Statens forurensningstilsyn
Norwegian Pollution Control Authority

Reduction of greenhouse gas emissions in Norway.

Mitigation options for 2020.

English summary

English summary of the report from the Norwegian Pollution Control Authority
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Summary

This is an English summary of the mitigation analysis that Norwegian Pollution Control Authority (SFT) published in June 2007[1]. The analysis describes technical mitigation options for reducing existing greenhouse gas (GHG) emissions in Norway towards 2020. The analysis is an update and extension of the mitigation analysis undertaken by SFT in 2005.[2]

The mitigation analysis can best be described as a catalogue of possible national mitigation options. The costs are based on a calculation of annual additional costs, and the cost-effectiveness is given as Norwegian kroner (NOK) per tonne reduced CO_2-equivalent.[3] The analysis focuses on technical mitigation options that can contribute to emission reductions. It does not include mitigation options that lead to significant changes in production structure or lifestyle. The analysis does not assess the policy measures that will be needed for triggering the mitigation options, but SFT has assessed existing barriers.

This is an aggregated analysis of potential mitigation options. It does not give specific recommendations as to which options should be implemented. Deciding the precise scale of the emission reductions to be achieved, and where to reduce emissions in Norway is a political question.[4]

This is a “bottom-up” type of analysis that aggregates the effect of individual mitigation options. This approach is useful for the assessment of specific policy options at sector level in a long-term perspective. The analysis does not, however, take into account the macroeconomic effects of the mitigations options, which is something a typical “top-down” model would do.

The United Nations Intergovernmental Panel on Climate Change (IPCC) has in its Fourth Assessment Report used both ”bottom-up” and ”top-down” approaches. The IPCC emphasises the importance of using both approaches as a basis for climate policies. According to the IPCC, both approaches result in about the same potential for mitigation, but there can be variations between sectors.

Emission projections towards 2020

The projections are based on the projections that were published in the National Budget for 2007. The mitigation options’ emission reduction potentials are calculated relative to the projections in 2020.

The projections show that the emissions in 2020 will be about 9 million tonnes CO_2-equivalents higher than in 1990 if no new measures are implemented. Based on these projections the annual Norwegian emissions will increase from 49.7 million tonnes CO_2-equivalents in 1990 to 58.7 million tonnes CO_2-equivalents in 2020. CO_2-capture from the gas-fired power plants at Kårstø and Mongstad is included in the emission projections in 2020.

[1] See http://www.sft.no/publikasjoner/2254/ta2254.pdf for full 2007 report in Norwegian.
[2] See http://www.sft.no/publikasjoner/luft/2121/ta2121.pdf for full 2005 report in Norwegian.
[3] The exchange rates as of 28.06.07 were 1 euro = 7.9 NOK and 1 dollar = 5.9 NOK
[4] See http://www.regjeringen.no/pages/1988897/PDFS/STM200620070034000DDDPDFS.pdf for the White Paper on Norway’s climate policy (in Norwegian).

The projections in the National Budget for 2007 include an annual energy efficiency of about 1 percent. SFT's mitigation analysis takes this into account by adjusting the emission reduction potentials for the mitigation options within transport and stationary energy use.

Emission reduction potential

The technical mitigation options are assessed both with regard to costs and achievability. In total, these technical mitigation options can result in an emission reduction potential of 19.9 million tonnes CO_2-equivalents relative to the emissions in 2020, or a reduction of 22 percent compared to the emissions in 1990. This potential includes many types of mitigation options, ranging from those that are difficult to achieve and have a high cost, to those with high degree of achievability and a cost below 200 NOK per tonne (see table 1.)

Table 1: Distribution of emission reductions (million tonnes CO_2-equivalents) according to cost per tonne reduced and degree of achievability

Achievability	Below 200 NOK	Between 200 and 600 NOK	Over 600 NOK	Sub total
High	2.5	2.6	0.7	5.8
Medium	2.2	3.1	2.3	7.7
Low	1.8	2.1	2.5	6.4
Sub total	6.5	7.8	5.5	19.9

An emission reduction potential of 14.1 million tonnes CO_2-equivalents relative to the emissions in 2020 can be achieved by implementing all mitigation options with a cost below 600 NOK per tonne. This is a reduction of 11 percent compared to the emissions in 1990. If only mitigation options with a high and medium degree of achievability are included, the emissions can be reduced by 13.5 million tonnes CO_2-equivalents relative to the emissions in 2020. This equals a reduction of 9 percent compared to the emissions in 1990. If only mitigation options with costs below 200 NOK per tonne and a high degree of achievability are included, the emissions can be reduced by 2.5 million tonnes CO_2-equivalents relative to the emissions in 2020.

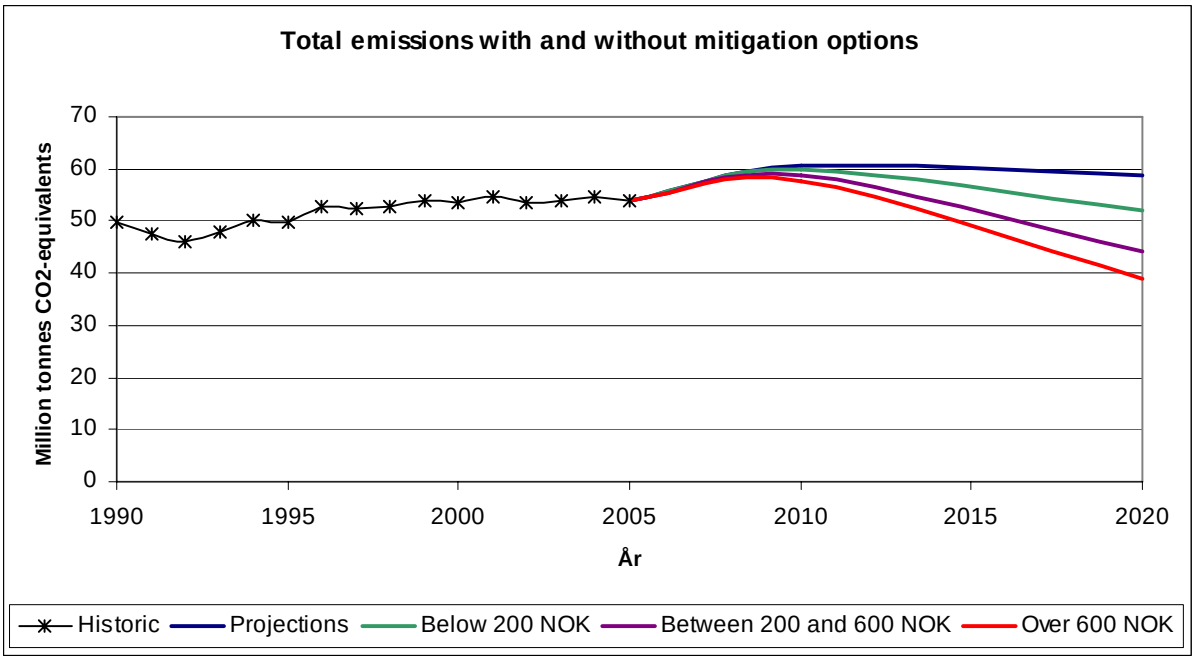

Figure 1. Potential emission reductions in 2020 by implementing mitigation options in different cost categories.

Cost calculations

The mitigation options are placed in three different cost categories. In order to compare costs, the additional costs of the mitigation options are expressed as an annuity where the investment costs are discounted over the mitigation options' lifetime. This is an economic calculation using net energy prices (excluding taxes). The additional costs express the difference in costs between the mitigation option and the existing solution or technology. For example, an increase in the oil and gas prices will reduce the additional costs for energy related mitigation options.

The mitigation options' costs towards 2020 are uncertain. Therefore, each mitigation option is placed within a cost category. Increased volume and improved technologies can contribute to reduce the costs by 2020.

Several mitigation options will in addition to reducing GHG emissions also reduce emissions of nitrogen oxides, particulate matter, sulphur dioxide, and volatile organic compounds. This will give an economic benefit, but these additional benefits are not included in the cost calculations. An example of such an economic benefit is the health effects from reducing local air pollution by implementing transport mitigation options.

Degree of achievability

Experience shows that even cost-effective mitigation options can be difficult to achieve because there are barriers that have not been taken into account. Such barriers can be loss of flexibility and time costs. In order to take into account these barriers, SFT has classified all the mitigation options into high, medium or low degree of achievability.

SFT has considered two major types of barriers:

1) **Technological barriers**: How dependent is society on new technology for the mitigation option to be implemented?
2) **Barriers related to policy measures**: To what extent are there acceptable policy measures that can contribute to overcoming barriers associated with the mitigation option?

For example, there can be technological barriers related to producing second generation bio-fuels while there are barriers related to policy measures when it comes to reducing the use of cars.

SFT would emphasise that by 2020 it is likely that new mitigation options will exist, and that these will increase the emission reduction potential. On the other hand, if the emission growth becomes higher than projected, this will reduce the impact of the mitigation options.

Mitigation options in various sectors

A total of 57 mitigation options in all sectors have been assessed.

CO_2 capture and storage from existing industry
SFT has assessed CO_2 capture and storage (CCS) from existing industry and has identified a total technical emission reduction potential of about 5 million tonnes CO_2-equivalents in 2020. The most realistic projects are probably from the refinery at Mongstad and from a plant in Grenland producing mineral fertilizers. These two projects currently account for about 1.3 million tonnes CO_2-equivalents and are likely to be implemented at a cost of less than 600 NOK per tonne. Other CCS projects have medium and low degree of achievability and have costs below and over 600 NOK per tonne. Effective policy measures are required if CCS from existing industry is to take place.

Road traffic
Within road traffic, SFT has identified technical mitigation options that can reduce emissions by about 4 million tonnes CO_2-equivalents. The largest effect will be from increasing the bio-fuel blend in regular diesel and petrol to 10 percent parallel with increasing the share of vehicles that use bio-ethanol (E85) and bio-diesel. Additionally, there are a number of mitigation options such as the EU's agreement with industry for producing more fuel-efficient cars and a larger share of cars using electricity and hydrogen.

About 50 percent of the mitigation options in this sector have costs between 200 and 600 NOK per tonne. Among the mitigation options with a high degree of achievability are bio-fuel blends in regular diesel and petrol, and a certain increase in efficiency of cars.

Buildings
The emissions from buildings can be reduced by 3.2 million tonnes CO_2-equivalents in 2020. The mitigation options include replacing oil for heating with renewable energy sources, Energy savings in existing buildings and reducing the energy requirements in new buildings by up to 50 percent. The mitigation options are placed in the cost categories below 200 NOK and between 200 and 600 NOK per tonne while the degree of achievability varies from high to low.

Oil and gas extraction
Oil and gas extraction currently accounts for 25 percent of Norway's GHG emissions. Electricity supply from land or centralised electricity offshore can together with a general

efficiency improvement contribute to emission reductions of 3 million tonnes CO_2-equivalents. The mitigation analysis assumes that new electricity production for meeting the increased demand offshore will be produced by gas-fired power plants with CCS, renewable energy sources or through increased energy efficiency.

SFT describes mitigation options for offshore electricity supply giving a reduction potential of 2.7 million tonnes CO2-equivalents. The mitigation options have been assessed to have a medium to low degree of achievability and a cost of over 600 NOK per tonne. The costs are based on cost data from the Norske Veritas and the Norwegian Oil Industry Association in 2003. SFT will now in cooperation with the Norwegian Water Resources and Energy Directorate and the Norwegian Petroleum Directorate assess these costs.

Industry

Energy and process mitigation options for industrial installations can contribute to emission reductions of 2.3 million tonnes CO_2-equivalents in 2020. The mitigation options include substituting oil with bio fuels and substituting fossil coal with charcoal. A majority of these mitigation options have a high degree of achievability with a cost below 200 NOK per tonne.

Agriculture

The emissions from agriculture can in total be reduced by 1.1 million tonnes CO_2-equivalents in 2020. The largest emission reductions can be achieved through collecting methane gas from ventilation air and the use of manure and waste for the production of bio gas. The mitigation options have a high degree of achievability with costs below 200 NOK and between 200 and 600 NOK per tonne.

Waste

Mitigation options within the waste sector can be achieved by reducing methane gas emissions through collection and extraction and by reducing the amount of biodegradable materials at landfills. The mitigation options have a reduction potential of 0.4 million tonnes CO_2-equivalents, have a high degree of achievability and a cost below 200 NOK per tonne.

Ships

Mitigation options and technological development for ships can reduce the emissions by about 0.4 million tonnes CO_2-equivalents. The mitigation options have a medium degree of achievability and the costs are in all cost categories.

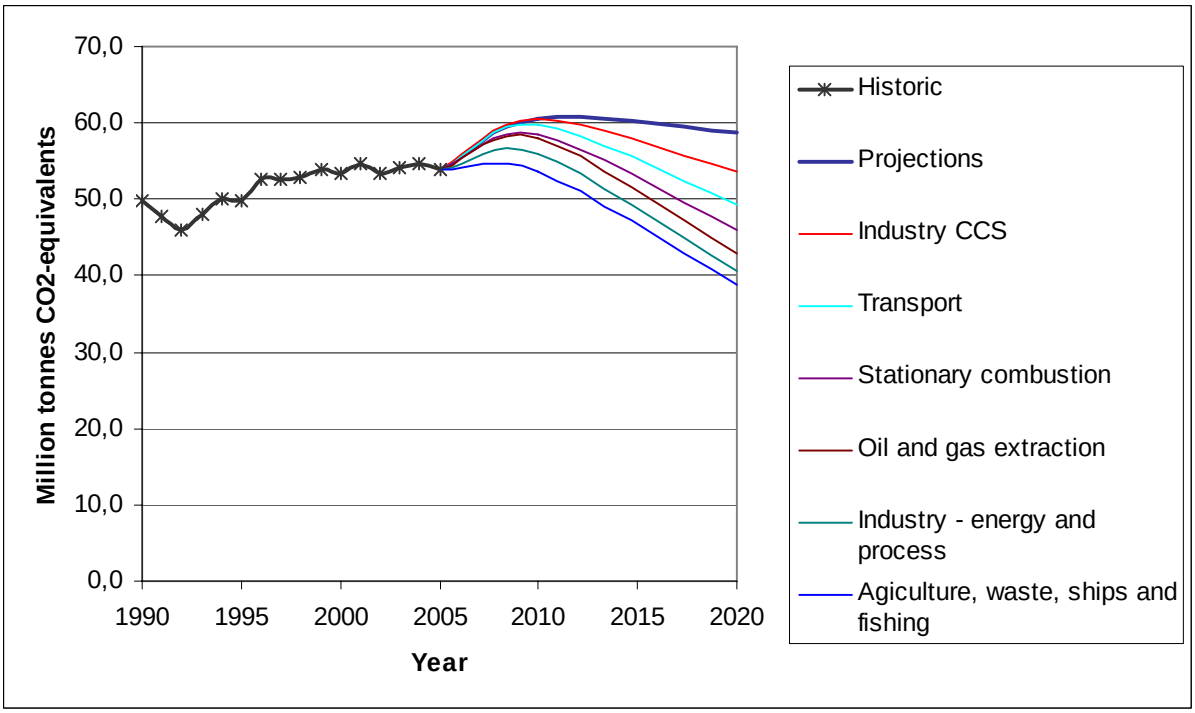

Figure 2: Potential for emission reductions up to 2020 in various sectors.

Comparison with the report from the Norwegian Commission on Low Emissions

In total, the potential emission reduction in 2020 is somewhat larger than the emission reduction potential in the report from the Norwegian Commission on Low Emissions from 2006[5]**.** The report presented mitigation options amounting to 18 million tonnes CO_2-equivalents by 2020.

The Norwegian Commission on Low Emissions focused on large mitigation options while SFT also included smaller mitigation options. SFT believes that if effective policy measures are implemented, more CCS from existing industry is possible and that this can occur earlier than recommended by the Norwegian Commission on Low Emissions.

About reduced emission growth

Preventing emissions from increasing can be more cost effective than implementing technical mitigation options. SFT has therefore assessed how a reduced emission growth in the transport sector can influence the level of emissions.

The projections forecast that emissions from road traffic will increase by almost 40 percent from 2005 to 2020. This corresponds to an increase in the traffic volume of about 60 percent. As an illustration of the significance of reduced growth, SFT has calculated the impact of traffic not increasing more than it has done for the past 15 years. This would result in emissions being 1.3 million tonnes CO_2-equivalents lower than the projections for 2020.

If the emissions from domestic air traffic were to stabilise at their current level, this would result in emissions being 0.4 million tonnes CO_2-equivalents lower than the projections for

[5] NOU:2006:18 ”Et klimavennlig Norge” (in Norwegian)

2020. A stabilisation of emissions from air traffic is being put forward in the European Commission's proposal for regulating air traffic from 2012.

About mitigation options within the forestry sector

Norwegian forests annually capture close to 30 million tonnes CO_2. This is due to a large net growth caused by active forest management during large parts of the past century. At the same time, the harvesting level has been stable throughout the period. The Kyoto Protocol only allows for a certain amount of carbon capture due to forest management to meet the Annex I countries' commitments for the period 2008-2012. SFT has not undertaken a detailed assessment of how much carbon that will be captured towards 2020.