**Road map for the Norwegian Continental Shelf (NCS)**

**Value creation on and reduced greenhouse gas emissions from the NCS up to 2030 and 2050**

**Introduction**

Global warming is one of the greatest challenges of our time, and sharp cuts in anthropogenic greenhouse gas emissions are essential. Emissions from the petroleum industry must therefore be reduced, and oil and gas must be utilised in the most energy-efficient way possible. The Norwegian petroleum sector will contribute to global climate targets, while the long-term value creation potential on the NCS is realised through intelligent management of Norway’s natural resources and industrial expertise.

**Purpose of the road map**

The NCS road map has been developed by the Norwegian Oil and Gas Association and the Federation of Norwegian Industries through KonKraft. The other participants in this collaboration body are the Norwegian Confederation of Trade Unions (LO), including the United Federation of Trade Unions and the Norwegian Union of Industry and Energy Workers, and the Norwegian Shipowners Association. It has two main goals:

* 1. Establish ambitions for the industry’s long-term production and value creation on the NCS up to 2030 and 2050
  2. Establish ambitions for reducing greenhouse gas emissions in the petroleum sector up to 2030 and 2050.

The road map deals first and foremost with the ambitions for reducing greenhouse gas emissions from the petroleum sector, and contains an action plan which describes the specific steps the industry will take to follow up the established goals. At the same time, the Konkraft partners are following up the ambitions set for production and value creation by initiating a dedicated process in the industry which will ensure long-term and genuine improvements in the Norwegian oil and gas sector’s competitiveness.

Attention in the road map is concentrated primarily on the value chain from drilling to field cessation, since these are the areas which the companies operating on the NCS have the greatest influence over. The petroleum industry in Norway will nevertheless look at how it can contribute to technology developments which reduce emissions from end users of oil and gas. Technology and solutions which cut emissions from production, transport and end use of oil and gas can also be exported and contribute to reducing emissions outside Norway.

KonKraft has drawn up a climate report which provides a more detailed description of petroleum operations on the NCS in light of the climate and energy challenge, as well as various technologies which can contribute to emission reductions both in Norway and globally.

**Background**

Global population growth and rising prosperity mean increased energy demand. The world’s population is expected to expand from seven to nine billion people by 2050. Access to sustainable energy which everyone can afford and halting anthropogenic climate change are two of the UN sustainability goals agreed by world leaders in 2015. A large proportion of today’s energy consumption is met from fossil sources and releases greenhouse gases, which contribute to global warming.

The UN’s COP21 climate summit in Paris adopted ambitious climate targets. While the goal of preventing the average global temperature from rising beyond 2°C still stands, the nations also agreed to seek to bring the increase down towards 1.5°C. The Paris agreement also specifies that the climate goals will be reached in a way which does not undermine employment and prosperity. Between 2050 and 2100, anthropogenic greenhouse gas emissions must not exceed the level which can be absorbed naturally and through carbon capture and storage (CCS). This provides the framework for tomorrow’s low-emission society.

Big commitments are being made globally to renewable energy and enhanced energy efficiency. At the same time, energy systems will also require a large proportion of oil and gas in a long-term perspective. Within the 2°C scenario defined by the International Energy Agency (IEA), oil consumption in 2040 will be somewhat lower than the present level while gas output is expected to be higher. Fossil energy bearers will decline significantly in total, but coal will account for the bulk of this reduction. Even in scenarios which meet the climate targets, a significant proportion of fossil fuels will be required to meet world energy requirements in 2050. Gas will be important in the future low-emission society, since it emits half as much CO2 as coal per unit of energy produced. Gas-fired electricity is far more flexible than coal-fired power generation, and thereby represents a very suitable system partner in the power supply sector for renewable solar and wind energy, which cannot be regulated. Gas utilised directly for heating is very energy efficient, too, and thereby has very low CO2­ emissions per calorific unit.

Oil and gas are also important feedstocks for chemicals, plastic raw materials and other finished products. Demand for these will also rise with the expected growth in population and prosperity.

Global oil demand shows a steadily rising trend. However, several factors – such as the shale oil revolution in the USA and the Organization of the Petroleum Exporting Countries’s (OPEC) change of strategy to protect market share – have caused supply to increase faster than demand in recent years. The result has been a sharp drop in oil prices, which has substantially reduced the level of investment in the industry worldwide. In the longer term, expectations are that the balance between supply and demand will be restored and that oil prices will rebound to higher levels. That will in turn trigger investment in new and existing facilities to balance supply and demand, and to ensure the availability of new resources.

Norway’s petroleum sector has been a massive success, which has benefited the Norwegian society in the form of jobs, robust centres of expertise and value creation. The Norwegian supplier industry operates globally in a number of areas, and ranks today as the second most important export sector for the country, after export of petroleum. Value creation by the petroleum activity has given the Norwegian government the opportunity to build up and maintain good welfare systems and to accumulate revenues in the government pension fund – global.

Forecasts from the Norwegian Petroleum Directorate indicate that less than half the resources on the NCS have been recovered so far. Gas is expected to represent more than half the remaining resource potential.

Norway is a leader for recovery factors from oil and gas fields on the NCS. That reflects a purposeful commitment to technology development and implementation, as well as close collaboration between different technical disciplines. Important areas include improvements to methods for data acquisition and modelling in order to identify new drilling targets, big advances in drilling technology, extensive use of gas or water injection for pressure support, and low-pressure production in the late life of the fields.

The Norwegian offshore fleet is part of a complete national maritime cluster where great attention is devoted to the environment and the interaction between the players have been crucial in securing the development of new environment-friendly technologies and forward-looking concepts. The innovative drive in this cluster has resulted in battery-powered vessels and ferries, energy-efficient and low-emission gas-fuelled engines, new hull and propeller designs and various solutions combining gas, batteries and fuel cells.

Sustainable solutions and more environment-friendly vessels are expected to be in even bigger demand by the oil companies in the future.

Norwegian petroleum production already leads the world for low greenhouse gas emissions. The average amount released per unit produced is less than half the global figure. This sector is subject to a number of policy instruments, such as the EU emission trading system (ETS), carbon tax, strict flaring provisions, emission/discharge permits with requirements for energy management, and requirements to use the best available technology and to assess power from shore for new developments. These instruments have had a substantial effect, and the industry is documented to have implemented measures which have cut its emissions by more than five million tonnes of CO2 in total since 1996. Since measures to improve recovery would normally increase energy consumption per barrel produced, maintaining low emissions per unit produced on the NCS while substantially boosting recovery factors represents a considerable achievement.

Given that starting point, further emission reductions from the petroleum sector will be demanding and probably involve a high marginal cost if existing technological solutions are used. In a 2050 perspective, emissions along the whole value chain from drilling and production to field cessation and end use of oil and gas must be substantially reduced from their current levels.

**Climate policy parameters**

All parties to the Paris agreement have been asked to sign by April 2017. Once the agreement comes into force, each country’s Intended Nationally Determined Contributions (INDCs) will no longer be regarded as indicative but as its official and binding climate plans. A status report must be produced every fifth year to assess the goals, with the alternatives being to either maintain or increase national ambitions.

The EU ETS has been adopted and functions as the EU’s main instrument for reducing greenhouse gas emissions from industry up to 2030. The goal for the sectors subject to the system is a 43 per cent reduction in emissions in 2005-30. Norway’s petroleum sector is part of the EU ETS. In addition, a national carbon tax is paid on emissions from petroleum operations on the NCS.

The ambition for the EU’s road map 2050 is to achieve an overall emission reduction of more than 80 per cent by that year compared with 2005. Continued step-by-step lowering of the emission allowance ceiling, also post-2030, is expected to be one of the instruments for meeting that target. The ambition will also be significant in developing and implementing low-emission solutions for the use of oil and gas exported from the NCS to the EU.

A system proposed in 2013 for Monitoring, Reporting and Verification (MRV) of CO2 emissions from shipping was adopted by the EU in May 2015, and requires that the shipping sector reports its release of CO2. This will form the basis for an estimate of actual CO2­ emissions by the industry. The International Maritime Organisation (IMO) decided in April 2016 to establish a binding global reporting system for CO2 emission from the shipping sector. This requirement could come into force on 1 January 2018, with actual reporting starting in August 2019. It is important for the maritime industry that the European and global systems develop in parallel to avoid having to deal with several regional systems.

**The petroleum industry in Norway has set the following overall climate and commercial goals for 2030.**

***Maintain safe and profitable production at the present level, and implement CO2 reduction measures from 2020 which correspond cumulatively to 2.5 million tonnes of CO2 equivalent per annum by 2030.***

This means that output from the NCS, measured in oil equivalents (oe), will be at about the same level as in 2015. Gas is expected to account for roughly half of 2030 production. While the bulk of output will still come from mature areas of the North and Norwegian Seas, the far north will be more important in 2030 than it is today.

The ambition for greenhouse gases includes emission cuts related to electricity and heat supply on oil installations, to short-lived climate forcers such as methane, and to drilling operations from mobile rigs, as well as enhanced energy efficiency at field and area level.

In addition, oil companies, suppliers and ship/rig owners will help to reduce emissions from the maritime part of the sector. By 2030, maritime operations on the NCS will be conducted with low- or zero-emission technology in the offshore fleet. Reductions from this part of sector come in addition to the ambition of 2.5 million tonnes of CO2 equivalent reduction.

**Where 2050 is concerned, the industry has the following ambition.**

***Maintain its position as Norway’s most important value creator and increase the average recovery factor to at least 60 per cent. The NCS will remain the world leader for low CO2 emissions, and the sector will develop and adopt technology and solutions which substantially reduce average CO2­ emissions per unit produced compared with the 2030 level.***

Through its follow-up of the action plan, the petroleum industry will identify the potential for emission reductions from various technological solutions in order to substantiate ambitions for reduced releases of greenhouse gas from the sector in 2050.

Systematic efforts will be made by the industry to help develop and implement technology and technological solutions which reduce emissions related to the end use of oil and gas.

The ambition means that the industry will be characterised by a high value creation, increased productivity and substantial employment in 2050. Vigorous offshore clusters will deliver substantial volumes of products and services to markets both in Norway and globally. Export deliveries will include low-emission technologies and other solutions which contribute to greater safety and more sustainable development.

The value creation goal means both that time-critical resources close to infrastructure are realised before the facilities are shut down, and that additional resources must be proven and infrastructure developed in new areas of the NCS.

The industry will continue to maintain a high safety standard and to work for continuous improvements in safety.

**What is required to realise the ambitions?**

The most important competitive advantage for the NCS is the overall expertise and innovative drive of the Norwegian offshore cluster. The industry has been willing to assume the risk of qualifying and adopting new technologies. New solutions have been developed through collaboration and competition, and labour relations based on open dialogue between employers, employees and government. Combined with strict government standards and enforcement, this has been crucial to the NCS becoming the world leader for both high recovery factors and low greenhouse gas emissions. NCS achievements have also been crucial for the attractiveness of Norway’s supplier industry and its substantial exports.

Together with the Norway’s maritime sector, the Norwegian government must work to influence an ambitious international regulatory regime. These regulations must help to raise standards, enhance energy efficiency and boost the environment-friendliness of international shipping, including offshore vessels.

Norway’s strong technical community has helped to turn sales of Norwegian-based technology and concepts from the supplies industry into the country’s second largest export sector after oil and gas. Examples include long-distance multiphase transport, horizontal drilling, subsea processing, water treatment, continuous environmental monitoring, lower emissions of such gases as NOx and volatile organic compounds (VOCs), and reduced discharges of oil in produced water. The petroleum sector has also been an innovation engine with ripple effects for other Norwegian industries over many decades.

Maximising value creation from and the competitiveness of the Norwegian offshore cluster while meeting ambitious climate goals calls for a new and strengthened commitment from the companies throughout the value chain. A far-sighted government must help to maintain the level of activity by providing stable and competitive operating parameters relating both to predictable access to acreage and to fiscal terms.

Norway’s petroleum industry has a unique starting point. Ninety fields will soon be in operation with associated infrastructure such as pipelines and land-based plants for processing, refining, storage and export. This provides a substantial potential for realising profitable volumes by improving recovery or by tying discoveries back to existing fields and pipelines in the mature parts of the NCS.

The far north will be very important for the long-term progress of the NCS. Since existing infrastructure in these areas is limited, attention over the next few years will be concentrated primarily on exploring for and maturing new resources which provide the basis for future developments. Close collaboration between companies and government to ensure good commercial solutions will continue to be needed here. Access to new exploration acreage is important as a basis both for new profitable projects and for establishing infrastructure which can be utilised by discoveries in areas which are already opened.

A substantial commitment to both research and development will continue to be needed for exploration operations, production methods, low-emission technologies and field development solutions. The largest technological leaps have earlier been achieved through big projects with robust economics and through collaboration in the industry. The growing maturity of the NCS and smaller average discovery size, higher costs and low oil prices call for more attention on cost-effective solutions. That includes a greater degree of coordination and standardisation/simplification of company-specific requirements, components, systems, and methodology, as well as operational optimisation based on better use of large volumes of information (Big Data) and an increased level of automation/robotisation.

Given the ambitious climate goals set by the EU and internationally, the price of CO2 emissions is likely to be substantially above today’s level in 2050. To meet the ambitions, technological solutions must be developed to improve energy efficiency and to generate electricity from emission-free or low-emission sources in an economically sustainable way.

Both public and industrial research efforts to advance technology for reducing greenhouse gas emissions must be strengthened.

Where shipping is concerned, the aim must be to establish “green operations” in order to reduce fuel consumption as well as systems for measuring and registering the effect of measures. Publishing and sharing information between the various shipping companies will be crucial. Experience so far demonstrates that measures initiated to reduce emissions have proved to be cost-effective, hence resulting in lower total costs than operating without such measures, even when CO2 prices or support schemes are ignored. In addition to measures at the project level, the companies should work actively with suppliers and partners to reduce emissions from rigs and support vessels and to improve logistics through better vessel utilisation, coordination across licences, and incorporating energy efficiency requirements in tendering processes.

Low greenhouse gas emissions must be a key requirement in planning new development projects, and the oil and gas companies have to assess the climate effects of various development solutions. The sector is subject to Norway’s carbon tax and part of the EU ETS. To ensure their implementation, measures not triggered by the overall cost of CO2 need to be supported by government incentives.

Norway’s petroleum industry is primarily about the production of oil and gas. Since by far the largest proportion of emissions relate to the use of these products, however, the industry has a clear ambition of strengthening its role in the development of Carbon Capture and Storage (CCS). This will be a significant and crucial technological field if the world is to reach its climate goals, but calls for good operating parameters, clarification of roles and specific full-scale projects. Work must build further on the substantial expertise available in Norway’s offshore cluster and land-based industry. Good forms of collaboration have been established between government, industry and academia, which must be extended to achieve the realisation of full-scale chains from capture to storage in Norway. Experience with fully established value chains is the only way to speed up learning to achieve the goal of cost-efficient CCS-solutions l. CCS is an important priority area internationally, and collaboration and experience transfer across frontiers and industries are crucial. CCS could also be relevant offshore to reduce production emissions.

In the short term, the most important steps will be increased adoption of existing low-emission technology on existing installations as well as incremental improvements to established technologies in order to boost their efficiency and/or reduce their cost. Looking further ahead, completely new technology areas, solutions and value chains than those available today must be developed and adopted.

**Action plan – follow-up of the road map’s climate goals**

The action plan concentrates primarily on climate measures, but a government contribution through predictable and competitive operating parameters is crucial. Given the long time frame in the industry from the opening of new areas until petroleum production begins, the authorities must clearly communicate long-term operating parameters which facilitate continued profitable development and operation of Norwegian petroleum resources. The tax regime must be structured in such a way that the companies want to invest in activities which are socio-economically profitable. Where long-term value creation on the NCS is concerned, access to new acreage will be crucial. The opening of new areas must be clarified through open processes, such as impact assessments and management plans. Furthermore, the regulations must involve a minimum of bureaucracy and contribute to competition and diversity.

The action plan describes what the industry can and should do itself, and what contribution the government can make to accelerate action. Speeding up further development of the most promising technological solutions which could yield significant long-term emission reductions is important. The government should reduce company risk where triggering good socio-economic measures on the basis of purely commercial considerations would be demanding.

The industry will continue to work on initiatives for achieving lasting changes and improvements in order to improve its competitiveness.

**Proposals to strengthen the commitment to developing the necessary low-emission technology**

1. A national centre for low-emission technology in the petroleum industry should be created.   
     
   This should be established on the basis of competition between universities/research institutes and with partners from the oil companies and the supplier industry. It should be supported by government funding, but the industry is also prepared to contribute financing. The centre will make recommendations on the development of low-emission technology, and coordinate the commitment to and direction of this work with such national strategies as OG21 and Maritim21 as well as the other relevant policy instruments.
2. Increased appropriations are also proposed for research on and development and demonstration of low-emission solutions for the petroleum industry.

* The government should provide NOK 100 million in fresh funds in the first year, and increase this by increments of NOK 100 million annually for 10 years. The industry would put up the same amount when making applications through the research programmes.

The assumptions are that the government contributes new appropriations and that the companies, including suppliers, participate with funds through applications for projects.

1. Established arrangements and strategies, such as the research and technology (FoT) scheme, OG21, Maritim21, Demo 2000, Petromaks and the Skattefunn tax incentive scheme for R&D, have functioned well, and the industry will continue to make active use of these programmes in order to achieve further progress for the Norwegian oil and gas cluster. The role Intsok (Norwegian Energy Partners) has played in promoting technology and company expertise internationally must be reinforced.

**Various time frames and technological solutions**

Up to 2030, a potential still exists for further energy efficiency measures on existing installations. Where costs are higher than the price of CO2, instruments such as Enova and the NOx fund could serve as triggers.

The oil companies and vessel owners will work purposefully to industrialise and implement new and existing solutions and technology in collaboration with suppliers.

Examples of such areas include the following.

**Power generation**

* measures and R&D which yield more efficient gas turbines (including existing machines)
* further development of combined cycle power stations (heat recovery units with steam turbines)
* hybrid solutions such as offshore wind power, batteries, fuel cells and wave energy
* cost cuts and technology development for power from shore to facilities (including rigs)
* hydrogen for blending with natural gas

**Drilling and production operations**

* more efficient and automated drilling technology
* reduction of and zero-emission solutions for flaring
* tailored solutions and operation for lower emissions in the late life phase (turbines, separation, compressor operation, energy optimisation)
* subsea solutions which reduce energy requirements
* improved recovery with low emissions
* automated operations and robot technology
* increased degree of joint operation and remote operation

**Logistics, base operation and support vessels**

* optimise the use of support vessels, coordinate operation, maintenance and logistics – including bases – across licences
* monitoring, reporting and verification of greenhouse gas emissions from ships
* battery technology and provision of electricity on ships

The following areas are central for new developments which will produce up to 2050:

* a value chain where technology development and concept choice in all phases of the field’s producing life, from development to cessation, help to reduce energy consumption per unit produced
* study and implement power supply solutions with low emissions
* optimised production strategies in relation to greenhouse gas emissions
* possible new value chains, such as hydrogen production from natural gas offshore and on land.

The industry will contribute to the development of CCS and make an aggressive commitment to:

* further development of the Technology Centre at Mongstad (TCM)
* developing new methods and technologies for CCS
* storage of CO2 on the NCS
* using CO2 to improve oil recovery
* transporting and storing CO2 sources from land-based industry
* international involvement to secure the adoption of CCS at gas-fired power stations

The government must help to reduce risk for the companies in establishing full-scale value chains for CCS, and clarify the division of roles, incentives and commercial conditions in collaboration with the industry.

In addition, the petroleum sector will follow up opportunities to utilise expertise from oil and gas operations in contributing to further development of other commercial activities in the ocean space through collaboration with relevant players and government agencies.

**Follow-up of commitments, milestones and reporting**

To ensure that the ambitions and goals in the road map are followed up, and that follow-up and prioritisation of technology development are optimal, the petroleum industry will do the following.

* Prepare a status report every fifth year on the development and adoption of low-emission technology and technological solutions by establishing a coordinated collaboration between OG21, Maritim21 and the proposed centre for low-emission technology in the petroleum sector.   
  The industry will also:
  + prepare further plans and recommendations for its own companies and for the policy instruments
  + study the potential of emission-reducing technology and solutions with the aim of quantifying a goal for greenhouse gas emissions from the NCS in 2050
  + update KonKraft’s climate report every fifth year.
* Report annually to the Norwegian Environment Agency (NEA) on measures implemented to enhance energy efficiency and reduce emissions.

The industry will also:

* + maintain the Norwegian Oil and Gas network for energy efficiency and measures to reduce emissions in order to ensure and encourage the exchange of experience between companies.
* Report annually to the Norwegian Environment Agency on potential and planned future measures (not made public because of commercially sensitive information).
* Organise annual meetings with the ministries of climate and environment and petroleum and energy on the following subjects:
  + the industry’s status, progress and future plans
  + review applications to the various R&D programmes for low-emission technology in the petroleum sector.

**International collaboration**

INTSOK was established to market Norwegian technology and expertise internationally, and utilising its network of contacts and knowledge will be important for disseminating information and developing a market for emission-reducing technology globally. This will contribute to implementing technology and technological solutions developed on the NCS which reduce production emissions in other petroleum provinces, and which help to cut emissions from end users of oil and gas.

A great many initiatives have been launched by or involve oil companies internationally. Examples include the Oil and Gas Climate Initiative (OGCI), Global Gas Flaring Reduction (GGFR), the Climate and Clean Air Coalition (CCAC), the Low Carbon Technology Partnerships Initiative (LO2) and a large number of initiatives to support the introduction of CO2 emission pricing. These initiatives must be continued and their follow-up has to become more specific.

**Export of low-carbon technology – industrial opportunities and global climate benefits**

Further development of energy-efficient/technological solutions which yield reduced emissions will have a potential for export to other petroleum provinces, which could help to reduce greenhouse gas emissions outside Norway.

Natural conditions in Norway qualify the country for developing tomorrow’s environment-friendly and sustainable transport solutions. It has a maritime industry with long experience of solving demanding transport and logistical assignments internationally. The long Norwegian coastline should be able to function as an incubator for technical solutions which can subsequently be exported and provide global spin-offs.

This represents an industrial opportunity for the supplier sector, while such technology can reduce emissions beyond the NCS. The following should therefore be done:

* + establish a method for conducting annual analyses which show the export value of low-carbon technology/energy-efficient solutions
  + develop a method for calculating the climate benefit of implementation of low-emission technology developed for the NCS outside Norway.

The development of methods should be coordinated with such government agencies as the ministries of climate and environment and petroleum and energy to ensure agreement over the choice of methods and results.