds of estimated Norwegian gas reserves remain to be produced. Most of the gas sold to Europe is used in residential and commercial buildings, industry and power generation.

Gas produced from the NCS flows through an integrated transport network encompassing more than 9 000 kilometres of pipelines, three processing plants on the Norwegian west coast and a gas liquefaction plant in Finnmark county with northern Europe's largest liquefied natural gas port, which exports seven million tonnes of LNG per annum by ship. This system is largely powered by electricity and has receiving plants for pipeline gas in four European countries, which are connected to onshore transmission networks.

FIGURE 15 GAS INFRASTRUCTURE FROM THE NCS TO THE EU AND THE UK

Source: Gassco

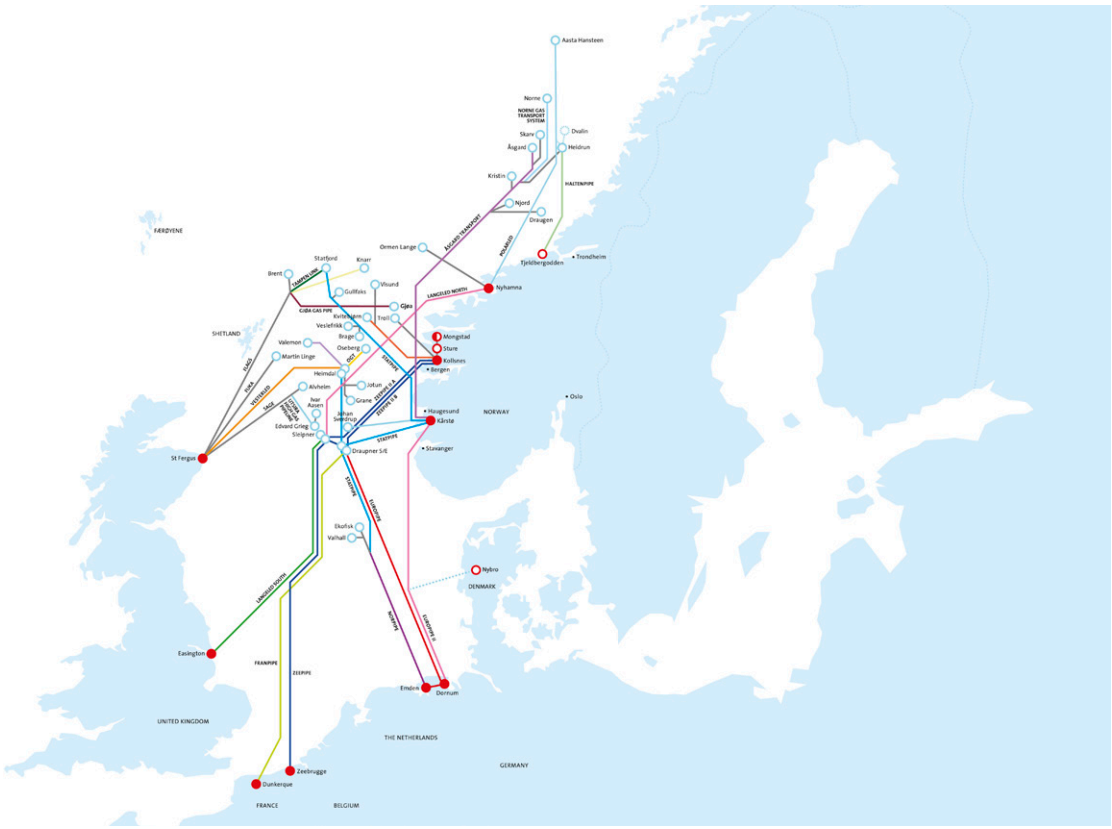
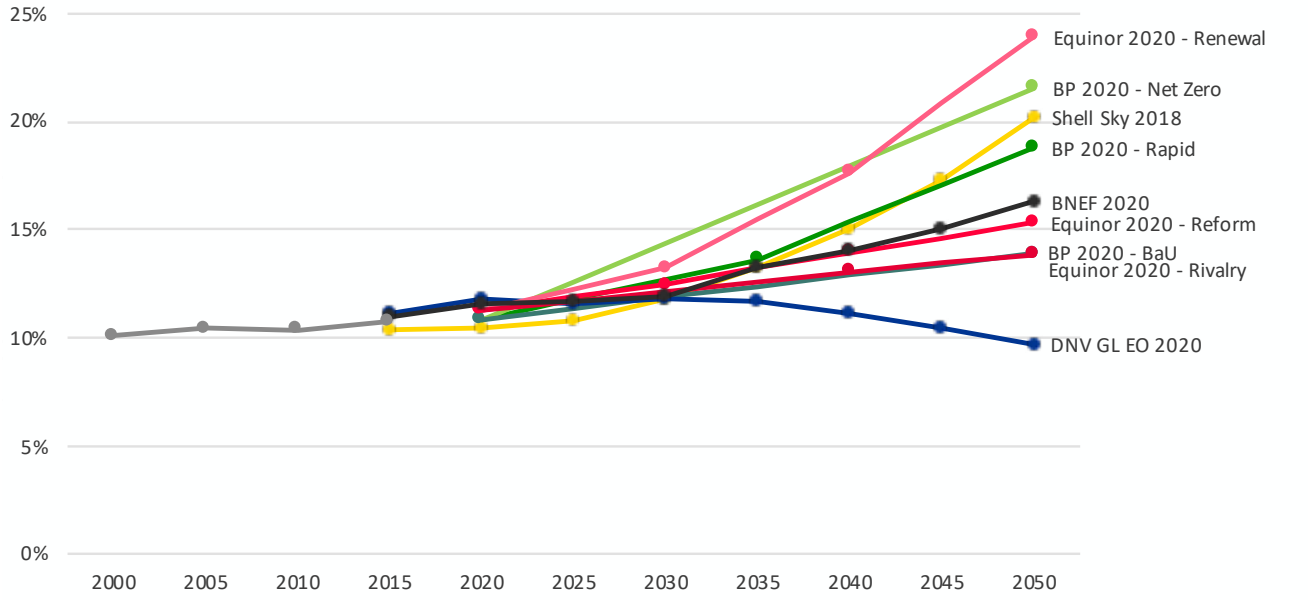


FIGURE 16 PROPORTION OF OVERALL OIL AND GAS DEMAND USED FOR NON-ENERGY PURPOSES
(SHARE OF OIL AND GAS FOR NON-ENERGY USE)

Source: Endrava (2021)



The UK has largely phased out coal-based power and heat generation, thanks in part to imports of Norwegian pipeline gas and increased output of renewable energy. *Demand for coal-fired power during winter peaks has also been reduced* because it is less competitive than gas-fired and renewable electricity.

Due to come on stream in October 2022, the *Baltic Pipe Project* will transport gas from fields on the NCS via Europipe II and a new gas pipeline to Poland. The climate report for this project reaches the following main conclusions:

- by replacing coal, oil and wood with electricity for heating buildings, particle emissions will be cut by 54 per cent – which is expected to save many thousands of lives annually in Poland
- by utilising gas in combination with wind power, Polish CO_2 emissions will be reduced by 70 million tonnes per annum
- defined as a project of common interest by the EU, the project will help to increase energy security and strengthen the European energy market by connecting Poland to gas fields on the NCS
- the pipelines could potentially be used for future transport of other gases, such as hydrogen.

With an expected decline in burning oil and gas to generate power and heat, and growing global demand for petrochemical products, the proportion of petroleum production used for raw materials rather than combustion is likely to rise.

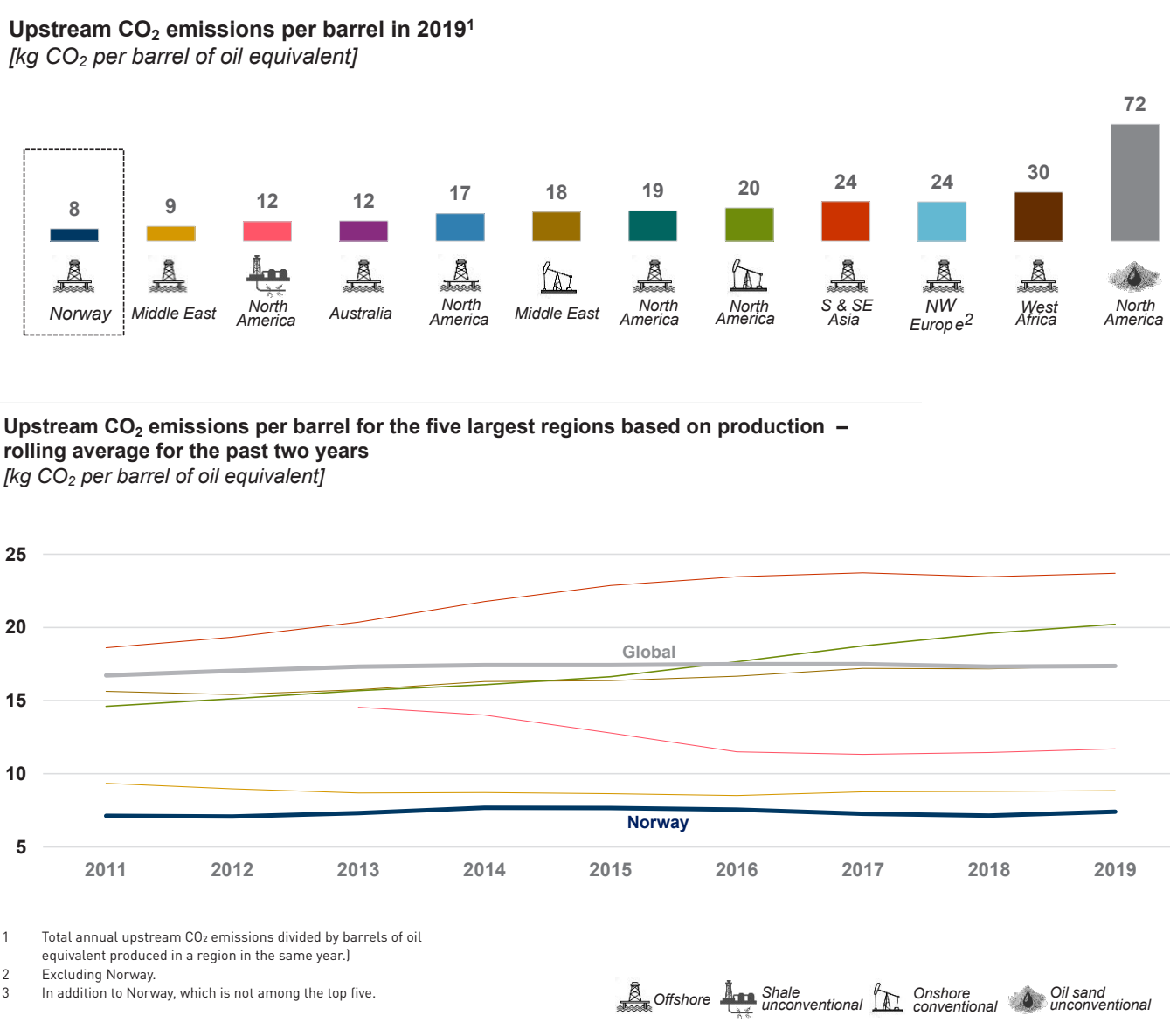
Natural gas is used to manufacture artificial fertiliser, making it an important part of the global value chain for food production. The heaviest oil components, such as bitumen, are turned into asphalt for road surfacing, important building materials and roofing. Oil and gas will also be needed as raw materials for composites and plastic parts in cars, aircraft, textiles, shoes and computers as well as many other products,

such as skis, kayaks and bicycles. Although a growing number of countries are limiting the utilisation of single-use plastics, total global demand for products composed of plastic materials is growing in line with rising prosperity. Many cosmetic and pharmaceutical products, paints and adhesives also derive from oil and gas.

Emissions from Norwegian petroleum production are low and will be even lower with the new climate measures. The latter give Norway's oil and gas sector a competitive advantage, since its products will still be needed for new and existing energy forms and as a raw material in manufacturing chains for a world which must also meet the climate goals in the Paris agreement.

FIGURE 17 CO_2 EMISSION INDICATORS FOR THE NCS COMPARED WITH OTHER OIL AND GAS REGIONS

Source: Rystad Energy



1 Total annual upstream CO_2 emissions divided by barrels of oil equivalent produced in a region in the same year.)
2 Excluding Norway.
3 In addition to Norway, which is not among the top five.

5.1 White Paper on long-term value creation from Norwegian energy resources

The government has announced that a White Paper will be presented to the Storting in the spring of 2021 concerning long-term value creation from Norwegian energy resources. The goal of this policy document is to manifest the industrial potential of these assets as the basis for future profitable jobs. That applies to oil, gas and renewable energy.

This White Paper will explain how the government intends to make provision for continued value creation and industrial progress based on Norway's energy resources. Important topics will be the future development of the Norwegian petroleum sector, the climate target of reducing emissions from oil and gas operations by 50 per cent in 2030, the power generation system on land and increased used of electricity by society, offshore wind power, and the roadmap for hydrogen.

The KonKraft partners provided a joint submission to the work on the new White Paper, and emphasised that the expertise and technological innovativeness of the Norwegian petroleum industry are crucial for Norway's contribution to the world achieving the goals set in the Paris agreement and reaching the UN's sustainable development goals.

The world will continue to need oil and gas in 2050, including in the Paris agreement's low-emission scenario. If Norway is to succeed in developing a new and forward-looking offshore energy industry, change and industrial development must take place in a continuous interaction between new and existing industrial expertise.

KonKraft pointed to six areas which are particularly crucial for maintaining the competitiveness of the NCS, so that Norway remains an attractive area for investment by the domestic and international oil and gas industry – including supplier companies and the maritime sector.

1. Ensure access to attractive acreage.

2. Ensure predictable and profitable operating parameters which secure a high level of activity and a broad range of players on the NCS.

3. Strengthen government support programmes.

4. A continued commitment to carbon capture and storage (CCS) and hydrogen from natural gas as an energy source.

5. Establish operating parameters which ensure offshore wind power developments on the NCS.

6. Support continued development of the oil and gas industry's value chains and expertise clusters.

In competing with other oil and gas provinces, it is crucial that the NCS is both commercially attractive and delivers in the top tier on climate footprint. Norway's oil and gas industry will occupy a key place for Norwegian value creation in this role. KonKraft has collaborated with Rystad Energy for some time in assessing the attractiveness of the NCS in relation to other areas. The NCS scores highly on most comparisons and, in this context, its low CO_2 emissions stand out particularly as an important competitive edge.

Norway reported a more ambitious climate target to the UN in February, which involves cutting GHG emissions by at least 50 per cent and up towards 55 per cent in 2030. At the same time as the country is cutting emissions, it must create industrial growth and jobs on the basis of the energy shift. A number of sectors will utilise more electricity, and power supply will be a key to success. The green transition will be one of the growth areas with the biggest potential in coming decades. Success calls for a successful transfer of technology and expertise between industries and companies. It also requires increased supplies of green power and access to acreage for developing more energy and other industrial commitments.

5.2 How are developments in Europe affecting Norway as an energy nation?

The EU reached agreement in December 2020 on cutting its GHG emissions by 55 per cent in 2030 compared with 1990. These new climate targets mean that the EU must restructure its energy systems. The European Commission has already produced several strategies for reaching the goals. Huge quantities of renewable energy are to be developed offshore, hydrogen production will increase many times over, and the energy infrastructure is to be customised for a renewable future with greater local output of both solar and wind power.

Up to 2030, the EU's climate ambitions will probably have only minor consequences for the Norwegian petroleum sector since the Commission expects oil and gas to still dominate the energy mix in 2030.

At the same time, the EU's own gas production is declining. *It was down by 11 per cent from the year before in 2019 and has continued to fall.* Norwegian gas will therefore remain attractive. While competition over delivering gas to Europe will naturally persist, Norway is well placed to participate.

In addition, *the EU's latest analysis* – prepared in connection with updating the climate targets – shows that it will continue to import natural gas in 2050.

Nevertheless, Norway's petroleum sector will need to adapt and adjust to developments in its most important European markets.

In its climate strategy of January 2020, KonKraft set specific ambitions for reducing emissions from the end use of oil and gas. Hydrogen from natural gas with CCS, and the use of CCS in industry, are crucial if the EU is to reach its climate goals. Natural gas must be more or less decarbonised by 2050, and the EU regards hydrogen as an important energy bearer. Its climate strategy lays a basis for how Norway can create a new and forward-looking energy industry on the NCS, including hydrogen, CCS projects and offshore wind power developments.

The UK has produced *a 10-point plan for a green industrial revolution*. It is committed to and scaling up hydrogen production, so that a whole town will be fully heated by the gas before the end of this decade. Equinor became involved as early as 2018 in the *H21 North of England*, which demonstrates how 3.7 million homes and 40 000 companies in that region could become emission-free by 2034. *The first English hydrogen pilot* is due to start in the first quarter of 2021, with more than 650 households and companies at Winlaton near Newcastle set to receive gas mixed with hydrogen over a 10-month period.

Norway's Longship project aims to lay the basis for establishing a central store for European CO_2. The EU has identified CCS as a key technology for reaching the climate goals. Norway has the capacity to receive emissions from large industrial players which lack other decarbonisation opportunities. And letters of intent have already been secured with substantial players such as Heidelberg Cement, Air Liquide, Stockholm Exergi, Arcelor Mittal, Ervia, Fortum Oyj, Preem, ETH Zürich and Microsoft.

This demonstrates that the oil and gas industry is constantly developing in order to deliver solutions in line with the EU's climate goals, and that it has a role to play in the fight against climate change. And that will also allow it to continue to create value and jobs for Norway.

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