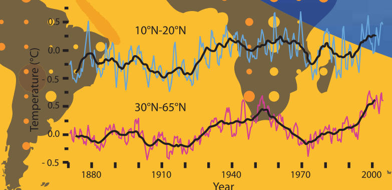
Report

Norway's fourth national communication under the Framework Convention on Climate Change

Status report as of December 2005



MILJØVERNDEPARTEMENTET

Norwegian Ministry of the Environment

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Contents

1. EXECUTIVE SUMMARY

This report is Norway's fourth national communication under the Framework Convention on Climate Change (UNFCCC). The first, second and third national communications were submitted in 1994, 1997 and 2002 respectively. The latest national greenhouse gas inventory report was submitted in April 2005. Norway ratified the UNFCCC on 9 July 1993. Norway ratified the Kyoto Protocol on 30 May 2002 and became a Party when the Protocol entered into force on 16 February 2005.

1.1 National circumstances

Norway is a constitutional monarchy with a democratic parliamentary system of governance. The current government, in office since October 2005, is a coalition of the Labour Party, Socialist Left Party and Centre Party. Together the three parties form a majority government. Norway has been part of the internal market established by the EU through the Agreement on the European Economic Area (EEA) since 1994. Through the EEA agreement Norway has to a large degree the same obligation to implement EU environmental legislation as the member states. The Storting (parliament) determines Norway's overall climate policy, and the government implements and administrates the most important policies and measures, such as economic instruments and direct regulations.

Most of Norway has a maritime climate with mild winters and cool summers. Because of the influence of the North Atlantic Ocean, Norway has a much warmer climate than its latitudinal position would indicate. Except for Finnmarksvidda in the north of the Norwegian mainland, the annual temperature has risen by 0.6-0.9 ºC during the last 100 years. Nevertheless, in the cool Norwegian climate there is a substantial need for energy to heat buildings. Population density is low on average, but in 2005 nearly 78 per cent of the population live in urban settlements. Agricultural areas account for 3 per cent of the mainland, while about 29 per cent is covered by forest.

Norway's energy and industrial profile is quite different from that of other industrialized countries. Half of all energy use is from renewables, and nearly all electricity is hydropower, which generates virtually no greenhouse gas emissions. However, there is only limited potential for further development of hydropower production. There is an energy-intensive industrial cluster based on the availability of hydropower, which generates substantial process-related emissions. Over the past thirty to forty years, Norway has also developed an oil and gas sector which today is the country's largest industry, and is responsible for about one fourth of the country's greenhouse gas emissions. Norway's decentralized settlement pattern gives rise to a relatively high demand for transport. In addition, the Norwegian economy is largely based on the extraction of raw materials and export of goods, which means that there is a large volume of goods transport. Nevertheless, because of the amount of renewable energy used in Norway, per capita emissions of CO_2 are lower than the OECD average.

1.2 Greenhouse gas inventory information

Norway's national greenhouse gas inventory covers emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and hydrofluorocarbons (HFCs). It also covers the precursors SO_2, NOx, CO and nmVOC. Emission figures for the period 1990-2003 are shown in table 1.1.

Table 1.1 Emissions of greenhouse gases for the years 1990-2003 in CO_2 equivalents.

Year	CO_2	CH_4	N_2O	PFCs	SF_6	HFCs	Total
1990	34,4	5,2	5,1	3,3	2,2	0,0	**50,1**
1991	33,5	5,2	4,9	2,5	2,1	0,0	**48,3**
1992	33,8	5,3	4,3	2,0	0,7	0,0	**46,0**
1993	35,4	5,3	4,6	2,0	0,7	0,0	**48,0**
1994	37,3	5,4	4,7	1,7	0,9	0,0	**50,0**
1995	37,2	5,4	4,8	1,6	0,6	0,0	**49,6**
1996	40,4	5,4	4,9	1,4	0,6	0,1	**52,8**
1997	40,6	5,5	4,8	1,4	0,6	0,1	**52,9**
1998	40,8	5,3	5,1	1,3	0,7	0,1	**53,3**
1999	41,6	5,2	5,3	1,1	0,9	0,2	**54,3**
2000	41,1	5,3	5,2	0,9	0,9	0,2	**53,8**
2001	42,7	5,3	5,2	1,0	0,8	0,3	**55,3**
2002	41,2	5,1	5,4	1,1	0,3	0,4	**53,5**
2003	43,2	5,1	5,3	0,7	0,2	0,2	**54,8**
Change 90-03	26 %	-2 %	5 %	-79 %	-89 %		**9 %**

Source: Norwegian Pollution Control Authority

In October 2004, a centralized review of Norway's greenhouse gas inventory was conducted by a UNFCCC expert review team. The team's main conclusion was that the Norwegian inventory is largely complete. The latest Norwegian national inventory report was submitted to the UNFCCC Secretariat on 15 April 2005. The report was prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories, and generally the estimation methods follow the Guidelines for National Greenhouse Gas Inventories published by the Intergovernmental Panel on Climate Change (IPCC). All data and information presented here are consistent with the information provided in the annual inventory report.

Norway's total emissions of greenhouse gases, measured in CO_2 equivalents, were about 54.8 million tonnes in 2003. CO_2 emissions account for approximately 80 per cent of this. N_2O accounts for about 10 per cent of total greenhouse gas emissions, and methane for about 9 per cent.

For the period 1990-2003, the increase in total greenhouse gas emissions expressed in CO_2 equivalents was about 9 per cent. The main increase was in emissions of CO_2, which rose by 26 per cent from 1990 to 2003. The petroleum sector made the greatest contribution to the growth in CO_2 emissions, and transport was second in importance. A relatively large share of transport-related emissions was generated by coastal shipping and the fishing fleet. The growth in CO_2 emissions has to some degree been counteracted by the decrease in emissions of fluorinated gases from metal plants. Overall emissions of CH_4 and N_2O have been relatively stable in this period. Agriculture and waste treatment are responsible for about 79 per cent of CH_4 emissions. Agriculture and two plants producing nitric acid (fertilizer) are the main sources of N_2O. There has also been a considerable increase in emissions of N_2O from road traffic. Emissions of fluorinated greenhouse gases have been reduced from 5.5 to 1.1 million tonnes of CO_2 equivalents from 1990 to 2003, mainly by reducing emissions of PFCs from aluminium production and SF_6 from magnesium production.

Total net sequestration from the land-use, land-use change and forestry sector was about 21 million tonnes of CO_2 in 2003, which would offset 38 per cent of Norway's total greenhouse gas emissions in the same year. Sequestration increased by 56 per cent from 1990 to 2003. Forest land is the most important contributor to carbon stock changes, and in 2003 was the only category that made a contribution to total sequestration, approximately 23.4 million tonnes of CO_2.

1.3 Policies and measures

Norway's climate policy is founded on the objectives of the Climate Convention and the Kyoto Protocol and the scientific understanding of the greenhouse effect set out in the reports from the IPCC. Climate change has been a major concern of Norwegian policy since the late 1980s. Most sources of greenhouse gas emissions are currently addressed through economic measures (taxes, emissions trading) that put a price on emissions. Norway has advocated cost-effectiveness across emission sources, sinks, sectors and greenhouse gases both domestically and internationally.

The Commission on low emissions was established early 2005. The Commission will deliver a report in 2006 with a description of how Norway can cut emissions by 50-80 per cent by 2050. I. a. based on the report from the Commission, the government will consider long-term targets for the reduction of greenhouse gas emissions.

A tax on CO_2 was introduced in 1991 as the first measure designed only to curb emissions of greenhouse gases. The tax covers about 68 per cent of Norwegian CO_2 emissions (more than half of total greenhouse gas emissions) and rates range up to NOK 337 per tonne. High rates apply to petrol and the petroleum activities, and lower rates to the use of mineral oils.

A tax on import and production of HFCs and PFCs was introduced on 1 January 2003. From 1 July 2004, this tax was supplemented by a reimbursement scheme which applies to all HFCs and PFCs delivered for destruction. An environmental tax on final disposal of waste is also used to limit emissions from waste and increase utilization for energy purposes.

The Pollution Control Act applies to greenhouse gas emissions. Hence greenhouse gas emissions are included in the discharge permit which for instance industrial installations are obliged to obtain pursuant to the Pollution Control Act. As a general rule, the emitter is granted a discharge permit for CO_2 corresponding to the amount in the application. One of the main reasons for this is that greenhouse gas emissions to a large extent are covered by other specific policy instruments such as the CO_2 tax, the emission trading system and specific agreements with the industry to cap emissions to a certain level. These instruments have been regarded as more efficient tools for reducing greenhouse gas emissions. The Pollution Control Act may still be used to specify technological requirements relevant to greenhouse gas emissions. However, this option's relevance in practice only applies to the establishment of new gas fired power plants.

The government has concluded a number of agreements with specific sectors of industry concerning the reduction of greenhouse gas emissions. Agreements and voluntary measures apply mainly to emissions of fluorinated gases from aluminium and magnesium production and N_2O emissions from fertilizers. When the national emissions trading scheme was being established, the government and the energy-intensive process industry also established an arrangement to reduce emissions from this sector by 2007. This arrangement and the emissions trading scheme together apply to about 30 per cent of total Norwegian greenhouse gas emissions.

On 1 January 2005, Norway's Greenhouse Gas Emission Trading Act entered into force, and an emissions trading scheme that is to operate from 2005 to 2007 came into effect. The scheme applies to 10-15 per cent of Norway's total greenhouse gas emissions. The main features of the scheme are the same as those of the EU emissions trading system. However, one difference for the period 2005-2007 is that Norwegian installations that are subject to the CO_2 tax are not included in the emissions trading scheme, even if they would come within the scope of the EU's emissions trading system. The general rule was to allocate 95 per cent of average emissions in the period 1998-2001. The provisions of the Emission Trading Act are only intended to be suitable for the period 2005-2007. The establishment of a statutory trading scheme for 2005-2007 makes it possible to test various elements of the system (monitoring/reporting, the registry, compliance, penalties etc.) before the Kyoto commitment period 2008-2012. Since monitoring and reporting systems already exist for most emissions that are not currently covered by the trading scheme, its scope can easily be widened. The effects of the trading scheme for the period 2008-2012 cannot be assessed before decisions on its scope and the allocation of allowances have been made. The government will put forward to the Parliament a proposal for a revised national emissions trading scheme for the Kyoto period.

According to projections and the assessment of the effects of the emissions trading scheme and the arrangement with the process industry, the total greenhouse gas emissions per year will be about 10 million tonnes higher than Norway's commitment under the Kyoto Protocol, or about 50 million tonnes for the period 2008-2012. Introduction of further domestic policies would reduce the need for acquiring Kyoto Units. Industrial enterprises included in the emissions trading scheme, will be able to acquire Kyoto units through the emissions trading system. There is a general provision for such acquisition in the Emission Trading Act. Details for the period 2008-2012 have not yet been decided. These will depend partly on how Norway's emissions trading system is linked to other trading schemes, in particular the EU ETS.

Almost all electricity produced on the Norwegian mainland is based on hydropower. The government has granted construction and operating licences for four combined cycle power plants fuelled by natural gas. Only two of the plants, Snøhvit and Kårstø, are under construction, and the owners of the two other plants have not yet taken the decision to build the plants. The government is committed to initiating the process that will make it possible to install carbon capture and storage facilities at the gas-fired power plant at Kårstø at a later stage. The aim is to realize this within 2009, and the government will contribute financially to this. The government will see to that new licences for gas-fired power plants are based on carbon capture technology. On 1 January 2005, the government established a state centre for sustainable gas technologies, Gassnova. Gassnova will promote technologies for carbon emission abatement, including carbon capture and storage.

In 2001, a national energy agency called Enova SF was established. Enova is responsible for promoting an integrated strategy for renewable energy and energy savings. Enova's long-term goal is to achieve 12 TWh per year in new renewable energy production and energy savings by 2010. The government parties have stated that Enova's targets for renewable energy and energy savings will be increased. The most important policy measure administered by Enova is the scheme for investment grants from the Energy Fund.

The CO_2 tax has been the most important instrument for reducing emissions in the petroleum sector and has had a substantial effect. It has led to general improvements in technology and to the introduction of emission-reducing measures such as reduced use of energy and reduction of flaring. Emissions of CO_2 per produced oil equivalent fell by 22 per cent from 1990 to 2003. However, the improvements have not been sufficient to counterbalance the increase in energy use caused by higher levels of activity of new technologies. Storage of CO_2 has a huge potential for reducing emissions. Since 1996, 1 million tonnes of CO_2 has been stored annually in a subsea geological formation in connection with the processing of gas from the Sleipner field in the North Sea. From 2006, about 0.7 million tonnes CO_2 produced with gas on the Snøhvit field is to be separated and stored beneath the seabed in a water-filled reservoir. The policy declaration from the present government (September 2005) states that the government will reinforce various policy measures and public financing in order to advance the realisation of relevant infrastructure and facilities for CO_2 capture and storage. Some of these tasks will be the responsibility of a state-owned company. The government intends to establish a "value chain" for carbon capture, transport and storage on the Norwegian continental shelf.

The CO_2 tax is also an important instrument for limiting CO_2 emissions from the transport sector. In addition, the Norwegian purchase tax on cars is one of the highest in the world and has since 1996 been differentiated according to car weight, engine output and engine volume. From July 2001, car producers have been obliged to include information on fuel efficiency and CO_2 emissions in their marketing. Taxation policy has been changed in a number of ways that favour the use of electric cars in Norway. As a result, the total price of electric cars will be reduced by 25 per cent. The government will promote the use of biofuels in accordance with the targets established in the EU directive on the promotion of the use of biofuels (2003/30/EC). The directive has not been included in the EEA agreement. It has not yet been decided which instruments will be used to achieve these targets. To encourage research and development on alternative fuels, funds have in recent years been allocated to projects on the development and testing of low-emission technologies including the production and use of hydrogen and biofuels.

Several voluntary measures and agreements have led to reductions of emissions from energy- and emission-intensive industries since 1990. This applies particularly to fluorinated gases from aluminium and magnesium production and N_2O from fertilizers. In recent years, CO_2 emissions from energy use in industry have been reduced considerably as a result of improved energy efficiency and changes in the energy mix. Under the arrangement established in 2004, the process industries have undertaken to keep emissions from specified installations below 13.5 million tonnes in 2007, equivalent to a reduction of 1.1 million tonnes CO_2 equivalents compared to the baseline. A proportion of these emissions reductions will be acquired through the emissions trading scheme. SF_6 emissions from a magnesium plant – the main source of SF_6 emissions in Norway – were reduced during the 1990s through voluntary measures, as well as reduced production level. Emissions from the agricultural sector and emissions and sequestration of greenhouse gases in forests are mainly dependent on general agricultural and forestry policies.

The method of calculating emissions from landfills was altered in several ways in 2004. It is now more in accordance with the IPCC guidelines and with the methods for calculation used in other countries. As a result, the calculated emission figures for 2002 were 45.6 per cent lower than they would have been using the old model. The most important policy instruments for reducing methane emissions from landfills are licensing requirements laid down under the Pollution Control Act and a tax on the final disposal of waste. Since 1990 substantial quantities of waste have also been delivered for recovery. The policies and measures implemented have offset the growth in waste volumes and led to a 20 per cent reduction in emissions between 1990 and 2003.

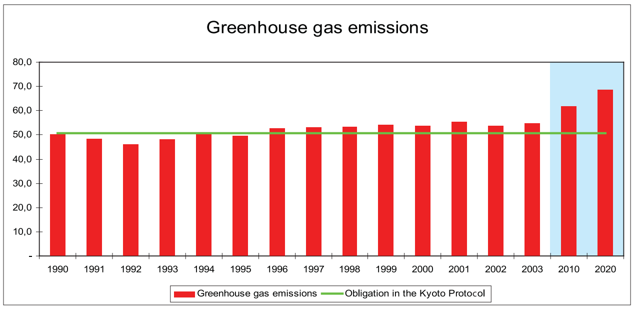
The government will introduce climate action plans for all relevant sectors of society, including specific targets for each sector.

1.4 Projections and the effect of policies and measures

The new government, which took office in October 2005, will present new long-term projections for greenhouse gas emissions in Norway in 2006. These projections will be submitted to the Climate secretariat. The projections summarised in Chapter 5 in this communication are thus based on preliminary technical assumptions and should be regarded as tentative. According to the preliminary projections, total greenhouse gas emissions are projected to rise by 23 per cent from 1990 to 2010 and by a further 11 per cent from 2010 to 2020 if present policies and measures are continued and no new measures are implemented. This projection does not take into account recent developments such as the establishment of the national emissions trading scheme, the arrangement concluded with the process industry and measures targeting the waste sector. Strong increases in emissions from oil and gas production, public electricity and heat production, and transport account for a large share of the expected rise.

CO_2 emissions are projected to rise from 34.4 million tonnes in 1990 to 49.9 million tonnes in 2010 and 57 million tonnes in 2020. Emissions of other greenhouse gases are projected to decline or only show a more modest increase up to 2020. With the introduction of emission-reducing measures in the aluminium and magnesium production industries, emissions of PFC and SF_6 are estimated to drop by 67 and 89 per cent respectively between 1990 and 2010. Emissions of HFCs are expected to increase as HCFCs and other ozone-depleting substances are phased out. Emissions of CH_4 are expected to decrease, and are by 2020 projected to be close to 20 per cent below the 1990 level.

Figure 1.1 Emissions of greenhouse gases for the years 1990-2003 and projections for 2010 and 2020 in CO_2 equivalents.



Sources: Norwegian Pollution Control Authority, Statistics Norway, Ministry of Finance

Emissions in 2020 will depend strongly on the demand for energy services, and on structural developments, particularly in the energy-intensive industries. There is considerable uncertainty as regards the realization of new power projects in the longer-term.

Assessment of Norway's current climate policy instruments and measures indicate that emission growth from 1990 to 2010 would be at least 17-22 percentage points higher without the policy instruments and measures that are already in effect. According to the projections, Norway faces an average "deficit" of about 11 million tonnes CO_2 equivalents compared to the commitment under the Kyoto Protocol in 2010. Taking into account recently adopted measures and the probable effects of the arrangement with industry, the figure is reduced to roughly 10 million tonnes CO_2 equivalents.

The net CO_2 sequestration in Norwegian forests has been estimated at about 21 million tonnes CO_2 in 2003. Annual net CO_2 removals are expected to reach nearly 24 million tonnes CO_2 by 2012.

1.5 Impacts and adaptation

In 1997, the Research Council of Norway set up a research programme to study regional climate development in northern Europe in a scenario with global warming (RegClim). RegClim has recently published results for climate change in Norway, comparing the period 2071-2100 with 1961-1990. The expected changes in the Norwegian climate include higher temperatures, changes in precipitation patterns and some changes in wind patterns. Over a period of 110 years, using a fairly optimistic scenario, the annual mean temperature will rise by between 2.5 and 3.5 °C. The rise in winter minimum temperatures in the northern parts of the country will be particularly marked. The most dramatic change will probably be in precipitation levels. Annual precipitation is expected to rise by between 5 and 20 per cent, and autumn rainfall will probably rise by more than 20 per cent along much of the westward-facing coastline. Thus the RegClim analysis indicates that there will be marked climate change in Norway over a period of 110 years, but the impacts will vary from one part of Norway to another.

A temperature rise is expected to lead to a shift of climate zones in both altitude and latitude. Climate change may therefore result in substantial changes in wildlife and vegetation. However, the extent to which the changes result in loss of biodiversity will depend on how far species and ecosystems are able to adapt. The predicted temperature rise may alter living conditions in freshwater. It is expected that a rise in temperature will have some impact on marine ecosystems. Climate change may result in changes in the distribution and stock sizes of most fish species. The overall effects on the marine ecosystem are not easily predicted. An increase in storm activity is expected to result in greater damage to fish farming installations and a higher risk of shipping accidents and oil spills along the Norwegian coast.

A temperature increase will probably have positive effects on crop production because the growing season will be extended in most parts of the country. Possible negative effects in the agriculture and forestry sector include operational difficulties as a result of more frequent and heavier precipitation, greater damage from pests and diseases, erosion and loss of agricultural soil and an increase in surface runoff, which may in turn have negative effects on freshwater ecosystems and drinking water quality.

Higher precipitation and a higher frequency of extreme weather may increase the costs of building, maintaining and repairing infrastructure and buildings. The Norwegian Public Roads Administration has started a project to evaluate the consequences of climate change for the road sector. The Planning and Building Act is currently being revised, and one aim is to develop it into a tool for ensuring that climate change is taken into consideration in local and regional planning. Energy production in Norway will be influenced by higher precipitation because most of our electricity is based on hydropower. A research project called Climate and Energy is planned to analyse changes in energy production as a result of climate change. Offshore petroleum production will be affected by stronger winds and higher waves.

The report from the Arctic Climate Impact Assessment (ACIA), which was finalized in 2004, states clearly that climate change in the Arctic is now more rapid and severe than in most other parts of the world. The Norwegian Ministry of the Environment has started a national programme which will run from 2005 to 2009 to follow up the ACIA report. Its focus will be knowledge relevant for adaptation strategies for the most vulnerable sectors of society and on filling the knowledge gaps described in the ACIA report. Norway is also in the process of developing a national strategy for adaptation to climate change. Compared to many other countries, especially the less developed countries, Norway is never the less relatively robust with respect to climate change and climate variability.

1.6 Research and systematic observation

Climate change is a long-term, complex problem that affects all sectors of society. Climate research is therefore extremely important both as a basis for developing policy and as a climate policy instrument. Norwegian public funding for research is for the most part channelled through the Research Council of Norway. The most recent white paper on research in Norway (Report No. 20 (2004-2005) to the Storting: *Commitment to Research*) emphasizes the importance of research on the interface between environmental and energy issues. This is one of the Research Council's target areas, and includes large-scale research programmes on climate change, energy systems and development, and the development of new energy technology and technology for CO_2 sequestration. The government plans a long-term effort to strengthen climate research in Norway. Its main priorities will be climate science, analyses of social constraints and climate policy instruments, and the development of technology to reduce greenhouse gas emissions. Research related to adaptation to climate change should also be given greater attention.

It is important for Norway to continue and strengthen its participation in international research cooperation, particularly within the IPCC, EU/EEA, OECD and IEA. The report from the Arctic Council on climate change and its consequences in the Arctic has identified needs for further research and been a stimulus for increased activity.

An analysis of the Research Council's budget showed that in 2005, approximately NOK 268 million was allocated to research related to climate change. This is an increase of about 137 per cent since 1998 when climate related research financed through the Research Council of Norway amounted to NOK 113 million.

The main framework for Norwegian research related to climate change is provided by the climate research programmes of the Research Council. The first of these was established in 1989. In 2004, a new 10-year large-scale programme called NORKLIMA: *Climate change and its impacts in Norway* was established. Its primary objective is to generate vital new knowledge on the climate system, on climate trends in the past, present and future, and on direct and indirect impacts of climate change on the natural environment and society, as a basis for adaptive responses by human society.

The large research programme RENERGI (Clean Energy) focuses on renewable energy production, energy efficiency and end-use, energy systems, hydrogen, and social science related to energy and climate change.

In 1997, the KLIMATEK programme was established with the objective of promoting the development and demonstration of technology that can reduce greenhouse gas emissions in Norway. From 2005, a new programme (CLIMIT) was established, which is focusing on gas-fired power plants using CO_2 capture and storage technology.

Norway does not have a national GCOS (Global Climate Observing System) programme at present. However, a research programme on monitoring of marine and terrestrial systems is established, and expansion of the programme to include environment and climate parameters is under consideration. The Norwegian Meteorological Institute sends data from the Norwegian meteorological stations to the WMO international data exchange according to standard procedures. The Norwegian Institute for Air Research monitors the concentration of a range of greenhouse gases at the Zeppelin Station in Ny-Ålesund, Spitsbergen. This is part of the WMO Global Atmosphere Watch (GAW) system, the Network for Detection of Stratospheric Change (NDSC) and the Advanced Global Atmospheric Gases Experiment Network (AGAGE). Norway also reports to international terrestrial and oceanographic observation systems. A national plan for biodiversity monitoring, which includes effects of climate change, was adopted in 1998. Recommendations from this plan have been included to a varying degree in ongoing national programmes.

1.7 Financial resources and transfer of technology

Norway provides substantial funds for climate change activities through a number of multilateral organizations, including the aid programmes of the UN development agencies and international financial institutions. The main channels for Norway's non-official development assistance (non-ODA) multilateral and regional support are the Global Environmental Facility (GEF), the UNFCCC Secretariat, the World Bank's Prototype Carbon Fund (PCF) and the Nordic Environment Finance Corporation (NEFCO). In addition, Norway funds several bilateral climate change-related activities.

The Norwegian government's contribution to the GEF for the period 2001-2003 was in the order of USD 21.6 million. Norway has also contributed substantial funds to the UNFCCC Secretariat to help establish the technical and institutional framework for the Kyoto Protocol. This includes extra-budgetary support and capacity-building efforts.
Norway is committed to investing USD 10 million in the PCF and contributed USD 5.32 million to NEFCO in the period 2001-2003. In addition, a fund called the Testing Ground Facility has been set up and is administrated by NEFCO. This is designed to provide financial assistance to JI projects in the Baltic Sea Region. In total Norway has contributed about USD 3 million to the fund.

Norway's development assistance programme is expanding. Annual contributions classified as ODA increased from NOK 12 143 million (USD 1 350 million) in 2001 to NOK 14 505 million (USD 2 049 million) in 2003. Norway's average ODA for the period 2001-2003 corresponded to 0.87 per cent of GNP. Norway's development assistance budget is set to rise further over the coming years to 0.95 per cent of GNP in the financial year 2005 and to 0.96 per cent in 2006.

Norway supports a number of capacity-building activities in developing countries that are relevant for the UNFCCC. Norwegian support for adaptation activities in developing countries that are particularly vulnerable to adverse effects of climate change is mainly channelled through the general contributions to multilateral development institutions. The transfer of technology and know-how to promote development, availability and efficiency of energy constitutes an important element of Norwegian ODA and has significant environmental co-benefits that are consistent with the promotion of the UNFCCC.

Figures for 2001-2003 show that Norway contributed USD 179 million to activities where the principal or significant objectives were related to fulfilment of the objectives of the UNFCCC. The government is currently preparing an action plan on how to address environmental issues in development co-operation. It will be finalized in 2006.

1.8 Education, training and public awareness

The Norwegian government gives high priority to providing information about climate change, the effects of climate change and climate policy. It also supports the efforts of others in the area of information and public awareness.

In the education sector, the curricula for primary and secondary schools include topics related to energy, energy use and climate change, designed to promote an early awareness of the adverse effects of climate change. A number of the courses offered at university and college level are of relevance for climate change.

The Ministry of the Environment works through many channels to enhance public awareness of issues related to climate change. The Environmental Information Act entered into force on 1 January 2004. It gives all members of the public a legal right to obtain environmental information both from public authorities and from public and private enterprises. The Ministry of the Environment has for a number of years been using websites, publications and other media to provide different target groups with relevant information. News, white papers, other reports, press releases and other relevant information are published on the Ministry's website (www.miljo.no), which is updated on a daily basis. A white paper on the government's environmental policy and the state of the environment is published every two years, and in this, the government presents its main aims and strategies in all key areas of environmental policy, including climate change. Its publication is followed by a broad debate about the government's environmental policy in the Storting (parliament).

Statistics Norway compiles an annual overview of statistics on important natural resources and different types of environmental pressure and pollution such as emissions to air, waste and waste water. The annual publication *Natural Resources and the Environment* provides a large amount of environmental information in an easily accessible form.

The research institute CICERO (Center for International Climate and Environmental Research) has been given a special responsibility for information on climate change. In addition to its research activities, CICERO takes an active part in the public debate on climate change. CICERO publishes the popular climate science magazine CICERONE and has for several years arranged the Climate Forum, which brings together representatives of business and industry, the government and researchers.

Internationally, Norway's support to UNEP and UNDP makes a significant contribution to enhancing public awareness of climate change-related issues and to capacity building.

2. NATIONAL CIRCUMSTANCES

2.1 Government structure

Norway is a constitutional monarchy with a democratic parliamentary system of governance. The current government is a coalition of the Socialist Left Party, Labour and the Center Party. Together the three parties form a majority government.

Norway has been part of the European Union's internal market through the Agreement on the European Economic Area (EEA Agreement) since 1994, although it is not a member of the EU. The main purpose of the EEA Agreement is to ensure equal conditions of competition throughout the EEA, which includes the EU member states and the three EEA countries, Norway, Iceland and Liechtenstein. In addition, the agreement institutionalizes a regular consultation process with the EEA countries, giving them opportunities to influence EU policy-making in areas of relevance to the internal marked, including environmental policies. Most EU legislation in the environmental field is also EEA-relevant, which means that Norway to a large degree has the same obligation to implement EU environmental legislation as the member states.

The Storting (Norwegian parliament) sets the overall national climate change policy, and the government implements and administers the most important policies and measures, such as economic instruments and direct regulations. Local government is responsible for implementing policies and measures at the local level, for example through waste management, local planning and transport measures. Through Local Agenda 21, the regional and local authorities are stimulated to take climate change into consideration when planning their activities. Most policies and measures in the area of climate policy are developed through interministerial processes before the political proposals are tabled.

2.2 Geographic profile and land use

The mainland of Norway extends for 1 752 km from north to south, spanning about 13 degrees of latitude. The total area of the mainland is 323 758 km^2. The mainland coastline is 2 650 km long, excluding fjords and bays. In the east, Norway shares a border with Sweden, Finland and Russia. In addition, the Arctic archipelago of Svalbard is under Norwegian jurisdiction. Emissions from Norwegian activities on Svalbard are included in the Norwegian emission inventories.

Most of Norway has a maritime climate with mild winters and cool summers. Because of the influence of the North Atlantic Ocean, Norway has a much warmer climate than its latitudinal position would indicate. On annual basis, the highest normal (1961-90) annual air temperatures, (up to 7.7 °C) are found along the south-western coast (see Figure 2.13). Outside the mountain regions, the lowest annual temperatures (down to -3.1 °C) are found at Finnmarksvidda. During winter the coast from Lindesnes to Lofoten has normal monthly mean temperatures above 0 °C. The absolute lowest and highest temperatures measured at official weather stations are -51.4 °C and +35.6 °C.

In the cool Norwegian climate there is a substantial need for heating buildings. The "heating season" (defined as the period of the year with daily mean temperature lower than 10 °C) lasted during 1961-90 around 240 days in coastal lowland areas. In mountain areas and northernmost parts of Norway the "heating season" lasts the whole year through.

Because of prevailing westerly winds, moist air masses flow regularly in from the ocean giving abundant precipitation over most of Norway. Areas just inside the coast of western Norway get most precipitation (see Figure 2.12). This zone of maximum precipitation is one of the wettest in Europe, and several sites in this region have normal annual precipitation of more than 3500 mm. On the

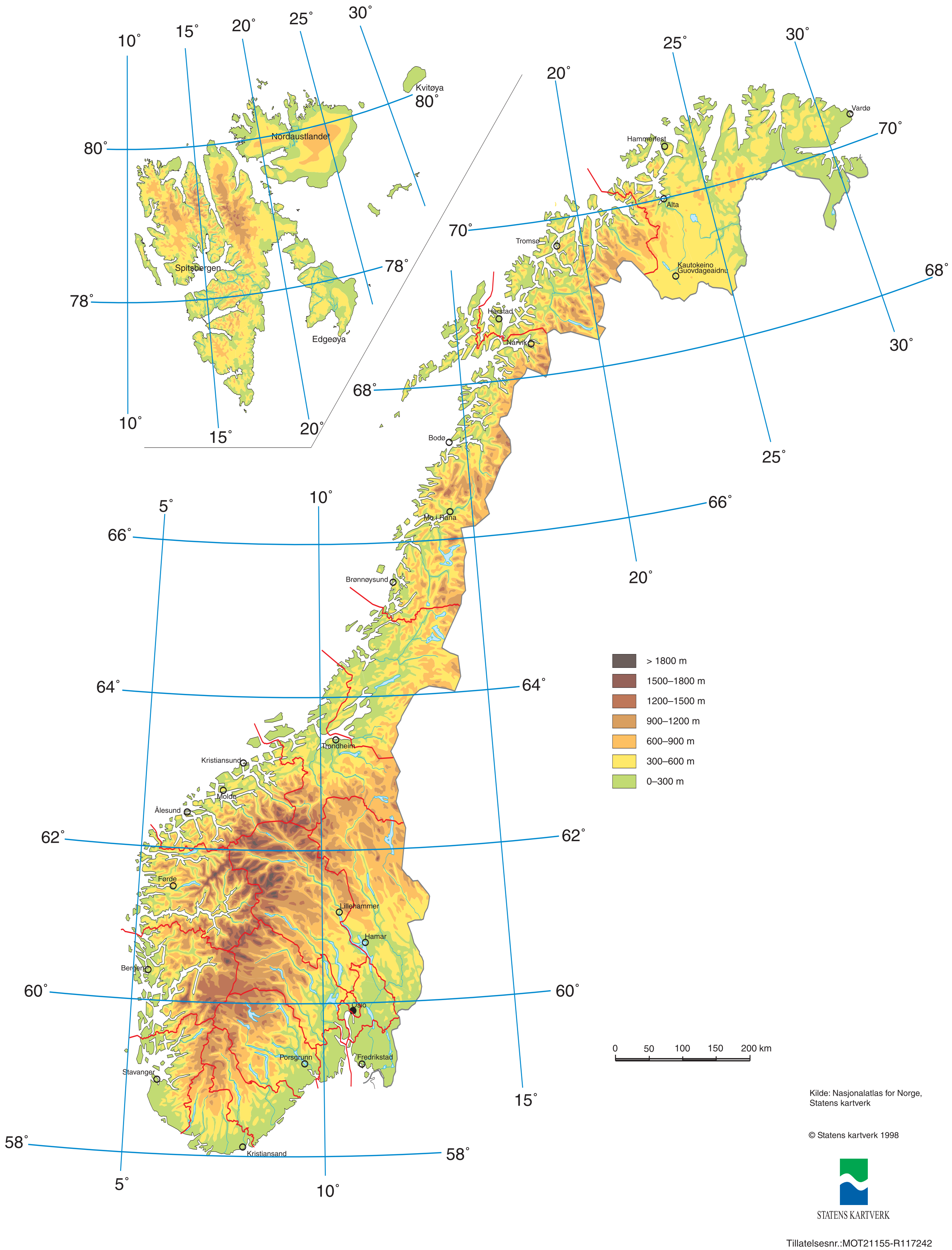
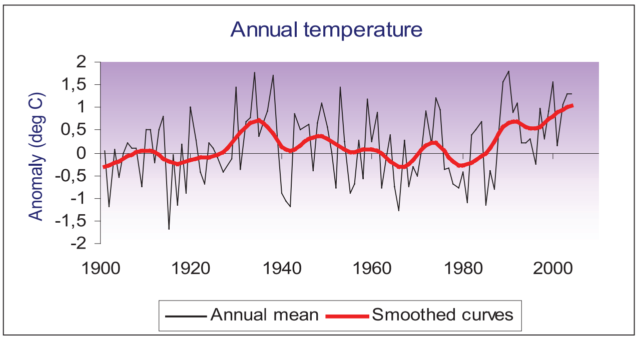


Figure 2.1 Map of Norway, including Svalbard, showing altitudes.
Source: National Atlas of Norway. The Norwegian Mapping Authority.

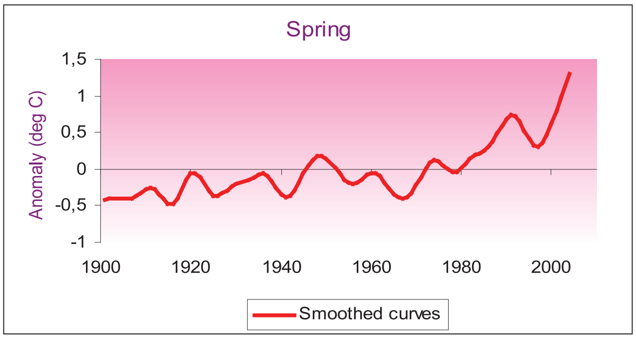
leeward side of the mountain ranges the annual precipitation is much lower, and a few sheltered stations in south-eastern Norway and Finnmarksvidda have normal annual precipitation less than 300 mm.

Figure 2.2 Annual temperature anomalies for the Norwegian mainland 1900-2004



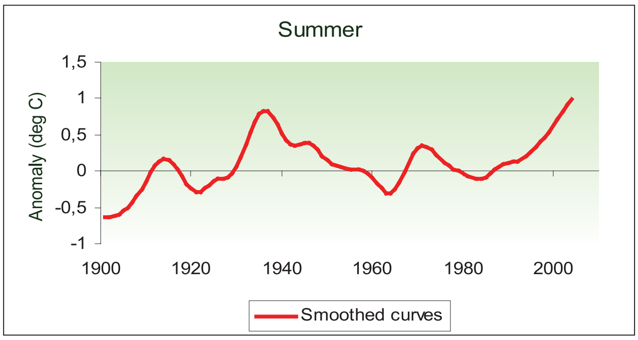
Source: Norwegian Meteorological Institute

Figure 2.3 Spring temperature anomalies for the Norwegian mainland 1900-2004



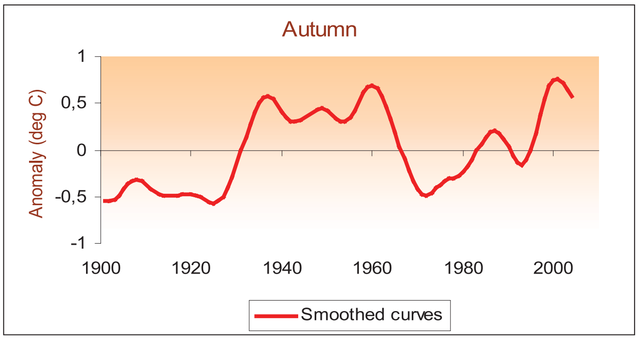
Source: Norwegian Meteorological Institute

Figure 2.4 Summer temperature anomalies for the Norwegian mainland 1900-2004



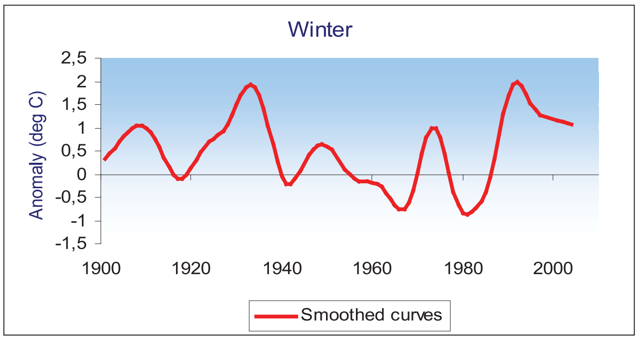
Source: Norwegian Meteorological Institute

Figure 2.5 Autumn temperature anomalies for the Norwegian mainland 1900-2004



Source: Norwegian Meteorological Institute

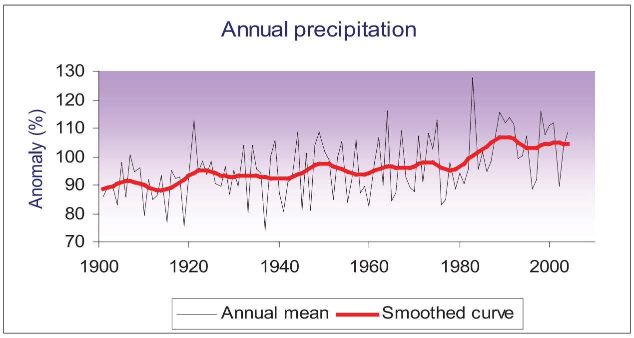
Figure 2.6 Winter temperature anomalies for the Norwegian mainland 1900-2004



Source: Norwegian Meteorological Institute

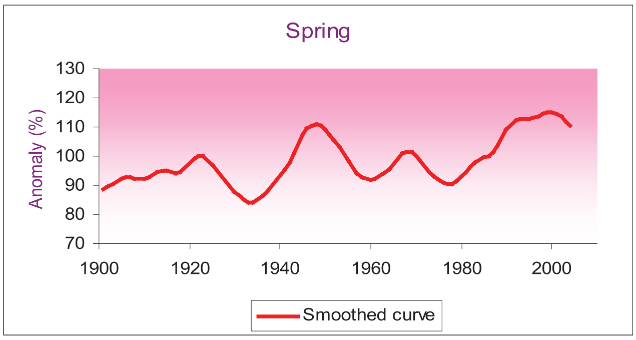
For all the above figures on temperature the anomalies are deviations (°C) relative to the 1961-1990 average. The smoothed curve of fig 2.2 show decadal scale variability, while the thin lines (annual temperature) indicate values for individual years. The last 3-4 values of the curves show only preliminary results as they may change when data for coming years are added.

Figure 2.7 Annual precipitation anomalies for the Norwegian mainland 1900-2004



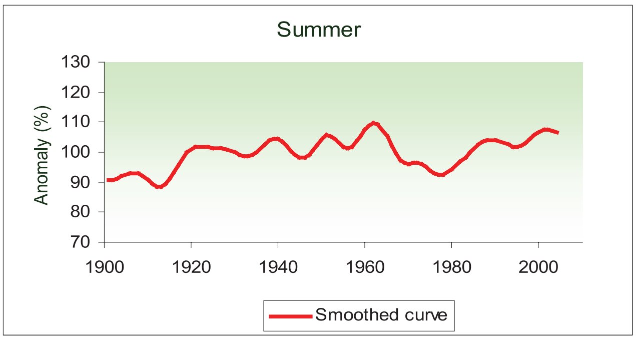
Source: Norwegian Meteorological Institute

Figure 2.8 Spring precipitation anomalies for the Norwegian mainland 1900-2004



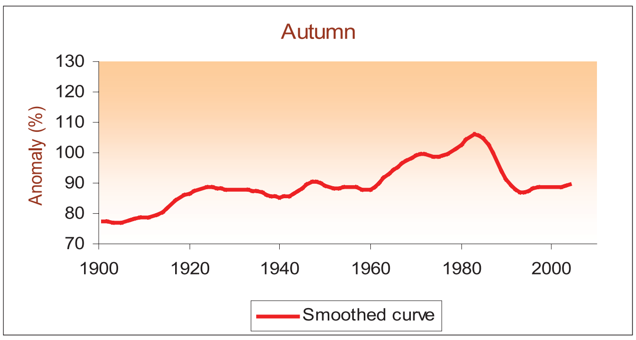
Source: Norwegian Meteorological Institute

Figure 2.9 Summer precipitation anomalies for the Norwegian mainland 1900-2004



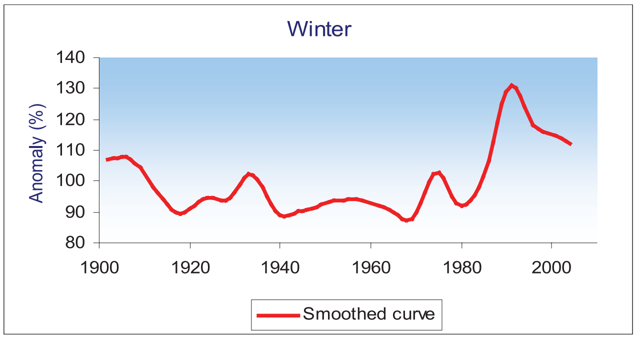
Source: Norwegian Meteorological Institute

Figure 2.10 Autumn precipitation anomalies for the Norwegian mainland 1900-2004



Source: Norwegian Meteorological Institute

Figure 2.11 Winter precipitation anomalies for the Norwegian mainland 1900-2004



Source: Norwegian Meteorological Institute

For all the above figures on precipitation the anomalies are ratios (in per cent) relative to the 1961-1990 average. The smoothed curve of fig 2.7 show decadal scale variability, while the thin lines (annual precipitation) indicate values for individual years. The last 3-4 values of the curves show only preliminary results as they may change when data for coming years are added.

The graphs in figures 2.2-2.11 show area-weighted variations in temperature and precipitation for the Norwegian mainland. Both annual as well as spring, summer and autumn temperatures have increased since the 1970s. The summer and winter temperatures were as high in the 1930s as the present level. Also annual precipitation has increased since the 1970s, particularly for the winter season.

For the period 1900-2004 as a whole, the annual mean temperature has increased in all parts of Norway. Except for Finnmarksvidda, the annual temperature in the rest of the country has become 0.6-0.9 °C higher during the latest 100 years. The largest increase is found during spring, where the mean temperature has increased by 1.3-1.5 °C both in south-eastern Norway and in large parts of northern Norway. Also the annual precipitation has increased all over the country during 1900-2004. The largest increase (15-20 per cent during the latest 100 years) is found in western Norway and in large parts of central and northern Norway. In most regions the precipitation increase is largest during spring and autumn.

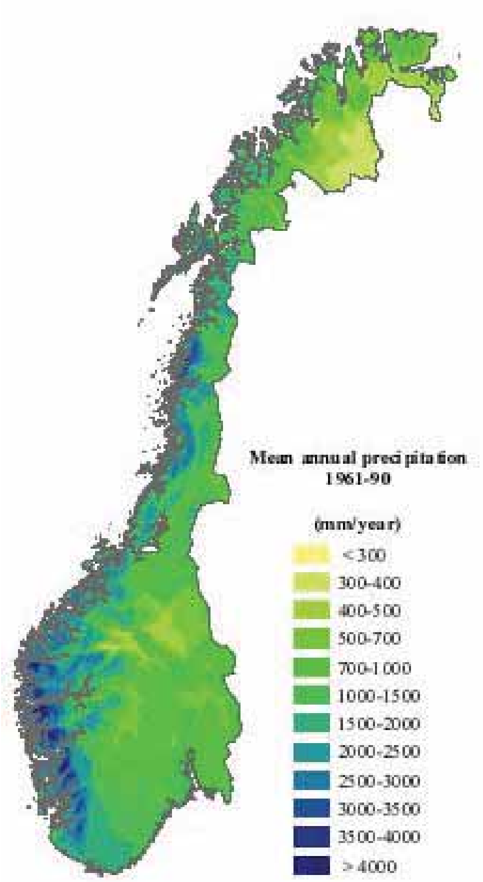


Figure 2.12 Norway's mean annual precipitation, 1961-1990 (mm/year)
Source: Norwegian Meteorological Institute

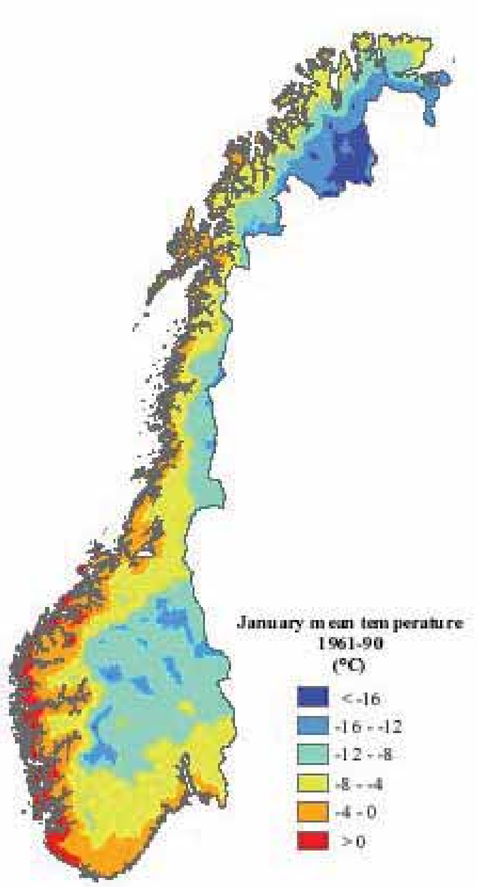


Figure 2.14 January mean temperature in Norway, 1961-1990 (°C)
Source: Norwegian Meteorological Institute

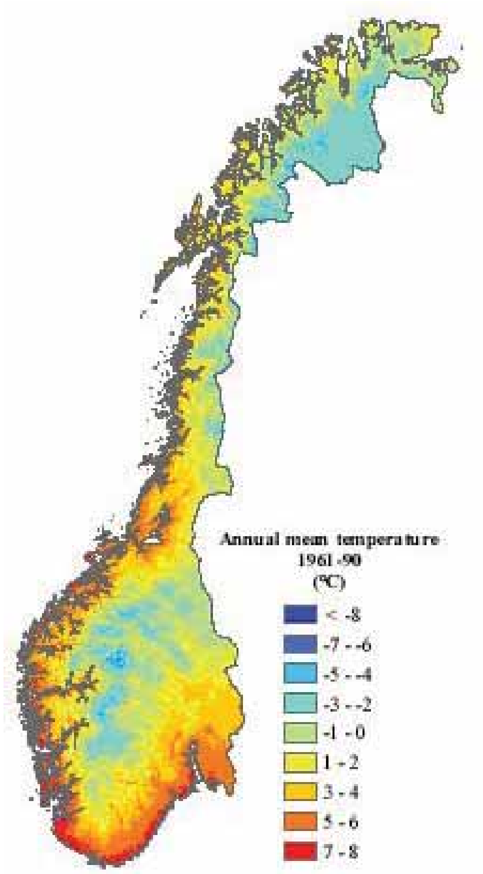


Figure 2.13 Norway's mean annual temperature, 1961-1990 (°C)
Source: Norwegian Meteorological Institute

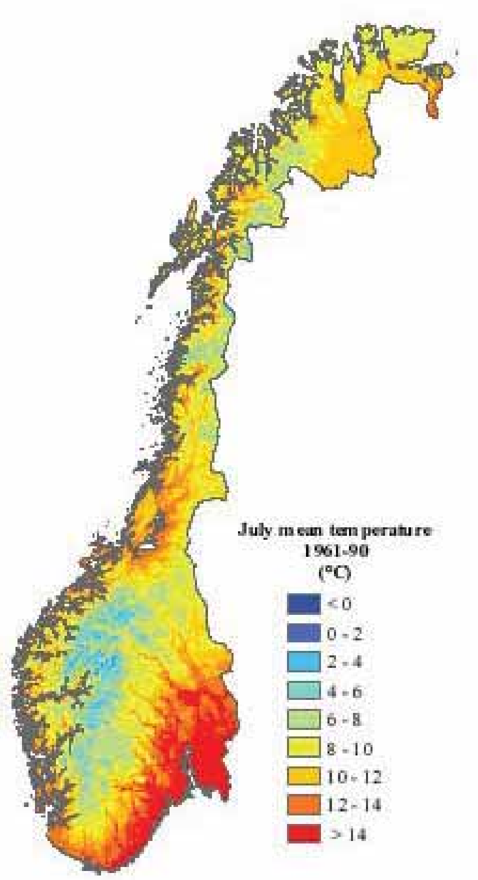


Figure 2.15 July mean temperature in Norway, 1961-1990 (°C)
Source: Norwegian Meteorological Institute

The size and elongated form of the country result in wide variations in climate, geology and topography and therefore in great variations in conditions for land use. About 30 per cent of its area lies 0–299 meters above sea level, and this is where most people live and where agricultural production is most intensive. As much as 20 per cent of the land area lies at least 900 meters above sea level.

Agricultural areas account for only 3 per cent of the mainland, while about 29 per cent is covered by forest. The remaining area consists of other cultivated land, scrub and heath along the coast, mountain forest and marginal forest, and sparsely vegetated mountains and mountain plateaus. Some 47 per cent of the land is above the tree line. Currently, almost 8 per cent of the land area is protected under the Nature Conservation Act. Nevertheless, the proportion of wilderness-like areas, defined as areas more than 5 km from major infrastructure development, has been reduced dramatically from about 48 per cent of the land area in 1900 to about 12 per cent today. Only about 5 per cent of the area of southern Norway is characterized as wilderness-like.

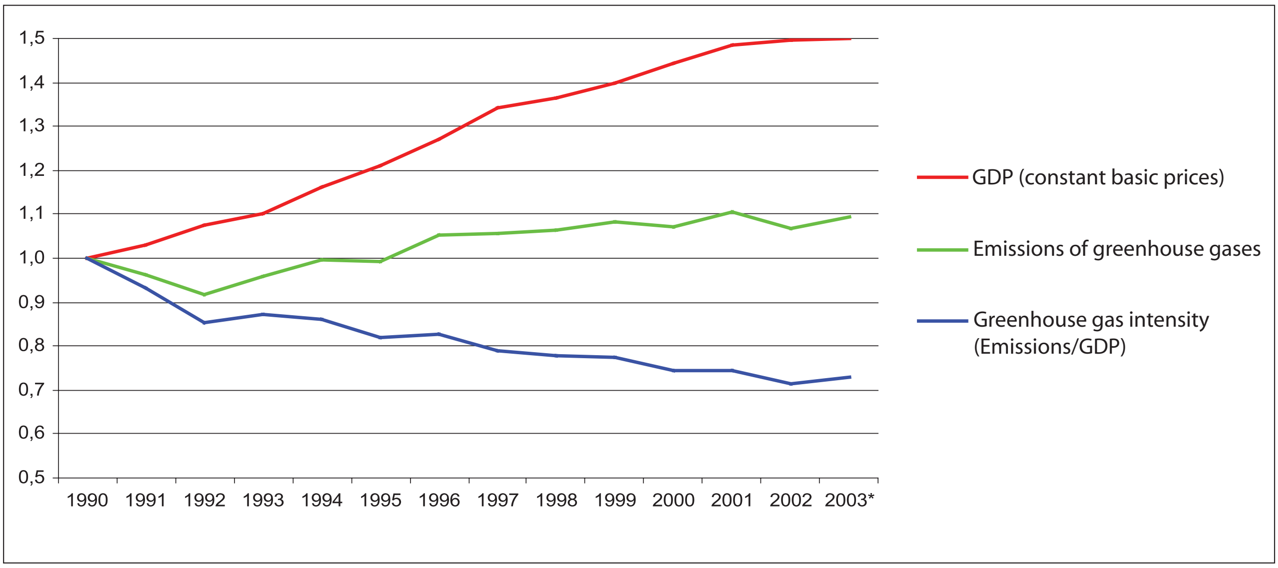
2.3 Population and urban profile

With a total area of almost 324 000 km^2 and only 4.6 million inhabitants, Norway has the second lowest population density in Europe after Iceland. An increasing percentage of the population lives in urban settlements in central parts of the country. Around 1900, 35 per cent of the population lived in densely populated areas. In 2005, almost 78 per cent of Norway's population lives in urban settlements. The number of large urban settlements is small – only 19 have more than 20 000 residents. Only four cities – Oslo, Bergen, Trondheim and Stavanger – have more than 100 000 residents. Currently, almost 30 per cent of Norway's population lives in the four largest cities.

2.4 Economic profile and industry

Measured in fixed prices, Norway's gross domestic product (GDP) has risen steadily during the past ten years. The Norwegian economy passed a cyclical peak in 1998, and since then the growth has been weaker than in the mid-1990s. However, growth in the mainland economy picked up appreciably in 2004 and the GDP increased by 2.9 per cent. Petroleum investment, which for a generation has played a decisive role in business cycle developments in Norway, is estimated to increase and stay at a high level in coming years. This will contribute to retain the activity in parts of the industry. The price of petroleum appears to have moved up to a markedly higher level than most observers previously anticipated, which means that financial investment in Norway will remain at record-high levels.

Figure 2.16 Change in greenhouse gas emissions and GDP 1990-2003



Source: Norwegian Pollution Control Authority, Statistics Norway

Production in manufacturing dropped both in 2002 and 2003 and mining and quarrying production dropped in 2002 and 2004. In the same period production in the service industries rose steadily. The production in the post and telecommunications sector measured in fixed prices has risen by more than 7 per cent per year over the past three years. The composition of the mainland economy has thus had a positive development with regard to greenhouse gas emissions. However, production has also risen in the domestic passenger transport and land transport. These sectors are major contributors to greenhouse gas emissions, as well as to local air pollution problems.

In 2003, Norwegian emissions of greenhouse gases increased more than value added for the first time in a number of years. Emissions of CO_2 increased in particular due, among other reasons, to higher levels of natural gas production, increased use of light fuel oils, as well as increased emissions from road transportation and coastal shipping. In 2004, the increase in GDP was back on 1990-levels whereas the rise in greenhouse gas emissions stayed rather stable.

Several aspects of international efforts to mitigate adverse effects of climate change may have consequences for Norway. The Norwegian economy is small and open and exports and imports constitute a relatively high share of GDP. International action to reduce or limit emissions of greenhouse gases may in this respect alter the external framework for the Norwegian economy and result in changes in the prices of important commodities.

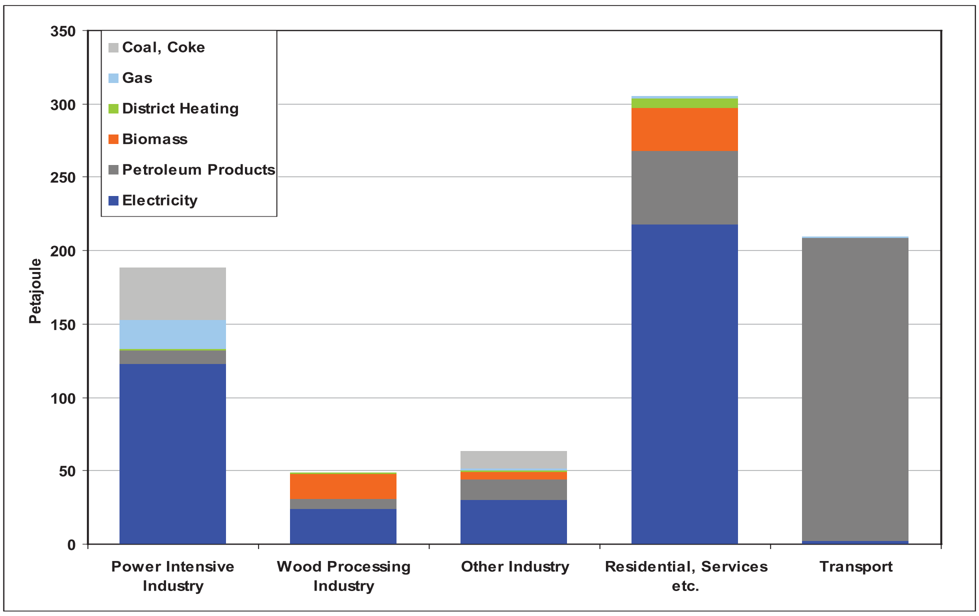
Norwegian CO_2 taxes have been in force since 1991 and cover about 68 per cent of the CO_2 emissions. The development of Norwegian CO_2 taxes illustrates the challenges a small open economy faces in being at the forefront of efforts to introduce efficient instruments designed at limiting global environmental problems. A lack of international implementation and co-ordination of such instruments may lead to leakage effects, and this in turn may mean that a country like Norway incurs substantial costs in achieving a given reduction in national emissions. However, due to the careful design of the CO_2 tax system, the competitive position of the Norwegian industries has not been significantly affected so far.

2.5 Energy

Electricity production in mainland Norway is based almost entirely on hydropower, which has no emissions of greenhouse gases, but has other environmental impacts. There is however a limited potential for further development of hydropower production, see Figure 2.18.

The Norwegian electricity market has been deregulated, starting with the entry into force of the Energy Act in 1991. Following the liberalization of the electricity markets in the Nordic countries, Norway, Sweden, Denmark and Finland have a common electricity market. Because of growing competition between energy sources, and variation in the availability of water supplies and consequently in hydropower production, emissions from electricity production in the Nordic countries vary from year to year.

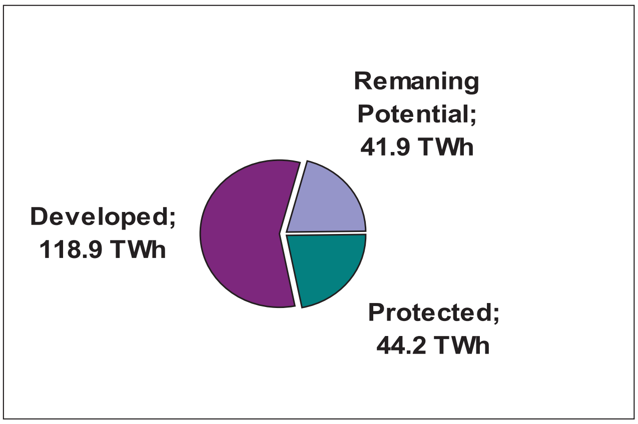
Figure 2.17 Norwegian energy balance, 2004



Source: Statistics Norway

Given the current production capacity, production in a year with normal precipitation is calculated to be 119.8 TWh (including 0.9 TWh thermal power). In a year with normal precipitation and temperature, Norway would be expected to be a net importer of electricity. Net imports in a normal year are now estimated to be 5-6 TWh. Electricity production in Norway in 2004 totalled 110.4 TWh. The net electricity imports in 2004 was about 11.5 TWh.

Figure 2.18 Norway's hydropower potential, January 2005, TWh/year.



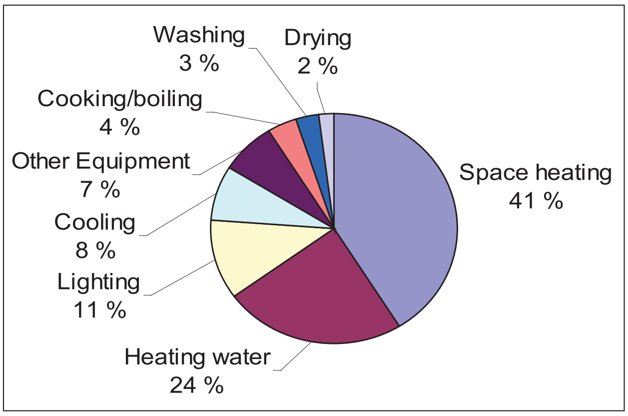
Source: Norwegian Water Resources and Energy Directorate

The petroleum sector is Norway's largest industry. In 2004 the petroleum sector accounted for 21 per cent of GDP, 27 per cent of state revenues, 47 per cent of the value of Norway's exports and 24 per cent of the country's total investments.

2004 was a record year for petroleum production on the Norwegian Continental Shelf. Production amounted to 3.2 million barrels of oil (including Natural Gas Liquids and condensate) per day and 78 billion standard cubic metres (scm) of gas, making a total of saleable petroleum of 263 million scm of oil equivalents. Oil production is expected to remain relatively constant until 2007, and then to fall gradually. Gas production is expected to increase until 2010 and to plateau at a level of 120 billion scm.

The petroleum sector accounted for about 25 per cent of total greenhouse gas emissions in Norway in 2003. Emissions of greenhouse gases from the sector have been increasing the last years, due to increased oil and gas production. However, at the same time the production has become more efficient. CO_2 emissions per produced oil equivalent fell by 22 per cent from 1990 to 2003.

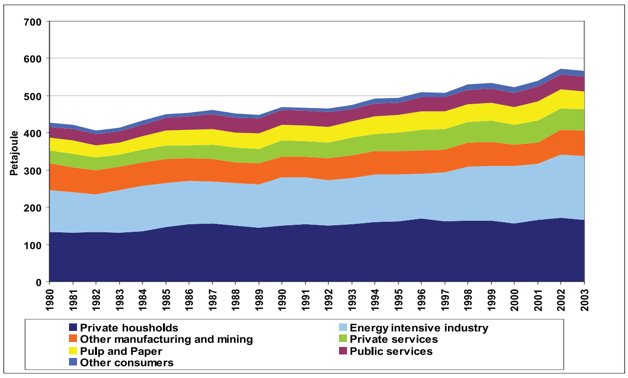
Figure 2.19 Electricity consumption in households by purpose



Source: Statistics Norway

Energy use in the manufacturing, residential and service sectors (i.e. stationary energy use) in Norway is relatively high compared to the levels in most other IEA countries, see Figure 2.17. This is partly explained by the cold climate and energy intensive industrial structure: adjusted for these two factors, Norway's levels of stationary energy use are just above the average for the thirteen IEA countries (Unander et al. 2000). Because of the amount of renewable energy (hydropower and some wind and biofuel) used in Norway, per capita CO_2 emissions are lower than the OECD average. Energy-related CO_2 emissions have not risen at the same rate as economic growth in Norway. The availability of relatively cheap hydropower has resulted in a long tradition of high electricity consumption, and has provided limited incentives for energy efficiency. Today, per capita electricity consumption is higher in Norway than in any other country in the world.

Figure 2.20 Stationary energy use by sector



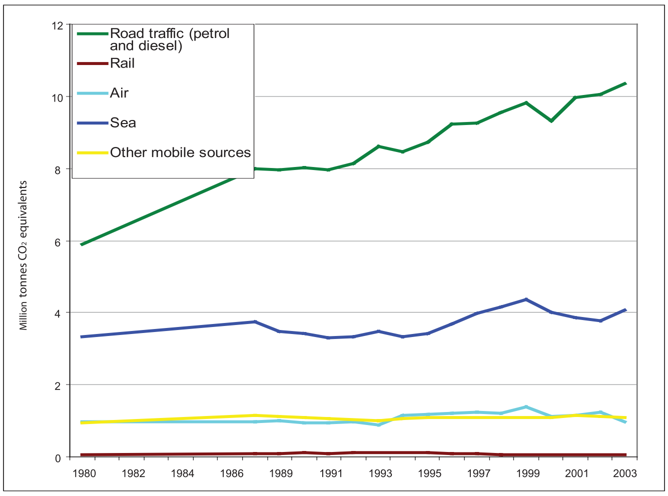
Source: Statistics Norway

Further details of the energy situation in Norway may be found in the Ministry of Petroleum and Energy's fact sheets on energy and water resources and on the petroleum sector and its environmental impact (see www.odin.dep.no/oed).

2.6 Transport

Norway's decentralized settlement pattern gives rise to a relatively high demand for transport, and makes public transport systems relatively costly. From 1960 to 2003, people's mobility in Norway, measured in kilometres travelled per person, rose by a factor of four, while the volume of public transport rose only insignificantly. In addition, the Norwegian economy is largely based on the extraction of raw materials and exports of goods, which means that there is a large volume of goods transport. The demand for rapid transport and more frequent deliveries of goods is also rising. As a result, the proportion of passenger transport by cars and the proportion of goods transport by road and air is rising, and this generates higher CO_2 emissions.

Figure 2.21 Greenhouse gas emissions from transport in Norway, by mode of transport. 1980-2003. Million tonnes CO_2 equivalents



Sources: Statistics Norway, Norwegian Pollution Control Authority

From 1980 up to the end of 2002, the volume of goods transport measured in tonne-kilometres has increased by 77 per cent, and if oil and gas transport from the North Sea is also included, the increase is no less than 296 per cent. The growth in transport from the North Sea to the mainland, and in goods transport by road are the main factors behind the overall rise in goods transport.

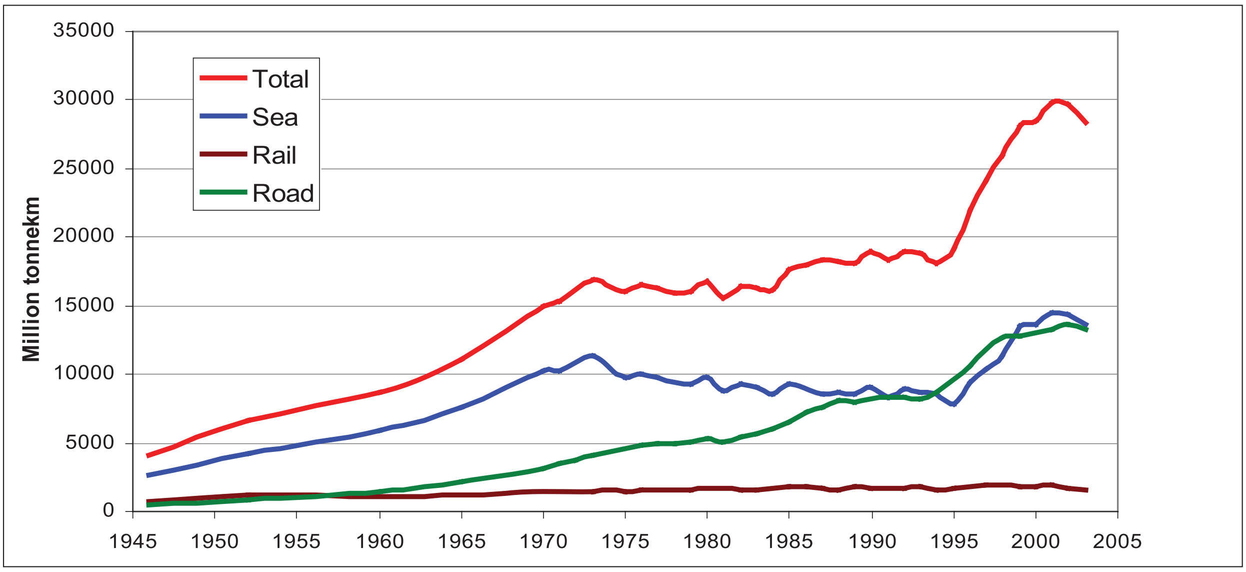
In 2003, 26 per cent of Norway's total greenhouse gas emissions were attributed to transport. Road traffic accounted for 19 per cent of the total. In 2003, CO_2 emissions from the transport sector were 28 per cent higher than in 1990.

2.7 Agriculture and forestry

Norway has limited land resources available for farming. Only about 3 per cent of Norway's area is cultivated land. The total size of agricultural areas in use has remained stable during the last few decades, but the importance of agriculture to the national economy has been declining. The agricultural sector generates about 9 per cent of total greenhouse gas emissions in Norway. Emissions from the agricultural sector have been stable over the past ten years.

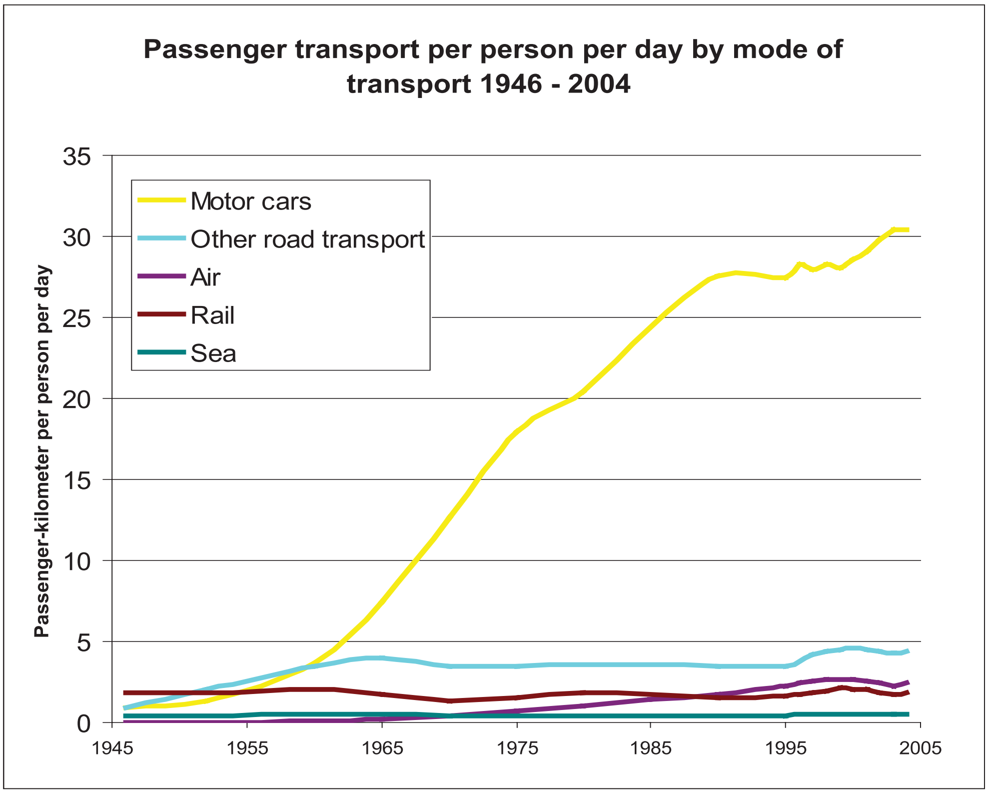
Forests cover some 29 per cent of the Norwegian land area. The relative economic importance of forestry has decreased over years, while other uses of forested areas have become more important. However, in some rural areas, forestry is still important economically, and the export value of

Figure 2.22 Goods transport by mode of transport. Million tonnekilometers. 1946, 1952, 1960, 1965, 1970-2003



Sources: Statistics Norway, Norwegian Pollution Control Authority.

Figure 2.23 Passenger transport pr. person pr. day by mode of transport 1946-2004



Source: Statistics Norway

timber is considerable, corresponding to 2.7 per cent of total exports in 2004.

In 2000, the net increment (annual increment minus roundwood removals and calculated natural losses) in Norwegian forests was 11.7 million m^3, or 1.7 per cent of the total growing stock. Removals of CO_2 in Norway due to land-use change are relatively insignificant compared to sequestration in existing forest. For 2003, the net sequestration of CO_2 from the land use, land-use change and forestry sector has been estimated at 21 million tonnes. That would correspond to about 38 per cent of the total anthropogenic greenhouse gas emissions.

3. GREENHOUSE GAS INVENTORY INFORMATION

3.1 Overview

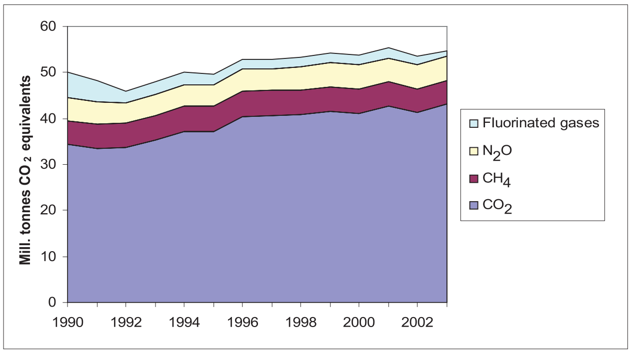
The Norwegian National greenhouse gas Inventory Report (NIR) has been prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories, and generally the estimation methods follow the Guidelines for National Greenhouse Gas Inventories published by the Intergovernmental Panel on Climate Change (IPCC). The latest national greenhouse gas inventory report was submitted to the UNFCCC Secretariat 15 April 2005. Some of the results from the report are highlighted in this chapter. All data and information are consistent with the information provided in the annual inventory report.

The 2004 greenhouse gas inventory submission of Norway was subject to a centralized review by an expert review team in October 2004. The main finding was that the Norwegian inventory is largely complete. A more detailed description of data and methodology is presented in the National Inventory Report.

The National Inventory Report covers emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and hydrofluorocarbons (HFCs) from 1990 to 2003, see Table 3.1. The total emissions of greenhouse gases for the same period is shown in Figure 3.1, and the emissions for year 2003 by gas is illustrated in Figure 3.2.

The total emissions of greenhouse gases, measured as CO_2 equivalents, were about 54.8 million tonnes in 2003. For the period 1990-2003 the increase in the emissions expressed in CO_2 equivalents was about 9 per cent. The increase is mainly due to economic growth in general, which has resulted in higher CO_2 emissions from most sectors. This trend has to some degree been counteracted by decreased emissions of fluorinated gases from metal plants. From 2002 to 2003 emissions increased by 2 per cent - mainly due to increased oil and gas production and increased sales of heating oil because of weather related increases in electricity prices.

Figure 3.1 Total emissions of greenhouse gases 1990–2003 in CO_2 equivalents



Sources: Norwegian Pollution Control Authority, Statistics Norway

Table 3.1 Emissions of greenhouse gases for the years 1990-2003 in CO_2 equivalents [1)].

Year	CO_2	CH_4	N_2O	PFCs	SF_6	HFCs	Total
1990	34,4	5,2	5,1	3,3	2,2	0,0	**50,1**
1991	33,5	5,2	4,9	2,5	2,1	0,0	**48,3**
1992	33,8	5,3	4,3	2,0	0,7	0,0	**46,0**
1993	35,4	5,3	4,6	2,0	0,7	0,0	**48,0**
1994	37,3	5,4	4,7	1,7	0,9	0,0	**50,0**
1995	37,2	5,4	4,8	1,6	0,6	0,0	**49,6**
1996	40,4	5,4	4,9	1,4	0,6	0,1	**52,8**
1997	40,6	5,5	4,8	1,4	0,6	0,1	**52,9**
1998	40,8	5,3	5,1	1,3	0,7	0,1	**53,3**
1999	41,6	5,2	5,3	1,1	0,9	0,2	**54,3**
2000	41,1	5,3	5,2	0,9	0,9	0,2	**53,8**
2001	42,7	5,3	5,2	1,0	0,8	0,3	**55,3**
2002	41,2	5,1	5,4	1,1	0,3	0,4	**53,5**
2003	43,2	5,1	5,3	0,7	0,2	0,2	**54,8**
Change 90-03	26 %	-2 %	5 %	-79 %	-89 %		**9 %**

1) HFCs are given as actual emissions (Tier 2).

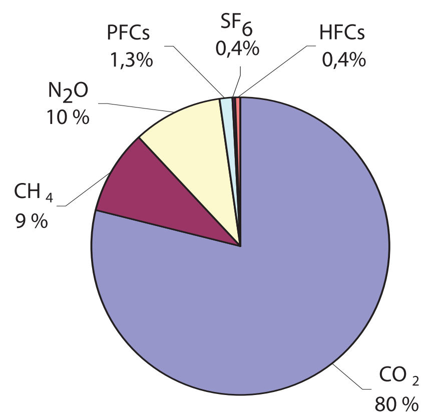
Sources: Norwegian Pollution Control Authority, Statistics Norway

CO_2 emissions account for approximately 80 per cent of total emissions and these emissions are also the main cause for the overall increase in emissions. Mobile sources (road traffic, costal traffic and shipping) and, in particular, oil and gas industry have contributed most significantly to this increase.

For CH_4 and N_2O overall emissions, as well as sectorial emissions from agriculture, have been relatively stable. Activity-related emissions of N_2O from nitric acid production and CH_4 emissions from waste handling were projected to increase. These projections have not materialized due to process optimalization on fertilizer plants and increased recovery of methane from landfills and incineration of waste. There has, however, been a large increase in emissions of N_2O from road traffic.

From 1990 to 2003 emissions of fluorinated greenhouse gases have been reduced from 5.5 to 1.1 million tonnes CO_2 equivalents. This is mainly due to reduced emissions of SF_6 from magnesium production and PFCs from aluminium production. In recent years emissions of SF_6 from electrical switchgear have also been reduced due to a voluntary agreement, while the upward trend on emissions of HFCs has been reversed due to taxation of this gas.

Figure 3.2 Emission of greenhouse gases 2003 by gas.



Sources: Norwegian Pollution Control Authority, Statistics Norway

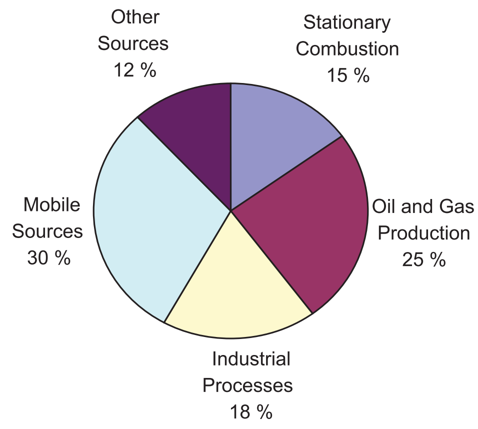


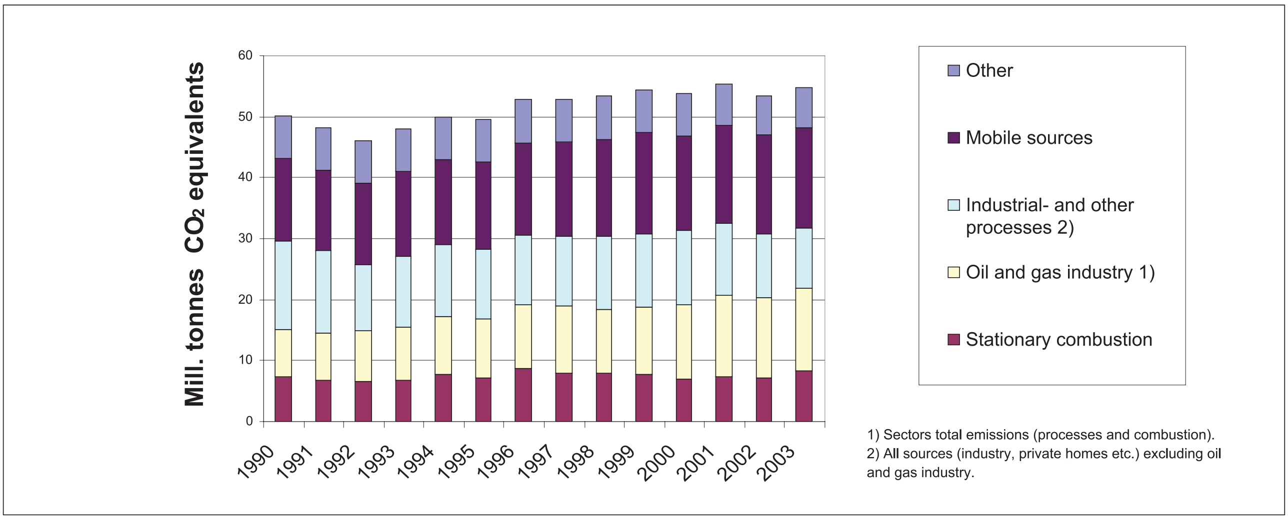
Figure 3.3 Emission of greenhouse gases 2003 by source category.
Sources: Norwegian Pollution Control Authority, Statistics Norway

3.2 Emissions of CO_2

The emissions of CO_2 in 2003 were 43.2 million tonnes. The Norwegian CO_2 emissions from the industrial sector are dominated by sources related to oil and gas extraction and production of metals, minerals and chemicals. A relatively large share of the transport-related emissions originates from coastal shipping and the fishing fleet. Since generation of electricity is almost exclusively from hydropower, emissions from stationary combustion are dominated by industrial sources.

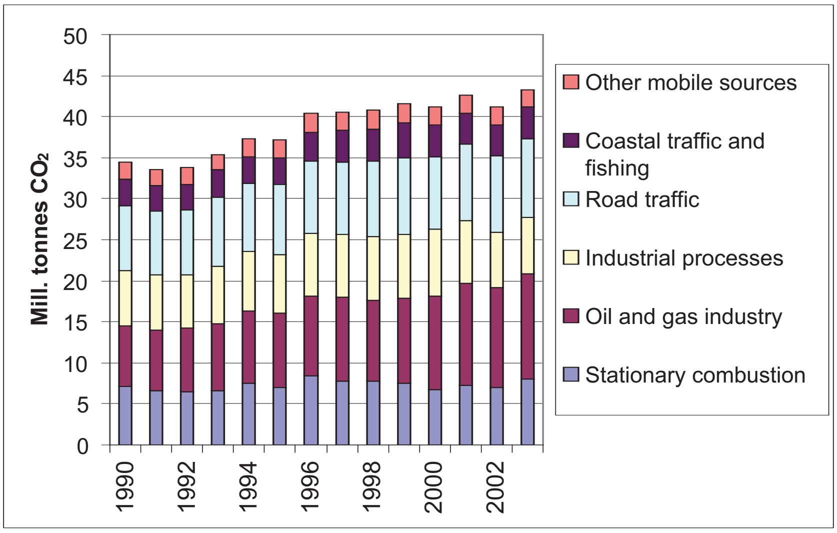
From 1990 to 2003 the total CO_2 emissions increased by 26 per cent, see Figure 3.6. The dominant force behind this increase is a nearly constant increase in emissions from oil and gas extraction during the whole period (from 7.4 to 12.8 million tonnes, accounting for 61 per cent of the increase). The main reason for this increase is a generally increasing production of oil and gas. Emissions from road traffic and coastal traffic and fishing have also increased during this period, while emissions from other mobile sources and industry (combustion and processes) are back on 1990 level after peaking in the mid- and late 1990s.

Figure 3.4 Total emissions of greenhouse gases 1990-2003 by source



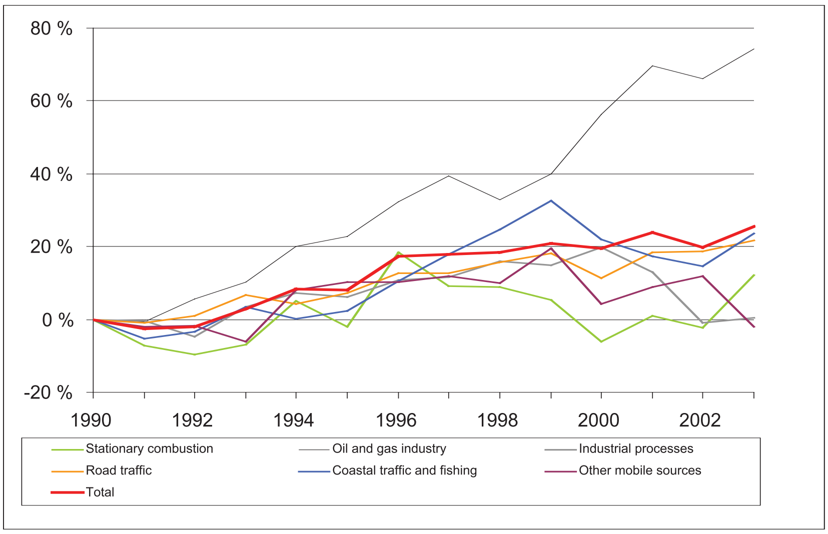
Sources: Norwegian Pollution Control Authority, Statistics Norway

Figure 3.5 CO_2 emissions 1990–2003.



Sources: Norwegian Pollution Control Authority, Statistics Norway

Figure 3.6 Changes in CO_2 emissions 1990-2003 by source category



Sources: Norwegian Pollution Control Authority, Statistics Norway

3.3 Emissions of CH_4

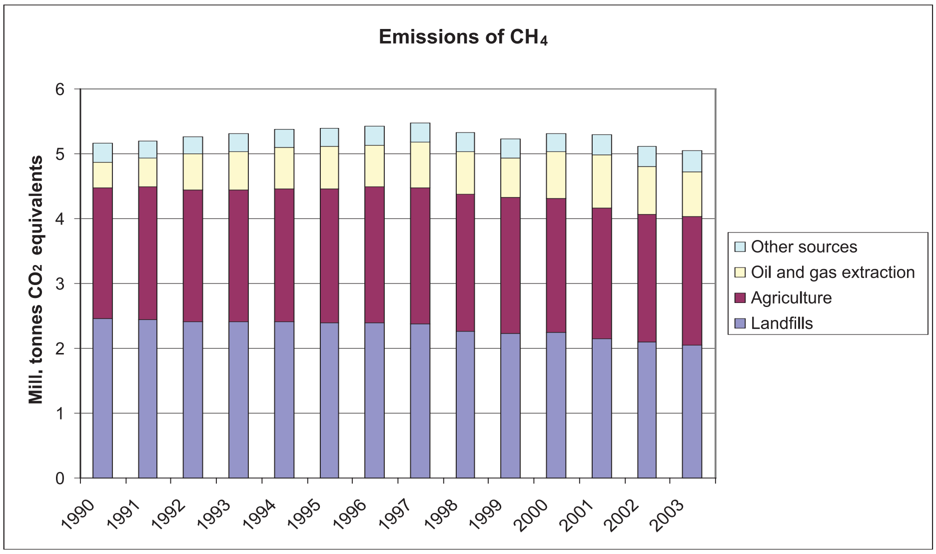
The total emissions of CH_4 were 241 000 tonnes (5.1 million tonnes CO_2 equivalents) in 2003. About 79 per cent of the emissions in 2003 originated from waste treatment and agriculture, see Figure 3.7.

Agricultural emissions are relatively stable from year to year and are little affected by short-term economic cycles. For waste treatment, emissions were relatively stable throughout the 1990s, as higher waste volumes were offset by increased recycling of waste and increased burning of methane from landfills. In the past 6 years, emissions from landfills have been reduced by 14 per cent despite increased waste volumes.

Combustion and evaporation/leakage in the oil and gas industry accounted for 14 per cent of the total CH_4 emissions in 2003, which is a 74 per cent increase from the 1990 level. Minor sources include emissions from petrol cars, domestic heating and coal mining.

For the 2003 emissions inventory, CH_4 emissions from waste were recalculated using an improved methodology. This led to significantly lower estimates for all years compared to previous estimates.

Figure 3.7 CH_4 emissions 1990-2003 in million tonnes CO_2 equivalents



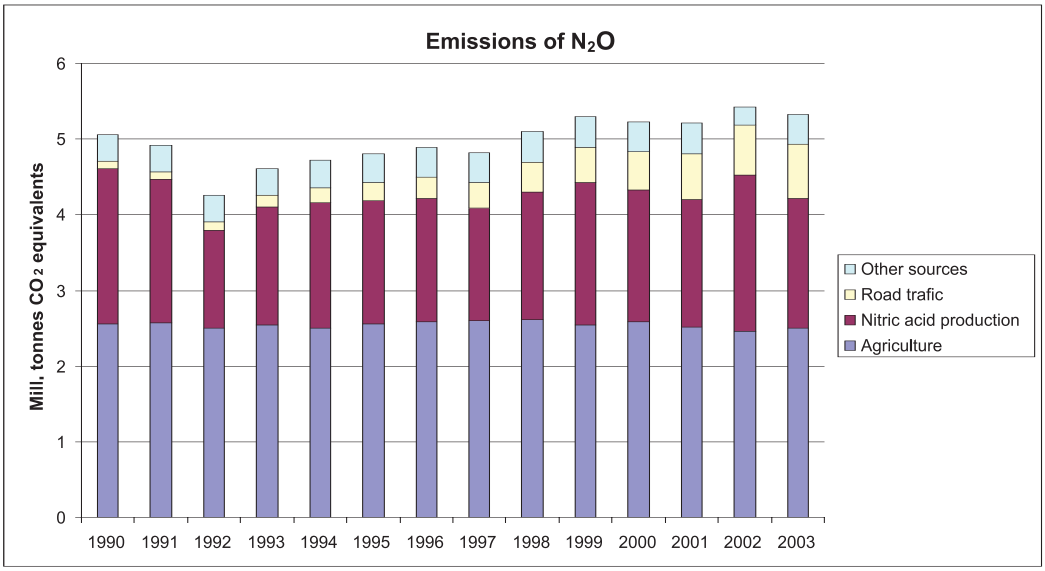
Sources: Norwegian Pollution Control Authority, Statistics Norway

3.4 Emissions of N_2O

Since 1990 N_2O emission levels have been of the same magnitude as CH_4 emissions. However the variations from year to year have been somewhat larger, due to fluctuations in emissions from nitric acid production. N_2O emissions are also characterized by a moderately increasing trend due to large increases in emissions from road traffic. The total emissions of N_2O were 17 200 tonnes (5.3 million tonnes CO_2 equivalents) in 2003.

Roughly half of the emissions originate from agriculture and these emissions producing nitric acid have been relatively stable from year to year. The other major source is the two plants manufacturing nitrogenous fertilizer. Changes in production processes led to decreased emissions in the beginning of the 1990s, while there have been moderate fluctuations in the following years due to changes in production volumes and improved management. Emissions from mobile sources are increasing considerably because of the introduction of catalytic converters, and presently account for 13 per cent of the total N_2O emissions.

Figure 3.8 N_2O emissions 1990-2003 in million tonnes CO_2 equivalents

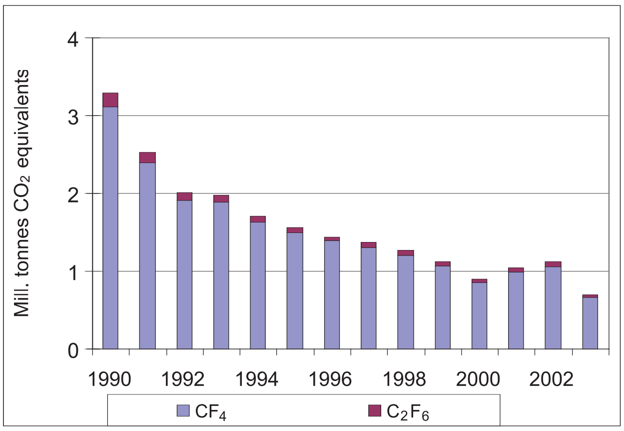


Sources: Norwegian Pollution Control Authority, Statistics Norway

3.5 Emissions of PFCs

The emissions of PFCs (CF_4 and C_2F_6) from Norwegian aluminium plants in 2003 were calculated to be approximately 0.7 million tonnes CO_2 equivalents, which covers virtually all Norwegian PFCs emissions. From 1990 to 2003 the emissions of PFC-gases were reduced by 79 per cent, see Figure 3.9. This is explained by improved technology, process control and conversion to Prebake technology, which has caused a reduction of the PFC emissions per tonne aluminium produced by approximately 84 per cent from 1990 to 2003.

Figure 3.9 PFC emissions 1990-2003 in million tonnes CO_2 equivalents



Sources: Norwegian Pollution Control Authority, Statistics Norway

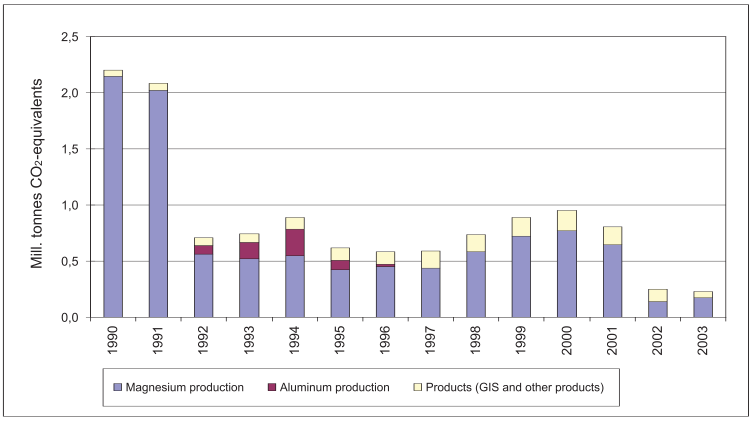
3.6 Emissions of SF_6

The emissions of SF_6 in 2003 were 9.7 tonnes (0.23 million tonnes CO_2 equivalents), which is significantly below the emissions in 1990.

The largest emission source in Norway is magnesium production (74 per cent) where SF_6 is used to cover the surface of liquid magnesium to prevent it from oxidizing. Relative emissions were reduced in the early 1990s due to improvements in technology and process management, as well as reductions in production levels. Fluctuations from 1992 to 2001 are mainly influenced by production volumes. Primary production stopped in 2002, resulting in a drop in emissions to about one quarter of the previous level. Similar use of SF_6 in the aluminium industry in the early 1990s has ceased.

The remaining quarter of emissions originate mainly from electrical switchgear (GIS). These emissions have been approximately halved since a voluntary agreement was signed in 2002.

Figure 3.10 SF_6 emissions 1990-2003 by source category in million tonnes CO_2 equivalents



Sources: Norwegian Pollution Control Authority, Statistics Norway

3.7 Emissions of HFCs

The emissions of HFCs were 0.24 million tonnes CO_2 equivalents in 2003, amounting to about 0.4 per cent of total emissions of greenhouse gases.

These emissions gained significance in the mid-1990s, when HFCs were introduced as substitutes for ozone-depleting substances. A trend of exponential growth was reversed after a tax on import and production of HFCs and PFCs was introduced in 2003. Due to increased demand caused by the phasing out of CFCs and HCFC, future growth in these emissions can not be ruled out. However, it is presumed that better maintenance of equipment and more use of low-GWP HFCs and alternative substances will result in a reduced growth rate compared to previous scenarios.

HFC-134a, HFC-125 and HFC-143a are the most important emissions, see Figure 3.11.

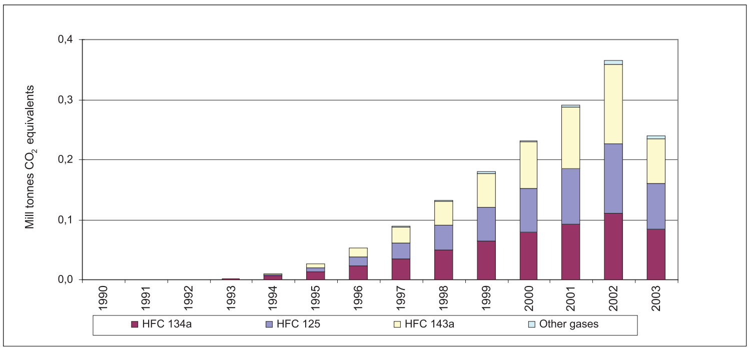
3.8 Emissions from international aviation and marine bunker fuels

In 2003, CO_2 emissions from ships and aircraft in international traffic bunkered in Norway amounted to a total of 2.5 million tonnes. CO_2 emissions from this category showed a growth of about 80 per cent during the period 1990 to 1997. This increasing trend was reversed in 1998, and from 1997 to 2003 emissions were reduced by 33 per cent. Compared to 1990, the emissions were 21 per cent higher in 2003.

3.9 Emissions and removals from land-use, land use change and forestry

The total net sequestration from the land-use, land-use change and forestry sector was about 21 million tonnes of CO_2 in 2003, which would offset 38 per cent of the total greenhouse gas emissions in Norway that year. The sequestration increased by 56 per cent from 1990 to 2003, while the increase from 2002 to 2003 was only 0.2 per cent. Forest land covers some 29 per cent of Norway, and is the most important land-use category. Forest land is also the most important contributor to carbon stock changes. In 2003 the land-use category forest land remaining forest land was the only contributor to the total sequestration with approximately 23.4 million tonnes CO_2. All other land-use categories showed net emissions, which totalled 2.5 million tonnes CO_2.

Figure 3.11 HFC emissions 1990-2003 by gas in million tonnes CO_2 equivalents



Sources: Norwegian Pollution Control Authority, Statistics Norway

4. POLICIES AND MEASURES

4.1 Overall policy context

Norway's climate policy is founded on the objectives of the Convention on Climate Change and the Kyoto Protocol and the scientific understanding of the greenhouse effect set out in the reports from the UN Intergovernmental Panel on Climate Change (IPCC). The policies and measures reported are thus seen as modifying long-term trends in anthropogenic greenhouse gas emissions and removals.

Climate change and emissions of greenhouse gases have been a concern of Norwegian policy since the late 1980s. As of today, Norway has a comprehensive set of measures covering almost all emissions of greenhouse gases.

Table 4.1 Norwegian green taxes 1997-2005

Applies to:	Type	1997	1999	2000	2001	2002	2005
Petrol tax, NOK/litre	basic rate, leaded (>0.05g/l)	4.76	5.03	5.13	4.85 4.53 (from 1 July)	4.62	x
	leaded (<0.05 g/l)	4.26	4.5	4.59	4.31 3.99 (from 1 July)	4.62	x
	unleaded	4.02	4.25	4.34	4.06 3.74 (from 1 July)	3.81	4.03 (sulphur free) and 4.07 (low sulphur
	CO_2 tax	0.87	0.92	0.94	0.72	0.73	0.78
Mineral oil NOK/litre	CO_2 tax	0.435	0.46	0.47	0.48	0.49	0.52
	Sulphur tax (per 0.25 per cent sulphur content. >0.05ppm)	0.07	0.07	0.07	0.07	0.07	0.07
	basic tax on heating oil			0.19	0.382	0.389	0.414
Autodiesel NOK/litre	basic rate	3.35	3.54	3.74	3.04 (until 1 July)		
	sulphur content <0.005 pst			3.54 (from 1 July)	2.72 (from 1 July)	2.77	2.92 (<10ppm sulphur)
	sulphur content >0.005 pst			0.25	3.04 (from 1 July)	3.1	2.97 (<50ppm sulphur)
	Sulphur tax (>0.005 pst)				0.26 (until 1 July)		
Lubricating oil NOK/litre	tax	1.05	1.11	1.46	1.5	1.53	1.62
	refund	1.5	1.8	1.65	1.7	1.73	1.83
Continental shelf NOK/litre (/Sm3)	CO_2 tax on: - natural gas/petroleum	0.87	0.89	0.7	0.72	0.73	0.78
	Sulphur tax, NOK/litre		0.013	0.013 0.026 (from 1 July)	0.027	0.028	0.03
Coal/coke NOK/kg	CO_2 tax	0.435	0.46	0.47	0.48	0.49	0
	Sulphur tax		3	3 6.0 (from 1 July)	3.09	0	0
Domestic air transport	CO_2 tax on mineral oil (reduced rate)Per passenger:			0.27	0.28	0.31	
	noise charge aircraft landings (Bodø)	noise differentiated	noise differentiated	noise differentiated			
	passenger (seat) tax:	70,5 141	114 (some domestic) 228 (foreign flights)	116 232	128 (from 1 April) 128 (from 1 April)	0 (from 1 April) 0 (from 1 April)	0 0
Electricity tax	production	0.0139 (0.0188 from 1 July)					
NOK/kWh	consumption	0.0562	0.0594	0.0856	0.113 0.103 (from 1 July)	0.93	0.99
Fertilisers	phosphorus	2.30 NOK/kg	2.30 NOK/kg	0	0	0	0
	nitrogen	1.21 NOK/kg	1.21 NOK/kg	0			
Tax on final disposal of waste	to landfills		300	306	314	320	533 (low environmental standard), 409 (high standard)
NOK/tonne	Incineration - basic tax		75	77	79	80	varies
	additional tax		225	229	235	240	varies
Car deposits NOK	deposit for new cars	900	1200	1300	1300	1300	1300
	refund for car wrecks	1000	1500	1500	1500	1500	1500

4.2 Cross-sectoral policies and measures

4.2.1 Introduction

Norway has advocated cost-effectiveness across emission sources and sinks, sectors and greenhouse gases both domestically and internationally. This has been a point of departure both for formulating the present climate change policy and for designing and implementing policies and measures that will ensure compliance with the quantitative commitments of the Kyoto Protocol.

4.2.2 The Norwegian CO_2 tax scheme

Table 4.2 Environmentally related taxes in effect in Norway in 2005

Tax	Tax-rate NOK	Introduced in year
CO_2 tax	Different rates, see table 4.3	1991
SO_2 tax, mineral oil per litre		1970
Per 0,25 per cent weight share sulphur	0.07	
Reduced rate per 0,25 per cent weight share sulphur	0.030	
Petrol tax, per litre		1931
Sulphur-free	4.03	
Low-sulphur content	4.07	
Autodiesel tax, per litre		1993
Sulphur-free	2.92	
Low-sulphur content	2.97	
Tax on lubricating oil, per litre	1.62	1989
Waste tax, NOK per ton		1999
Landfills, NOK per ton		
Landfills with high environmental standard	409,00	
Landfills with low environmental standard	533,00	
Incineration plants	Varies	
CO_2 tax on incineration kr per ton	40.57	
Tax on environment and health damaging chemicals		2000
TRI, per kg	55.71	
PER, per kg	55.71	
Tax on HFCs and PFCs, per ton CO_2 equivalent	187.27	2003
Environmental tax on beverage containers made of		1973
Glass, per unit	4.46	
Metal, per unit	4.46	
Plastic, per unit	2.69	
Card board boxes, per unit	1.11	
Basic tax on non-refillable beverage containers, per unit	0.91	1994
Tax on electricity consumption, per kWh	0.0988	1951
Tax on electricity consumption, reduced rate (industry), per kWh	0.0045	
Heating oil tax, per litre	0.414	2000

CO_2 taxes were introduced in 1991 as a step towards a cost-effective policy to limit emissions of greenhouse gases. The main structure of the tax has been relatively stable since then, although there were some adjustments of coverage following experience of the first year of operation and some extension of the coverage took effect in 1999. The CO_2 tax is levied on about 68 per cent of total CO_2 emissions, corresponding to more than 50 per cent of total greenhouse gas emissions. For some goods such as petrol, other tax elements (basic tax, VAT) constitute a larger proportion of the price. For example, the fiscal tax on petrol is NOK 4.07 per litre, whereas the CO_2 tax is NOK 0.78 per litre. Thus, the total tax on such goods must be taken into account when evaluating the effect on emissions. The present coverage and tax rates are shown in Table 4.3.

As an adjustment towards firmer state aid rules determined by the EFTA Surveillance Authority (ESA), the CO_2 tax on coal and coke for energy purposes was abolished from 1 January 2003. Given the almost negligible actual and planned use of coal in the Norwegian energy system, and possibilities to address any such use with other policies and measures, consequences on emissions are very small, if any.

The development of the Norwegian CO_2 tax scheme illustrates the challenges a small open economy may face in seeking to be at the forefront of efforts to introduce efficient instruments to mitigate global environmental problems. Without international implementation and coordination of such instruments, carbon leakage may be a problem – in other words, companies may move their activities, and thus emissions, to countries without similar taxes or regulations. However, the design of the CO_2 tax system has meant that the competitive position of Norwegian industries has not been significantly affected so far.

Using taxes to achieve a cost-effective policy domestically would have required a uniform tax rate for all emissions of greenhouse gases. For some emissions, particularly of non-CO_2 gases, this has not been technically feasible. So far, very few other countries have introduced CO_2 taxes, and even those countries that have done so have not taxed the activities that are not included in Norway's CO_2 tax scheme. In several European countries, the role and design of CO_2/energy taxes are being reconsidered in the light of the introduction of an emissions trading scheme for CO_2. The proportion of Norwegian emissions that are not subject to the CO_2 tax is higher than for other countries that apply a CO_2 tax, as Norway has more emission intensive industries in relative terms.

Whereas the main features of the tax have been stable since some adjustments just after its introduction, there have been changes in the tax rates for the offshore industry and the use of petrol. As a follow up to the recommendations of the Green Tax Commission, some sources of emissions were added in 1998. The CO_2 tax was extended to domestic air transport, domestic sea transport of goods, and the supply fleet in the North Sea.

As a major exporter of fossil fuels, Norway is well aware that widespread international taxation of these commodities, as well as other policies and measures that influence demand, could have implications for prices and thus affect the revenue earned by exporters. This has been emphasized in relation to Article 4.8 and 4.9 of the Convention as well as Article 2.3 and 3.14 under the Kyoto Protocol. This is one of the reasons why Norway emphasizes the need to devise cost-effective policies, and thus minimize such effects. The final effects are, however, highly uncertain and will generally also depend on the producers' policies. Norway's share as a consumer is so small that it is not believed to significantly affect these markets.

Table 4.3 Norwegian CO_2 taxes 2005

	Tax –rates per litre oil and petrol, kg. Coal and coke or Sm3 gas	Tax rate per tonne CO_2
Petrol	0.78	337
Mineral oil		
Light oil	0.52	198
Heavy oil	0.52	171
<u>Reduced tax</u>		
Pulp and paper industry	0.26	86-99
Fishmeal industry	0.26	86-99
Domestic aviation	0.31	118
Domestic shipping of goods	0.31	118
Continental shelf (supply fleet)	0.31	118
<u>Exemptions</u>		
Foreign shipping	0	0
Fishing in Norway	0	0
Fishing in distant water	0	0
External aviation	0	0
Oil and gas in the North Sea		
Oil	0.78	289
Gas	0.78	333

The most significant effects of the CO_2 tax have probably been in the offshore petroleum industry, given that the sector generates a substantial proportion of total emissions and that the tax introduced major economic changes in this sector. These effects are monitored by the Norwegian Petroleum Directorate, which reports annually to the Ministry of Petroleum and Energy and the Ministry of Finance. Measures taken by the industry demonstrate a greater focus on environmental issues. The general focus on environmental issues is supported by the authorities.

The main effects of the tax in this sector are believed to be a result of improvements in the performance of installations planned and put in place after the tax was adopted, as well as replacement of old technology on installations that were already in place before the tax was introduced. By 2003, emissions per unit produced were 22 per cent lower than before the tax was introduced. However, the CO_2 tax is not the only factor that influences emissions per unit produced. General technological developments contribute to fewer emissions per unit produced, while a change in the characteristics of the petroleum fields towards more mature fields increases the energy use per unit produced. As a consequence, emissions per unit have been stable or slightly rising since 1996. In future, technology choices will be determined by expectations related to carbon costs, through a CO_2 tax or the price of credits and quotas

(AAUs, RMUs, ERUs and CERs) under the Kyoto Protocol from 2008.

Based on reports from the companies operating on the Norwegian Continental Shelf it is estimated that the CO_2 tax has contributed to make investments in more energy efficient technology profitable. As a consequence of investments in more energy efficient technology, emissions of CO_2 from the petroleum sector in 2000 were 2 million tonnes lower than they would have been in the absence of these investments. In addition, 1 million tonnes of CO_2 per year (equivalent to 2 per cent of domestic emissions of greenhouse gases) has been separated from the Sleipner West's gas production and reinjected into the Utsira formation (an aquifer) since 1996. (See Section 4.4.1) The reinjection of CO_2 from the Sleipner field is a direct response to the CO_2 tax. Thus, the tax has contributed to reduce emissions from the offshore petroleum sector by 3 million tonnes CO_2 in 2000, equivalent to 5 per cent of total greenhouse gas emissions in Norway. Given the lifetime of these measures and the increase in the sector's activity level, it is believed that the CO_2 tax has reduced the emissions level at least as much after 2000.

The CO_2 tax also represents a significant proportion of the consumer price of heating oils both to households and industry, although some industries pay lower rates. Emissions from these sources account for 10-15 per cent of the total national emissions of greenhouse gases. Many actors using heating oils have systems that allow the instant flexibility to use other energy sources, in particular electricity, in response to market prices. There are also possibilities for using fuels such as biomass. Intuitively, the tax would be expected to influence the day-to-day fuel choices of some actors, as well as the investments in technology that can use different energy sources. Furthermore, higher prices would encourage efforts to implement energy conservation measures.

In the transport sector, demand for fuels in the short run is less elastic than for heating oils. Furthermore, the CO_2 tax represents a smaller portion of the total consumer prices of petrol and autodiesel than of other fuels (generally around 10 per cent for petrol and less for autodiesel over the period it has been in effect). This is the case even though the highest absolute rates (NOK 337 per tonne CO_2 for 2005) have always been levied on petrol. However, to the extent that the CO_2 tax has increased the price of transport fuels, it is reasonable to assume that it must also have limited the increase in the volume of transport somewhat and encouraged the purchase of more fuel-effective vehicles than would otherwise have been chosen. It may also have led to some changes in preferred modes of transport.

In the Third National Communication documentation was also given for estimating the effects of the tax in other sectors than the offshore petroleum industry. The effect was estimated to 0.8 million tonnes. On average, emissions in the sectors studied were reduced by 3-4 per cent.

4.2.3 Tax and reimbursement scheme for HFC

A trend of exponential growth in HFC and PFC emissions was reversed after a tax on import and production of HFCs and PFCs was introduced in 2003. The tax is NOK 187 (approximately 23 Euro) per tonne CO_2 equivalents of gas imported or produced. This approximately equals the CO_2 tax rate on mineral oil. In 2004, this tax was supplemented with a reimbursement scheme, which prescribes a similar refund when gas is destroyed. Combined and over time, these two schemes amount to a proxy tax on emissions of HFC.

The tax and reimbursement scheme have resulted in better maintenance and improved routines during discharge of old equipment. It also gives a strong incentive for choosing HFCs with lower GWPs or alternative substances and processes. The first year after the tax was introduced emissions were reduced by 34 per cent. Estimates for 2004 are somewhat higher, indicating some excess buying of gas before the introduction of the tax.

It is expected that the tax will significantly reduce emissions compared to previous scenarios. However, due to increased demand caused by the phasing out of CFCs and HCFC, future growth in these emissions can not be ruled out. Rough estimates suggest that the emissions in 2010 will be about 50 per cent of what the emissions would have been without this measure, i.e. an emission reduction of approximately 0.5 million tonnes of CO_2 equivalents.

4.2.4 Tax on final treatment of waste

Norway introduced a tax on the final disposal of waste (including both landfills and incineration) from 1 January 1999. The purpose of the tax is to put a price on the environmental costs of emissions from landfills and incineration plants, and thereby act as an incentive to reduce emissions, increase recycling, reduce the quantities of waste and enhance utilisation of emissions for energy purposes. On landfills, the tax in 2005 is NOK 409 or 533 per ton waste, depending on the quality of the landfill site. On incineration plants, the tax is differentiated according to emissions.

For the effects of this tax, see Section 4.2.5.

4.2.5 Regulation by the Pollution Control Act

The Pollution Control Act applies to greenhouse gas emissions. Hence greenhouse gas emissions are included in the discharge permit which for instance industrial installations are obliged to obtain pursuant to the Pollution Control Act.

As a general rule, the emitter is granted a discharge permit for CO_2 corresponding to the amount in the application. One of the main reasons for this is that greenhouse gas emissions to a large extent are covered by other specific policy instruments such as the CO_2 tax, the emission trading system and specific agreements with the industry to cap emissions to a certain level. These instruments have been regarded as more efficient tools for reducing greenhouse gas emissions.

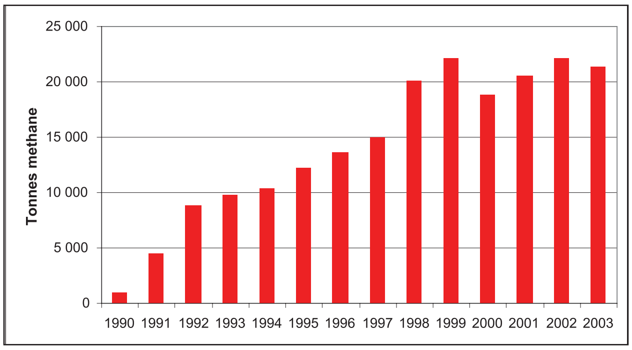
The Emission Trading Act has reduced the need for specification of emission limits for greenhouse gases. The Pollution Control Act may still be used to specify technological requirements relevant to emissions. However, this option's relevance in practice only applies to the establishment of new gas fired power plants.

In the waste sector, regulations under the Pollution Control Act are used in combination with other policy instruments. A number of measures to reduce the amount of organic waste deposited and to increase the collection and combustion of methane from landfills have been established. The most important measures are:

- Requirement to collect methane from landfills (gradually introduced from 1998)
- Tax on final treatment of waste from 1999
- Prohibition of depositing wet organic waste (gradually introduced from 2000)
- Measures to increase recycling, agreements with sectors of industry, measures introduced by local authorities etc. (gradually introduced from early 1990s)

The effect of these measures has been good, both in relation to the amount of waste generated, the waste deposited and the collection of methane from landfills. The Norwegian Pollution Control Authority has data illustrating how much methane has been collected and either used for the production of energy or flared during the last 10 years, see Figure 4.1. The figure illustrates that collection of methane has reduced the methane emissions by 12 000 tonnes in 1995, 19 000 tonnes in 2000 and 21 000 tonnes in 2003. This is the equivalent of 0.25, 0.4 and 0.45 million tonnes CO_2 equivalents, respectively. It is expected that this measure will reduce the emissions by 0.5 million tonnes CO_2 equivalents in 2005 and 0.6 million tonnes in 2010.

Fig 4.1 Methane collection from Norwegian landfills 1990-2003



Source: Norwegian Pollution Control Authority

The effects of the other measures are more difficult to quantify. A rough estimate suggests a reduction in methane emissions of about 3 500 tonnes in 2000, 13 000 tonnes in 2005 and 15 500 tonnes in 2010. This will give an effect of 0.07, 0.25 and 0.3 million tonnes CO_2 equivalents, respectively.

The effects of another instrument for reducing emissions from waste disposal sites, i.e. tighter requirements for the collection and use of landfill gas, have also been calculated. The calculations give a reduction of 7 000 tonnes of methane in 2010, or 147 000 tonnes CO_2 equivalents. A ban on landfilling of biodegradable waste has been proposed from 2009, which would gradually eliminate emissions from landfills.

The aggregate effect of these measures is an emission reduction of 1 million tonnes CO_2 equivalents in 2010.

Greenhouse gas effects of regulations introduced to reduce other emissions

NmVOC is not counted as a greenhouse gas, but is converted into CO_2 in the atmosphere. In the annual emission reports under the Convention on Climate Change, Norway therefore includes indirect emissions of CO_2 stemming from nmVOC leakages from fossil energy.

The Norwegian Pollution Control Authority has, on the basis of the Pollution Control Act, required that the operators in the Norwegian petroleum industry reduce emissions of nmVOC from offshore loading and storage of crude oil by 1 January 2006. Emissions must be reduced by 70 per cent compared to what the emissions would have been without any measures. The requirement is related to the Norwegian commitments under the Convention on Long Range Transboundary Air Pollution (Gothenburg Protocol).

The requirement to recycle nmVOC has been estimated to reduce the emissions by 60 000 to 70 000 tonnes of nmVOC in 2005 or approximately 200 000 tonnes of CO_2 equivalents.

Pursuant to requirements from the Norwegian Pollution Control Authority, a recycling plant for nmVOC emissions was put into operation at the Sture petroleum terminal in 1996. Theoretically, at full capacity, between 70 and 80 per cent of the nmVOC emissions that are generated at the terminal can be recycled. In practice, however, the recycling is lower than expected, approximately 60 per cent. In 2005, recycling of approximately 6 000 tonnes of nmVOC emissions, or almost 20 000 tonnes of CO_2 equivalents, is expected. The level of recycling is expected to fall as oil production is reduced.

Total nmVOC emissions have fallen by 32 per cent from 391 000 tonnes in 2001 to 266 000 tonnes in 2004. This reduction of 125 000 tonnes nmVOC constitutes approximately 390 000 tonnes of CO_2 equivalents.

For more details on fugitive fuel emissions from the petroleum sector, see Section 4.4.2.

4.2.6 Agreements and voluntary measures

The government has concluded a number of agreements concerning the reduction of greenhouse gas emissions in specific sectors of industry.

Emissions from the production of aluminium

In 1997, the major aluminium producers signed an agreement with the Ministry of the Environment to reduce emissions of greenhouse gases (CO_2 and PFCs) per tonne aluminium produced by 50 per cent in 2000 and 55 per cent in 2005, compared to 1990 levels. The industry's own reports shows that the agreement has been fulfilled so far – emissions were about 60 per cent lower per unit produced in 2003 than in 1990. It is however somewhat difficult to separate the effects of the agreement from other effects. According to the Norwegian Pollution Control Authority, the emissions were reduced by 4 million tonnes CO_2 equivalents from 1990 to 2000. The industry had however already reduced their emissions by 40 per cent from 1990 to 1997, when the agreement was signed. If – as a "business-as-usual" scenario – one assumes that the industry would not have changed the level of the emissions without the agreement, i.e. no improvements in efficiency, the highest estimate of 4 millions tonnes can be characterized as the reduction achieved through voluntary action before 1997. If one only includes the effects after the agreement was signed, i.e. in the agreement period, the estimated reductions are lower, about 1.2 million tonnes CO_2 equivalents in 2003 compared to the "business-as-usual" scenario.

Emissions of SF_6 from the electro industry

In June 2001, a non-profit trust, which by an agreement with the government is in charge of the collection, recirculation and destruction of discarded electric and electronic equipment, established a SF_6 recovery facility. In March 2002, this was followed up by a voluntary agreement between the Ministry of the Environment and the business organizations representing most users of gas-insulated switchgear (GIS) and the one producer. According to this agreement, emissions are to be reduced by 13 per cent in 2005 and 30 per cent in 2010 relative to base year 2000. The total SF_6 emissions from the industry were approximately 4.7 tonnes in 2000, or 110 000 tonnes of CO_2 equivalents. Preliminary estimates show that emissions in 2003 were 62 per cent below target, while emissions in 2004 were 56 per cent below target, something which indicates that the target for 2010 already has been met. This achievement is due to a coordinated effort by the electric utility sector to improve maintenance and recovery. Emissions from the GIS production facility have been almost halved due to better process management and significant investments in new equipment, while emissions from GIS in use have been reduced by 70 per cent. However, future emissions for single years might be significantly higher if, for example, large accidents occur.

Statistics Norway is currently performing a detailed assessment of the reductions in the GIS sector.

Arrangement to reduce emissions in the processing industry

In 2004, the Ministry of the Environment agreed on an arrangement with the Federation of Norwegian Process Industries. Sources include the aluminium, ferro-alloy, carbon, mineral fertilizer and carbide industries accounting for approximately 30 per cent of total Norwegian greenhouse gas emissions. This arrangement also includes some installations covered by emissions trading. The arrangement ensures that operators in the process industry – some of which at this stage are not included in the emissions trading scheme – nevertheless undertake to reduce their greenhouse gas emissions by the end of 2007. According to the arrangement, total emissions of greenhouse gases in the process industry are not to exceed 13.5 million tonnes of CO_2 equivalents (all six Kyoto gases) by the end of 2007.

The Norwegian emissions trading scheme (see Section 4.2.7 below) combined with this arrangement applies to just as many emission sources and gases as those the former government included in its proposal for an emissions trading scheme for the processing industry in the supplementary white paper on climate policy 22 March 2002. Following the establishment of this arrangement, almost all Norwegian emissions are covered by climate measures. By 2007, the combined effects of the arrangement and the Norwegian emissions trading scheme are expected to yield an annual reduction of 1.1 million tonnes of CO_2 equivalents in the processing industry compared to business as usual. Between 0-0.4 million tonnes of this reduction is expected to come from the emissions trading scheme. In addition, one can expect a reduction of approximately 0.1 million tonnes from gas refineries and terminals, provided the same allocation percentage (0.95 per cent of the projections) is used for these installations. Concerning the period after 2007, the scope and allocation of the Norwegian emissions trading scheme and whether it will be supplemented by a similar arrangement with the industry, has still not been decided. For these estimates, the same reductions are assumed for 2010 as for 2007.

Other voluntary emission reductions

Several other voluntary reductions have taken place without direct incentives from the government. These have also led to reduced emissions from industry.

Sulphur hexafluoride (SF_6)
Since 1985, Norsk Hydro has reduced its consumption of SF_6 as a blanket gas used in the production of magnesium. The reduction was largest from 1987 to 1989, before SF_6 was known to be a greenhouse gas with a very high global warming potential. From 1987 to 1989, Norsk Hydro reduced its emissions by more than 3 million tonnes CO_2 equivalents. The emissions were also reduced in the beginning of the 1990s. From 1990 to 1995 the emissions were reduced by approximately 1.7 million tonnes of CO_2 equivalents, but there has been a weak increase from 1995 to 2001. The specific emissions (emissions per tonne magnesium produced) were reduced considerably from 1990 to 1995, but were stable from 1995 to 2001. In 2002, the primary production of magnesium was closed down and the total emissions of SF_6 were reduced by approximately 70 per cent. The total emission reductions assumed for 2003, 2005 and 2010 were 1.8 million tonnes CO_2 equivalents, but the effect of the voluntary reductions are estimated at 0.5 million tonnes CO_2 equivalents.

Nitrous oxide (N_2O)
Emissions of nitrous oxide from the production of nitric acid amounted to 1.9 million tonnes of CO_2 equivalents in 2003. Improvements in the production process have led to emission reductions of 10-15 per cent per unit produced from 1990 to 2003. In 2000, this corresponded to a reduction of about 0.3 million tonnes CO_2 equivalents. According to the Norwegian Pollution Control Authority, N_2O emissions from the production of nitric acid could be reduced by a further 0.5 million tonnes of CO_2 equivalents per year by implementing new abatement technology. This can be achieved at much lower cost than many other emission reductions in Norway – approximately NOK 15 per tonne CO_2 equivalent, according to the Pollution Control Authority. Emissions of N_2O from stationary combustion in industry were estimated at about 150 tonnes in 2003, i.e. about 0.9 per cent of total emissions of N_2O in Norway, or 0.08 per cent of total greenhouse gas emissions in Norway. It is estimated that more than 50 per cent of these emissions are associated with the use of wood, bark and black liquor in the pulp and paper industry. Except for the reduction obtained by generally more effective use of energy, the possibility of reducing emissions has not been investigated further.

4.2.7. Emissions trading

Norway on 1 January 2005 passed The Greenhouse Gas Emission Trading Act, thereby introducing an emissions trading scheme (ETS) operating from 2005-2007. The establishment of the scheme from 2005 is an important step towards fulfilling Norwegian obligations under the Kyoto Protocol.

The Norwegian emissions trading scheme for the period 2005-2007 closely resembles the EU ETS, and covers selected sectors, mainly industry. A total of 51 installations are included, covering roughly 6-8 million tonnes a year, or 10-15 per cent of total Norwegian greenhouse gas emissions. The emissions trading scheme applies to CO_2 emissions that are not subject to the CO_2 tax and that are subject to the duty to surrender allowances under the EU ETS. The total amount of Norwegian allowances for 2005-2007 is 20.5 million tonnes.

The emissions trading scheme in the period 2005-2007 applies to CO_2 emissions from companies that – before the introduction of the ETS – had little or no incentive to limit their emissions. According to the Greenhouse Gas Emission Trading Act, combustion installations above 20 MW that are not subject to the CO_2 tax (including those operated by enterprises in the categories landing of oil and gas, gas refining and petrochemicals, and any gas-fired power plants that are constructed), oil refineries, coke ovens, iron and steel manufacturers and manufacturers of cement, lime, glass, glass fibre and ceramic products are, on further conditions, required to surrender allowances corresponding to their CO_2 emissions.
51 installations have been given permits in the following sectors;

- Combustion installations above 20 MW:		**36**
- District heating (using natural gas)	8	
- Gas based electricity plants (CCGT)	2	
- Pulp and paper (using natural gas)	6	
- Fish meal and fish oil (using natural gas)	7	
- Petrochemical, including crackers	4	
- Gas processing and terminals	4	
- Other		**5**
- Refineries		**2**
- Steel production		**1**
- Cement plants		**2**
- Other production based on minerals		**10**
Total		**51**

The close ties to the EU ETS are explained by a desire to establish contact and trade between the two emissions trading systems, but also to maintain the competitive position of Norwegian industry vis-à-vis the EU. The similarity between the systems applies both to the sources and the gases that are included, as well as to other elements of the scheme, for instance allocation methodologies. The main difference between the two schemes is that the offshore petroleum industry and the use of mineral oil onshore – accounting for 25 per cent of total Norwegian emissions – are not covered by emissions trading in Norway for the period 2005-2007. Instead, these sectors are subject to the CO_2 tax mentioned above.

The Greenhouse Gas Emission Trading Act gives the government the authority to determine the total number of allowances to be allocated to operators that are included within the scope of the 2005-2007 emissions trading scheme. The government's allocation decision was based on various considerations, including Norway's international commitments to reduce greenhouse gas emissions, the applications received from enterprises that are included in the scope of the scheme, actual and projected emissions in Norway, the fact that different sectors and enterprises should be treated in the same way, and the technological and economic potential for reducing emissions. Allowances for the period 2005-2007 were allocated to operators free of charge. The general rule was to allocate 95 per cent of average emissions in the period 1998-2001. In cases where emissions had risen or fallen substantially after 1 January 2001 due to substantial changes in the nature or scale of the installation's operations, or it was considered reasonably certain that this would happen before 31 December 2007, the allocation of allowances was based on projected emissions in 2005-2007, together with actual emissions in 2002-2004. Allocation to new entrants, i.e. installations that started operations after 1 January 2001, was also based on projections. Allowances are issued annually. Operators must surrender allowances covering their emissions within 1 May the following year.

Operators included within the scope of the emissions trading scheme must report their CO_2 emissions to the pollution control authorities each year. If an operator contravenes the provisions on reporting, the pollution control authorities will suspend his right to transfer allowances to other account-holders. The pollution control authorities can also impose coercive fines and even penal measures in the event of serious contravention of its provisions. Excess emission fines (2005-07: 40 Euros) are imposed if an insufficient amount of allowances is surrendered. In addition, the operator must purchase allowances covering the deficit.

The provisions of the Act are only intended to be suitable for the period 2005–2007, and amendments will have to be made at the end of this period to adapt the Act to later periods. There is still uncertainty as to the Norwegian ETS from 2008 onwards, when the commitments from the Kyoto Protocol enter into force. The scope and allocation will i.a. depend on how the link to the European Union's emission trading system will be established.

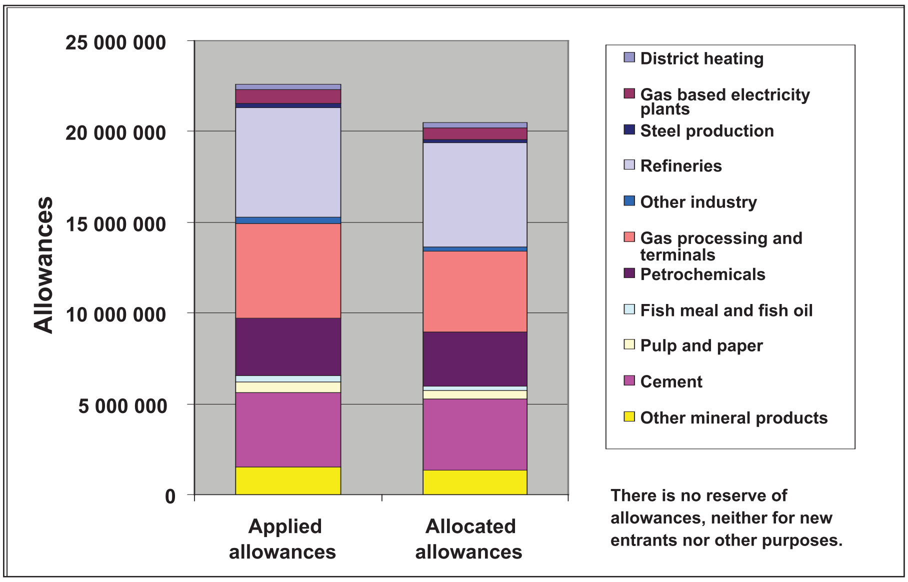
4.2.8 Use of the Kyoto mechanisms

According to the projections, the current gap to be covered through further national measures or net acquisitions of AAUs, CERs and/or ERUs ("Kyoto units") under the Kyoto mechanisms (Articles 6, 12 and 17) is about 10 million tonnes annually, or about 50 million tonnes for the period 2008-2012. The uncertainties in this estimate are described in chapter 5. Introduction of further domestic policies would reduce the need for acquiring Kyoto units.

The industry will acquire Kyoto units through the emissions trading system. There is a general provision for such acquisitions in the Emission Trading Act, and detailed operational provisions for using CERs from CDM in the system for 2005-2007 are given in a domestic regulation. Those CERs will be cancelled. The regulation regarding the period 2008-2012 have not yet been decided. These will partly depend on the linkage between Norway's emissions trading system and other trading schemes, in particular the EU ETS.

In the absence of other policies and measures than the trading scheme designed to bring Kyoto units into the Norwegian registry, it is foreseen that the state will acquire the remaining Kyoto units necessary to comply with the quantitative commitment under Article 3.1. Some minor quantities are expected to be acquired through the involvement in pilot schemes through the World Bank (PCF) and the Testing Ground Facility as well as through bilateral projects.

Figure 4.2 Allocated allowances 2005-2007, distributed by sectors.



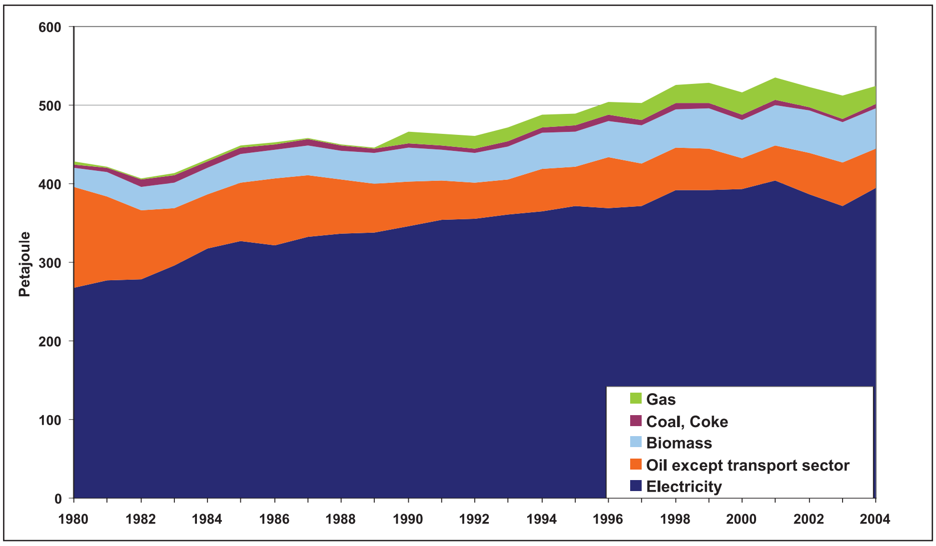
4.3 Energy and transformation industries

4.3.1 Electricity production on the mainland

Almost all electricity produced on the Norwegian mainland is based on hydropower. Thus, nearly all CO_2 emissions from electricity production are related to offshore petroleum production. However, the government has granted construction and operating licences for four gas-fired combined cycle power plants in Norway. These plants would have a total production capacity of approximately 16 TWh/year, and would generate total CO_2 emissions of about 5.7 million tonnes per year. Naturkraft AS has received licences for two facilities, Industrikraft Midt-Norge AS for one and Statoil for an integrated gas-fired power plant at its Snøhvit gas liquefaction plant in northern Norway. The last of these will be in operation in 2006. The Kårstø plant is also under construction and is planned to be in operation in the autumn of 2007. These two plants have a total production capacity of about 5 TWh and would generate total CO_2 emissions of about 2.1 million tonnes per year. Gas-fired power plants are covered by the Greenhouse Gas Emission Trading Act. The gas-fired power plant at Kårstø will be allocated quotas according to the Act if it is built before 2008. The government is committed to initiating the process that will make it possible to install carbon capture and storage facilities at the gas-fired power plant at Kårstø at a later stage. The aim is to realize this within 2009, and the government will contribute financially to this. The government will see to that new licenses for gas-fired power plants are based on carbon capture technology.

1 January 2005 the government established

Figure 4.3: Trends in stationary energy use



Source: Statistics Norway

Gassnova, a state center promoting innovative, sustainable and cost effective gas technologies. Gassnova shall work market oriented enhancing co-operation and joint development ventures among government agencies and industry. Gassnova's activities are financed through the returns on NOK 2 billion fund. In 2005, about NOK 100 million are allocated to Gassnova's activities. In a joint effort with the Norwegian Research Council, Gassnova manages the CLIMIT-programme which is designed to promote research, development and demonstration of technologies for natural gas power generation with capture and storage of CO_2. This programme will in total administer NOK 150 million in 2005.

4.3.2 Use of new renewable energy sources

In Norway there is an integrated strategy for increased production of renewable energy and energy saving. As a part of this strategy the development of wind power and renewable heat production has been singled out with its own quantitative targets. The government's targets are to develop 3 TWh/year wind power and 4 TWh/year renewable heat production within 2010.

The national energy agency Enova SF is responsible for promoting the integrated strategy for renewable energy and energy saving. Enova's long term goal is 12 TWh new renewable energy production or energy savings by 2010. Enova's most important measure is investment support granted from the Energy Fund. The grant of investment support is based on competition between all projects which fall within Enova's scope.

The targeted policy for development of wind power and the support measure has led to a great interest among the industry, which again has led to a great number of planned projects, applications for licenses and wind farms being constructed. By the end of 2004 there were 53 planned projects with a total production of several TWh/year, 11 projects with a total production of 3.3 TWh/year were granted licenses and another 11 projects with a total production of 810 GWh/year were completed or under construction.

Like other forms of energy production, wind power influences the environment and other interests. It is therefore a precondition that the development of wind power is done in a sustainable way. The Norwegian licensing system plays an important role in securing a sustainable wind power sector in Norway. The licensing process is regulated in the Energy Act and the Planning and Building Act. Besides taking energy system impacts into account, the licensing process involves a thorough assessment of possible environmental impacts and influence on other interest as for example tourism and defence matters.

Since 2003, the Ministry of Agriculture and Food has been financing a bioenergy programme. Its main objectives are to increase production of bioenergy from agriculture and forest biomass and promote deliveries of heating from the agricultural sector. Use of bioenergy in Norway represents about 5 per cent of the energy balance.

4.3.3 Energy efficiency

The schemes for increased energy efficiency and energy savings are an integrated part of the energy agency Enova's programme structure. Enova's goal for energy efficiency is to limit energy use considerably more than would be the case if developments were allowed to continue unchecked.

Enova's energy efficiency programmes are linked to information and education and network activities and cover measures in all industrial sectors as well as households, see also Section 9.7. The result so far from Enova's activities for the years 2002 to 2004 is 1.4 TWh/year energy saved.

The objectives described in Section 4.3.2 and above indicate that Enova will focus on both energy demand and energy supply. The most important criteria for project selection will be kilowatt-hours saved (energy saving projects) or new capacity installed (energy supply projects) in relation to funding. The targets for heat and wind will be seen as minimum targets.

Enova also participates in international activities and acts as an adviser to the Ministry of Petroleum and Energy in questions related to energy efficiency and new renewables. The Norwegian Water Resources and Energy Directorate is responsible for tasks related to legal and policy questions concerning the demand and supply of energy.

4.4 The petroleum sector

4.4.1 CO_2 emissions

The petroleum sector emitted 12.2 million tonnes CO_2 in 2004, which accounted for 28 per cent of the national CO_2 emissions. CO_2 emissions from the petroleum sector are expected to increase until 2009 and then decrease. The majority of CO_2 emissions from the petroleum sector relate to offshore installations, mainly from energy production in gas turbines and flaring. Other CO_2 emissions come from land based gas terminals and indirectly from VOC emissions (process emissions).

Total CO_2 emissions from the sector have grown year by year, primarily as a result of an increased activity level. Increased total emissions in absolute numbers have, however, coincided with a more efficient petroleum production. Emissions of CO_2 per produced oil equivalent fell by 22 per cent from 1990 to 2003. Improvements in the utilisation of energy and reductions in flaring have, however, not been significant enough to counterbalance the increase in energy consumption from higher levels of activity.

Emissions linked to the production of a unit of oil/gas will vary both between fields and over a single field's lifetime. Transport distances to the gas markets and reservoir conditions are factors that cause the energy requirements, and hence emissions, to vary from field to field. In addition, a field will have higher emissions per produced unit the older it gets, due to the fact that the proportion of water in the well stream increases as the field ages. The trend on the Norwegian Continental Shelf towards more mature fields and the movement of activities northwards is leading towards increased emissions per produced unit.

The CO_2 tax has been the most important instrument for reducing emissions in the petroleum sector and has had a significant effect. The reductions of CO_2 per produced oil equivalent are to a great extent due to general improvements in technology and emission reducing measures, as a result of the introduction of the CO_2 tax in 1991. The Norwegian Petroleum Directorate (NPD) prepares annual reports on the effects of the CO_2 tax on the petroleum sector. In the last reports, the NPD has concluded that the CO_2 tax does not have a similar effect on the implementation of new measures for reducing CO_2 emissions offshore as before. Further reductions in CO_2 emissions may therefore require other measures.

The Greenhouse Gas Emission Trading Act established a system of tradable quotas for the period 2005-2007. For the time being, in the petroleum sector, only some land-based installations are subject to tradable quotas. Offshore activities are exempted and subject to CO_2 taxation. The Greenhouse Gas Emission Trading Act will be reviewed before 2008 and the trading system is aimed to be linked to the EU Emissions Trading Scheme.

In order to reduce CO_2 emissions further, the petroleum authorities have a continuous focus on research and development of new technologies. The petroleum authorities facilitates several research programs and published in 2003 together with the

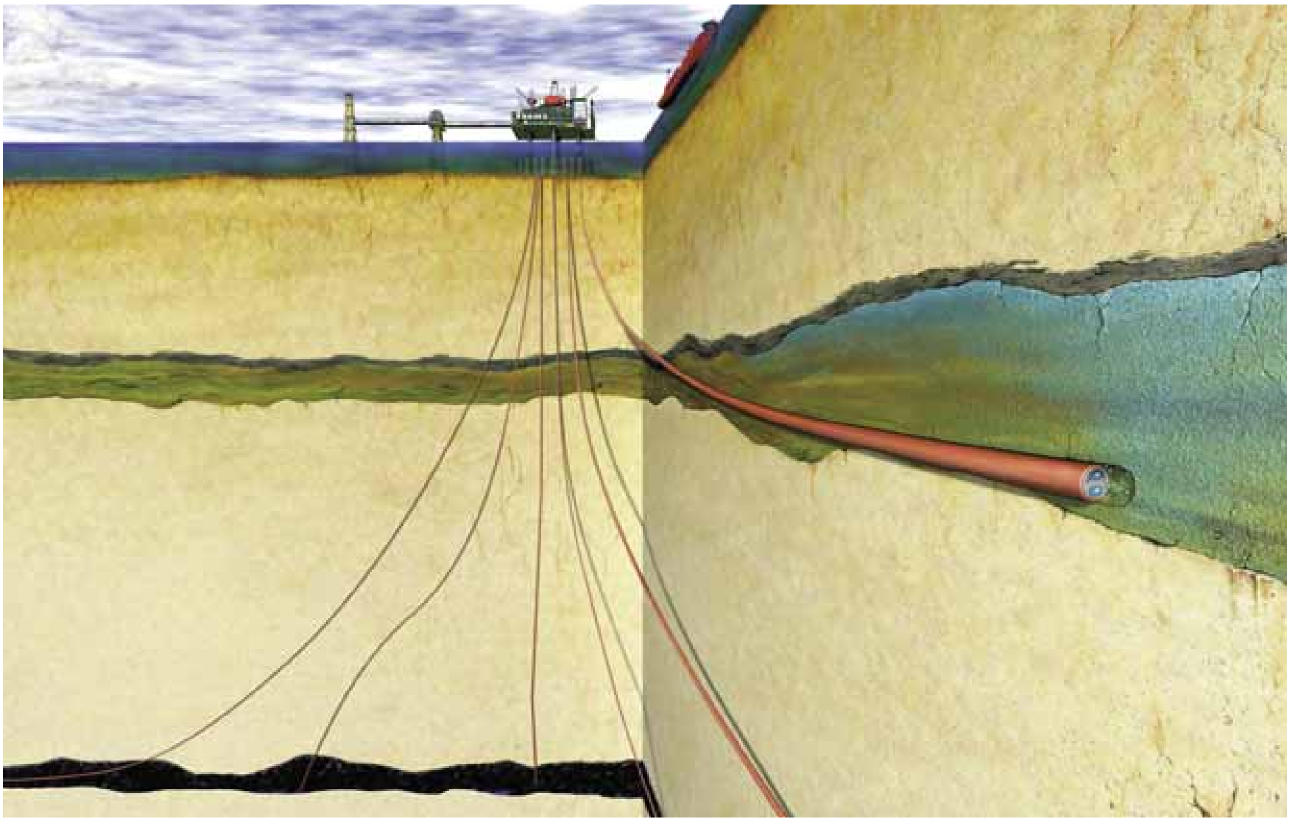


Figure 4.4 Carbon capture and storage at the Sleipner field
Source: Statoil ASA

industry a report on the possibilities for more energy-efficient production on the Norwegian Continental Shelf.

Storage of CO_2 has a big potential for avoiding emissions. The industry has gained valuable experience from storage of CO_2 from natural gas production and storage at the Sleipner field in the North Sea. Since 1996, 1 million tonnes of CO_2 has been stored annually in the Utsira formation 1000 meters beneath the seabed, in connection with the processing of gas from the Sleipner field. In 2007, production of LNG from the Snøhvit field is expected to start. The CO_2 produced with the gas on the Snøhvit field is to be separated and stored 2,600 metres beneath the seabed in a water filled reservoir. In the future, Norway will have a large potential for storing CO_2 due to its access to large water filled reservoirs and fully produced oil/gas reservoirs off the Norwegian coast.

Storing of CO_2 in fully produced reservoirs is, geologically speaking, a good solution, since the structure is highly likely to be impermeable in as much as it will have retained gas and oil for millions of years. The Norwegian authorities are working actively to ensure that such CO_2 storage can be achieved in a safe and secure manner. Work is therefore being undertaken under the auspices of the OSPAR and London Conventions to ensure that sound international regulations for CO_2 storage are established. In 2004, the Norwegian authorities organised a scientific OSPAR workshop on the potential environmental impacts of long-term storage of CO_2, where a number of international experts took part.

The petroleum authorities have estimated a considerable technical potential for enhanced oil recovery through the use of CO_2 in mature oil fields on the Norwegian Continental Shelf. In 2004, the Ministry of Petroleum and Energy commissioned the Norwegian Petroleum Directorate (NPD) to produce a study of the prospects of implementing projects to inject CO_2 for enhanced oil recovery. NPD's conclusion from the study is that there is a large technical potential for additional oil recovery on the Norwegian Continental Shelf if enough CO_2 could be made available at the optimum time in the fields' production life at commercial conditions. It is unlikely to find sufficient quantities of pure CO_2 from principal sources in Norway to cover the need for possible CO_2 injection for enhanced oil recovery on the Norwegian Continental Shelf. In addition to CO_2 sources in Norway, therefore, other sources around the North Sea are being assessed. Transportation of CO_2 is a major component in using CO_2 for enhanced oil recovery and requires large investments in infrastructure. Even though CO_2 injection projects are technically feasible to implement, the NPD concludes that CO_2 injection for enhanced oil recovery is currently not commercially viable.

Since fossil fuels will continue to play an important role in the future, new and more cost effective technologies must be developed in order to make carbon capture, use of CO_2 for enhanced oil recovery, and storage economically viable. The state centre, Gassnova, will promote technologies for carbon emission abatement, including CO_2 capture and storage technologies for gas fired power plants.

Norway took the initiative to establish an informal governmental forum for dialogue on CO_2 for enhanced oil recovery between Norway, Denmark and the United Kingdom. The forum will contribute to exchange of information on activities related to capture, storage and use of CO_2 between the countries. The Norwegian Minister for Petroleum and Energy and the British Energy Minister signed in November 2005 a joint declaration to undertake a bilateral effort to explore possible areas of cooperation to encourage injection and permanent storage of CO_2 in sub-seabed geological structures.

The policy declaration from the present government parties (September 2005) states that the government will reinforce various policy measures and public financing in order to advance the realisation of relevant infrastructure and facilities for CO_2 capture and storage. Some of these tasks will be taken care of by a state owned company. The government intends to establish a "value chain" for carbon capture, transport and storage on the Norwegian Continental Shelf. To ensure a sound economic and legal framework of the state's involvement in the area of carbon capture, use and storage, the government has proposed to allocate NOK 20 million to evaluation projects in 2006.

4.4.2 Fugitive fuel emissions

The petroleum sector is the primary source of emissions of nmVOCs in Norway. In 2004, some 53 per cent of Norway's emissions of nmVOCs derived from the storage and loading of crude oil offshore. The petroleum sector's share is decreasing as a result of the phasing in of emission-reducing technology. In 2003, emissions of nmVOC from the petroleum sector were reduced by 31 300 tonnes. The total emissions of nmVOCs in Norway has had a 32 per cent decrease from 2001 to 2004, mainly because of reductions in the petroleum sector.

Several of the newer fields on the Norwegian Continental Shelf employ floating storage installations. This type of installation may produce higher emissions of nmVOCs than is the case on fields where the oil is stored in the base of the platforms (Statfjord, Draugen and Gullfaks). This is due to the fact that, with floating storage installations, emissions will also occur between production and storage. The forecast for nmVOC emissions from the sector shows a strong downward trend in years to come, both because emission-reducing technology will be installed and because oil production is expected to peak within a few years.

For a number of years, the oil companies have worked to make technology for recovering nmVOCs available to storage vessels and shuttle tankers. There currently exists proven recovery technology that reduces emissions from loading by around 70 per cent. Several vessels have now installed emission reducing technology. The operators of fields with buoy loading on the Norwegian Continental Shelf have formed a joint venture to install recycling equipment for nmVOC on storage vessels and shuttle tankers.

A recovery installation for nmVOCs was deployed at the crude oil terminal at Sture in 1996.
This is the first of its kind at a crude oil terminal. Use of the installation requires loading tankers to be fitted with coupling equipment. From 1 January 2003, a requirement was issued that all vessels must be fitted with equipment for recovering nmVOCs, and the ships are not normally granted access to the installation without the necessary equipment.

Norway has implemented EC Directive (94/63/EC) on the control of volatile organic compound (VOC) emissions resulting from storage of petrol and its distribution from terminals to service stations. The technology required by the directive has already been installed in most petrol distribution and storage systems, and substantial emission reductions have been achieved.

For more details on the effects of the measures introduced to reduce fugitive fuel emissions, see Section 4.2.5.

4.4.3 Methane emissions

Combustion and evaporation/leakage in the oil and gas industry accounted for 14 per cent of total methane emissions in 2003. These emissions are largely caused by landing and loading of crude oil offshore. Methane emissions from the oil and gas industry have been increasing since 1990 due to higher production in the oil and gas sector.

4.5 Transport

4.5.1 CO_2 emissions

CO_2 emissions from the transport sector have risen by 28 per cent from 1990 to 2003, and this is related to the rise in the transport volume and a shift to more energy-demanding modes of transport (more road and air traffic). In 2003, road traffic accounted for about 19 per cent of total Norwegian greenhouse gas emissions, coastal shipping for about 5 per cent and air traffic for about 2 per cent. The transport sector is expected to be responsible for a substantial proportion of the projected growth in emissions up to 2010.

The CO_2 tax is the main instrument for limiting CO_2 emissions from the transport sector (see Table 4.1). The tax rates for 2005 are NOK 0.78 per litre petrol and NOK 0.52 per litre diesel. In addition, the tax on transport oils in Norway is one of the highest in the world, currently NOK 4.03 per litre petrol (sulphur free) and NOK 2.92 per litre diesel (sulphur free).

As regards transport by sea, fuel for domestic passenger transport by ship is subject to the same CO_2 tax as other mineral oils, whereas a reduced rate applies to fuel for domestic goods transport. Since 1 January 1999, domestic air traffic and supply ships have also been subject to the CO_2 tax. In the Budget-proposal for 2006 the government proposes to remove the reduced rate. According to this proposal domestic aviation, domestic shipping of gods and supply ship will be liable to the same rate as other use of mineral oil. It's estimated that the increase in the tax rates might lead to reduced emission of approximately 0.05 million tonnes.

The Norwegian purchase tax is one of the highest in world, and has since 1996 been differentiated according to weight, engine output and engine volume. From July 2001, car producers have been obliged to include information on fuel efficiency and CO_2 emissions in their marketing. The government intends to expand this requirement to other types of vehicles. The EURO vehicle inspection system was fully implemented from 1998. This has given some improvements in average energy efficiency.

A changeover to certain alternative fuels, such as electricity, gas, hydrogen and biodiesel, can limit CO_2 emissions from the transport sector. Taxation policy has been changed in a number of ways that favour the use of electric cars in Norway. Electric cars are exempted from the purchase tax, VAT and the annual tax. The government will promote the use of biofuels in accordance with the targets established in the EU directive on the promotion of the use of biofuels (2003/30/EC). The directive has not been included in the EEA Agreement. What instruments to be used has not yet been decided. To encourage research and development on alternative fuels, funds have in recent years been allocated to projects on the development and testing of low emission technologies including production and use of hydrogen and biofuels.

Research funds have also been allocated to other alternative fuels such as natural gas. Natural gas is already used as fuel for buses in certain towns. Natural gas is currently not subject to the CO_2 tax. A pilot project for the use of natural gas in ferries was launched in February 2000. Direct CO_2 emissions from gas-fuelled ferries are about 20 per cent lower than from diesel ferries. In the offshore sector the use of natural gas in vessels has moved a step further. Two supply vessels fuelled by natural gas have been operating in the North Sea since 2003. CO_2 emissions from these vessels are about 20-30 per cent lower than other supply vessels in the North Sea. From 2007, five car ferries fuelled by natural gas will begin operation on ferry services in the Norwegian highway network.

Subsidies for the expansion of public transport may under certain circumstances limit CO_2 emissions from the transport sector, but it is difficult to evaluate their net environmental effect. Norway has a long tradition of land-use planning based on legal instruments. The government put forward a white paper on this issue in spring 2002, which focused on coordinated land-use planning and environmentally friendly transport. Policies and measures should stimulate the use of bicycles and pedestrian transport. The effect of a given level of subsidies varies according to the strategies followed in the transport sector. The government gives high priority to public transport, especially railway transport. A special programme has been established to support the country's four largest towns in improving the infrastructure for public transport. In 1999, support for public transport (subsidies and transfers to buy transport services) totalled nearly NOK 4 billion. The government tabled a white paper on public transport in the spring session of 2002.

Bicycling is a cheap and environmentally friendly mode of transport. There is a potential for increased cycling in Norway. The National Public Road Administration has recently developed a strategy on how to promote cycling in Norway.

4.5.2 Nitrous oxide (N_2O)

The transport sector accounted for about 2400 tonnes of N_2O emissions in 2003, corresponding to 14 per cent of total emissions of N_2O. The main source is road traffic, where the emissions have increased steadily during the 1990s because of the introduction of catalytic converters and the increasing volume of traffic. General measures to reduce emissions from road traffic may also reduce the emissions of N_2O in the transport sector. However, no specific measures to reduce N_2O emission have been introduced.

4.6 Industry

4.6.1 CO_2 emissions from industry

In recent years, CO_2 emissions from energy use in industry have been reduced considerably as a result of improved energy efficiency and changes in the energy mix. Energy efficiency has been improved by general capital replacement and operational changes, which received some support from an earlier grant scheme for energy efficiency measures. In the industrial sector, electricity and bioenergy have to a large extent replaced mineral oils as an energy source. This has been especially pronounced in the pulp and paper industry, which is increasingly using bark and other biological waste products as fuel. The price of mineral oil has generally been higher than that of electricity during the 1990s, and this has also helped to bring about changes in the energy mix.

In 2003 emissions of CO_2 from Norwegian cement production are estimated to be about 1.4 million tonnes per year, corresponding to about 0.9 tonne CO_2 per tonne cement. Of this, about 60 per cent is generated by production of clinker, through the decomposition of limestone during the production process, and therefore directly dependent on the production volume. The remaining 40 per cent of the emissions originates from the sources of energy, which are coal, waste oil, bio-energy and liquid organic hazardous waste. Besides the introduction of hazardous waste as a fuel, replacement of coal with alternative fuels (bioenergy, tyres, plastic waste and various types of packaging waste) and improvements of energy efficiency have been tested as ways of reducing landfilling and, where relevant, CO_2 and methane emissions. Estimates from the Norwegian Pollution Control Authority suggest that the increased used of bioenergy in cement production had reduced CO_2 emissions by up to 20 000 tonnes in 2000 and that this will rise to 100 000 tonnes by 2010.

Emissions of CO_2 from metals manufacturing were about 4.8 million tonnes in 2003, corresponding to about 8 per cent of total emissions of CO_2 equivalents in Norway. The largest source category is the ferro-alloy industry, which alone accounts for about 5 percentage points. CO_2 emissions from aluminium production is the other important source, contributing 3 percentage points. CO_2 from aluminium production, together with PFC emissions, are addressed in the agreement between the government and the industry described in Section 4.6.3. CO_2 emissions from metals manufacturing derive primarily from the use of coal and coke as a reducing agent, and are therefore primarily dependent on the volume of production. Hydropower is used as the main energy source, causing no CO_2 emissions.

4.6.2 Nitrous oxide (N_2O)

The main industrial source of emissions of nitrous oxide is the production of nitric acid. In 2003, emissions of nitrous oxide from this source amounted to about 1,9 million tonnes CO_2 equivalents, corresponding to about 3.5 per cent of total greenhouse gas emissions in Norway. Change in production processes led to a decrease in emissions from this industry in the early 1990s, while there was a moderate increase in the following years as a result of an increase in production.

For more details on the emissions of N_2O, see Section 4.2.6.

4.6.3 Emission of PFCs from aluminium production

Aluminium production is the only known significant anthropogenic source of emissions of the perfluorocarbons (tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6)) from industry. Emissions of tetrafluoromethane and hexafluoroethane were 102 and 4 tonnes respectively in 2003, corresponding to a total of about 0.7 million tonnes of CO_2 equivalents.

Emissions of PFC for other applications are very small, but potential use is covered by the tax refund scheme for HFC and PFC, see Section 4.2.3. From

1990 to 2003, emissions of PFC gases measured as CO_2 equivalents were reduced by 79 per cent.

4.6.4 Emissions of SF_6

The main source of SF_6 emissions is one magnesium plant where the gas is used as an additive to air for covering the surface of liquid magnesium during the casting process. The covering gas is emitted to air after use.

The amount of SF_6 used was reduced from 90 tonnes in 1990 to 7.2 tonnes in 2003 as a result of improved routines and maintenance in the plant as well as reduced production levels. According to estimates from the Norwegian Pollution Control Authority, the voluntary action resulted in emission reductions corresponding to about 0.5 million tonnes CO_2 equivalents in 2003. In 2002, primary production on the plant was closed down, hence the SF_6 emissions were reduced to around one quarter of the previous level. The remaining emissions originate from the secondary magnesium foundry only. The remaining emissions (26 per cent in 2003) mainly originate from gas-insulated switchgear (GIS). Emissions occur as a result of leakage or accidents, or if installations are discharged without recovering the gas.

See Section 4.2.6 for more details on the emissions of SF_6.

4.6.5 Emissions of HFCs

These emissions gained significance in the mid-1990s, when HFCs were introduced as substitutes for ozone-depleting substances. The main ranges of application are refrigeration and air condition equipment. Other areas of application include foam blowing (one factory) and, previously, fire extinguishers. The most important gases are HFC-134a, HFC-125 and HFC-143a, which account for about one third of CO_2 equivalent emissions each.

A tax on the import and production of HFCs was introduced in 2003. For more details, see Section 4.2.3.

4.7 Agriculture

4.7.1 N_2O emissions

Emissions of N_2O from agriculture were estimated at 8 080 tonnes in 2003. The emissions have been fairly stable through the 1990s and have been reduced by 2 per cent from 1990 to 2003. In 2003, 48 per cent of the total N_2O emissions came from the agricultural sector. Emissions can be reduced by a better and more integrated use of manure and mineral fertilizer, improved management of crop residues and reduction in cultivation of histosoils. However, some of these activities may cause other environmental problems or reduce the economic outcome from the production by reduced harvest or increased costs.

Improved soil cultivation practices can reduce the risk of erosion, loss of nutrients and the associated emissions. Improving the use of fertilizing schemes based on increased use of analyses of soil, harvest, crop residues, and manure are important tools to obtain emission reductions without losses in harvests.

Information about enhanced practices is disseminated to farmers mainly by the Norwegian Agricultural Extension Service, which is a private enterprise owned by farmers. Information is also given by up-stream companies, governmental agricultural institutions and the Norwegian fertilizer manufacturer.

4.7.2 Methane emissions

Methane emissions from the agricultural sector were estimated at about 95 000 tonnes in 2003, and constitute about 39 per cent of total Norwegian methane emissions. The emissions are stable, and have been reduced by 1.5 per cent from 1990 to 2003. Most of the methane emissions from the agricultural sector are generated as an inevitable by-product of digestion in ruminants (and also represents a loss of energy during the process). These emissions are mainly affected by the national market for red meat and general agricultural policies and measures. The livestock numbers in Norwegian agriculture has been fairly stable through the 1990s. The storage and disposal of manure accounts for about 16 per cent of methane emissions from agriculture.

4.8 Forestry and CO_2 sequestration

Long-term fixation of carbon in biomass can be achieved by increasing forest biomass. One of the main objectives of Norwegian forestry policy has been to maintain and enhance forest resources as a basis for continued utilization of the natural resource base. Enhancing national forest resources makes a significant contribution to limiting Norway's net atmospheric emissions of greenhouse gases.
The total net sequestration from the land-use, land-

use change and forestry sector (LULUCF) was about 21 million tonnes of CO_2 in 2003, which would offset 38 per cent of the total greenhouse gas emissions in Norway that year. The sequestration increased by 56 per cent from 1990 to 2003. Forest land was the only contributor to the total sequestration with approximately 23.4 million tonnes CO_2. All other land-use categories showed net emissions, which totalled 2.5 million tonnes CO_2. The total net removal from the land-use, land-use change and forestry sector was calculated with the new methodology following IPCC Good Practice Guidance for LULUCF.

The increased CO_2 sequestration from the forest sector is a result of historical and current forest management practices. A number of measures to increase the production of forest biomass have been evaluated and may be of interest in an integrated system of forest management. General forest policy instruments have both direct and indirect effects on the development of forest resources and the use of timber and bioenergy, and thus on carbon uptake and storage in forests and forest products. A continuous evaluation of forest policy will ensure that measures taken to enhance Norway's sink capacity maintain biodiversity and do not reduce the recreational value of Norwegian forests. Hence, the annual net CO_2 removals are expected to increase slowly over the next 10–15 years, see Section 5.4.

4.9 Waste management

The method of calculating emissions from landfills was altered in several ways in 2004. The method now complies with the IPCC Guidelines and with the methods for calculations used in other countries. As a consequence, the emission figures for 2002 were calculated as 45.6 per cent lower than they would have been with the old model. The trend in methane emissions from 1990 to 2002 was, however, not noticeably affected since the new method also has been employed on the historical figures.

It is estimated that emissions of methane from landfills in 2003 totalled about 97 600 tonnes, corresponding to about 3.7 per cent of the total greenhouse gas emissions in Norway. The methane emissions from landfills were reduced by about 19 700 tonnes from 1990 to 2003. From 2002 to 2003, the emissions have been reduced by about 2 400 tonnes. Looking at the period from 1990 to 2003 as a whole, the emissions from the waste management sector have decreased by approximately 20 per cent. Higher waste volumes have been offset by increasing recycling and extraction and combustion of landfill gas.

The most important policy instruments to reduce methane emissions from landfills are licensing requirements laid down under the Pollution Control Act and a tax on the final treatment of waste.

Licenses include requirements for collection and combustion of methane from landfills. The licensing requirements are being steadily tightened to comply with the EU-directive on the landfill of waste, which has been implemented in the Norwegian legislation. The directive requires substantial reductions in the proportion of biodegradable municipal waste landfilled, and strengthens the requirements to collect methane generated in landfills. With some trifling exemptions, it is currently prohibited to dispose easily degradable organic waste at all in landfills in Norway.

Norway introduced a tax on the final disposal of waste (including both landfilling and incineration) on 1 January 1999. The purpose of the tax is to put a price on the environmental costs of emissions from landfills and incineration plants, and thereby act as an incentive to reduce emissions, increase recycling and to reduce the quantities of waste. On landfills, the tax in 2005 is NOK 409 or 533 per tonne waste landfilled, depending on the quality of the landfill site. On incineration plants, the tax is put on the registered emissions on certain substances.

Landfills with organic waste extract landfill gas, either for energy purposes or by flaring it. Today, virtually all landfills that will remain in business after 1 January 2006 have installed a landfill gas extraction system, and nearly 22 000 tonnes of methane were recovered in 2003. The figures have been quite stable since 1998, but studies indicate that the extraction can be increased by 5-10 000 tonnes annually (0.1 – 0.2 million tonnes CO_2 equivalents) by low cost efforts. Calculations from the Norwegian Pollution Control Authority state that emission reductions corresponding to about 0.25 million tonnes CO_2 equivalents in 1995 and about 0.5 million tonnes in 2002 have been achieved by extracting the landfill gas or by flaring it.

The amounts of waste recycled have increased significantly since 1990, consequently the landfilling is reduced and so are the emissions of landfill gas. It is difficult to quantify the effects of waste recycling, but estimates presented in White Paper No. 54 (2000-2001) indicate that increased recycling between 1992 and 1998 has given emission reductions corresponding to about 0.6 million tonnes of CO_2 equivalents in 1998. In the subsequent period from 1998 to 2003 increasing recycling has contributed to additional annual emission reduction of about 0.4 million tonnes CO_2 equivalents.

Methane emissions from landfills are not included in the Norwegian emissions trading scheme. It has been concluded that whether methane emissions from landfills could be included in the emissions trading system, and how this should be done, should be evaluated at a later date.

New instruments will be imposed in the waste management policy. In White Paper No. 21 (2004-2005) the former government proposed a ban on the landfilling of decomposable waste from 2009. The Parliament agreed on this proposal, and the Norwegian Pollution Control Authority has been given the task of preparing the detailed change of the Landfill regulation to account of the proposal. In the White Paper, the government also proposed stricter requirements for the extraction of methane gas from landfills. This is now being implemented.

5. PROJECTIONS AND THE EFFECT OF POLICIES AND MEASURES

5.1 Introduction

This new government, which took office in October 2005, will present new long-term projections for greenhouse gas emissions in Norway in 2006. These projections will be submitted to the Climate secretariat. The projections presented in this chapter are thus based on preliminary technical assumptions and should be regarded as tentative. This chapter describes in more detail the projections for greenhouse gas emissions in Norway up to 2020. The baseline scenario, along with key macroeconomic assumptions and a description of the methodology is presented in Section 5.2. The sensitivity of the projections to changes in key macroeconomic assumptions is also briefly discussed in this section. Measures and policies adopted after 2003 are not included in the baseline scenario. In particular, recent events such as the entry into force of the national emission trading scheme for greenhouse gases, the arrangement with the processing industry and efforts directed at the waste sector are not incorporated. The estimated impact of adopted measures and some new proposals are provided in Section 5.3.

Projections of CO_2 sequestration in forest are briefly discussed in Section 5.4, while Section 5.5 discusses projections of NOx, nmVOC, NH_3 and SO_2 as they have an indirect effects on greenhouse gases.

5.2 The baseline scenario – projections of greenhouse gas emissions with adopted and implemented measures

5.2.1 The baseline scenario

In the baseline scenario, total greenhouse gas emissions are projected to rise by 23 per cent from 1990 to 2010 and by a further 11 per cent from 2010 to 2020 (Table 5.1 A). Strong increases in emissions from oil and gas production up to 2008, transport and public electricity and heat production account for a major share of this growth.

CO_2 emissions are projected to increase strongly in the baseline scenario, from 34.4 million tonnes in 1990 to 49.9 million tonnes in 2010 and 57 million tonnes in 2020 (Table 5.1 D). The aggregate emissions of other greenhouse gases are projected to remain stable up to 2020. Due to emission-reducing measures in the aluminium and magnesium production industries, emissions of PFC and SF_6 are estimated to drop by 67 and 89 per cent, respectively, between 1990 and 2010. As regards emissions of HFCs, they are expected to increase as HCFCs and other ozone-depleting substances are phased out. Emissions of CH_4 are expected to continue to decrease, and is by 2020 projected to be close to 20 per cent below the 1990 level.

For the period up to 2020, emission projections depend among other things on how the Norwegian energy demand is met (including renewable energy sources, gas-fired power stations and import). The uncertainty concerning new power stations is considerable. The profitability of new power projects is dependent on framework conditions, the development of the integrated Nordic energy market and the prices of raw materials as coal, gas and crude oil. The emission projections up to 2010 are based on increased generation of windpower and hydropower, while increased supply from gas-fired power stations is assumed from 2010 to 2020. Based on current technology, increased generation of power based on gas will contribute to increase total emissions from the energy sector. The policy declaration from the present government (September 2005) states that the government will reinforce various policy measures and public financing in order to advance the realisation of relevant infrastructure and facilities for CO_2 capture and storage.

Projections are sensitive to developments in electricity demand from energy intensive sectors. In the baseline scenario, production in these industries is assumed to increase up to 2020, implying an increased use of electricity from 33 TWh in 1999 to 38 TWh in 2010 and 40 TWh in 2020. If use of electricity in energy intensive sectors is assumed constant at 1999-level in 2010 and 2020, greenhouse gas emissions would, ceteris paribus, be reduced by roughly 1 million tonnes CO_2 equivalents in 2010 and 4 million tonnes in 2020.

Table 5.1 A Greenhouse gas emissions by sector. Baseline scenario. Million tonnes CO_2 equivalents and percentage change

	Million tonnes				Percentage change		
	1990	**2003**	**2010**	**2020**	**1990-2003**	**1990-2010**	**2010-2020**
Total Energy	29.3	39.2	44.3	50.7	34 %	51 %	14 %
Oil and gas production[1]	7.6	13.5	14.2	9.9	78 %	87 %	-30 %
Petroleum refining	1.7	2.1	1.9	2.0	22 %	11 %	6 %
Public electricity and heat production[2]	0.3	0.6	1.3	9.9	123 %	344 %	n.a.
Manufacturing industry and construction	3.6	4.0	5.0	5.3	12 %	40 %	6 %
Transport	11.3	14.6	17.6	18.9	28 %	55 %	8 %
Other sectors[3]	4.8	4.4	4.4	4.8	-9 %	-8 %	8 %
Industrial processes	13.7	8.9	11.2	12.0	-35 %	-18 %	7 %
Agriculture	4.6	4.5	4.4	4.4	-2 %	-4 %	0 %
Waste	2.6	2.2	1.9	1.6	-14 %	-25 %	-16 %
Total	50.1	54.8	61.8	68.7	9 %	23 %	11 %

1 Including emissions from gas terminals and on and offshore oil loading.
2 Including emissions from gas-fired power plants.
3 Including mobile emissions from forestry, fisheries and agriculture.

Table 5.1 B Projections of greenhouse gas emissions by sector and gas. Baseline scenario. Million tonnes CO_2 equivalents. 2010

	CO_2	CH_4	N_2O	PFK	HFK	SF_6
Total Energy	42.3	1.0	1.0			
Oil and gas production	13.4	0.7	0.0			
Petroleum refining	1.9	0.0	0.0			
Public electricity and heat production 1)	1.2	0.0	0.0			
Manufacturing industry and construction	4.9	0.0	0.1			
Transport	16.6	0.1	0.9			
Other sectors	4.2	0.2	0.0			
Industrial processes	7.5	0.0	1.8	1.1	0.5	0.2
Agriculture	0.0	2.0	2.5			
Waste	0.1	1.7	0.1			
Total	49.9	4.7	5.4	1.1	0.5	0.2

1) Including one gas-fired power station approved for construction in 2000 (Kårstø).

Table 5.1 C Projections of greenhouse gas emissions by sector and gas. Baseline scenario. Million tonnes CO_2 equivalents. 2020

	CO_2	CH_4	N_2O	PFK	HFK	SF_6
Total Energy	48.7	0.8	1.1			
Oil and gas production	9.4	0.4	0.0			
Petroleum refining	2.0	0.0	0.0			
Public electricity and heat production	9.9	0.0	0.0			
Manufacturing industry and construction	5.2	0.0	0.1			
Transport	17.8	0.1	1.0			
Other sectors	4.5	0.2	0.0			
Industrial Processes	8.2	0.0	1.8	1.2	0.5	0.3
Agriculture	0.0	2.0	2.5			
Waste	0.1	1.5	0.1			
Total	57.0	4.3	5.5	1.2	0.5	0.3

Table 5.1 D Greenhouse emissions by gas. Baseline scenario. Million tonnes CO_2 equivalents

	1990	2003	2010	2020	1990/2010	2010/2020
CO_2	34.4	43.2	49.9	57.0	45 %	14 %
CH_4	5.2	5.1	4.7	4.3	-8 %	-10 %
N_2O	5.1	5.3	5.4	5.5	7 %	2 %
PFK	3.3	0.7	1.1	1.2	-67 %	8 %
HFK	0.0	0.2	0.5	0.5		0 %
SF_6	2.2	0.2	0.2	0.3	-89 %	21 %
Total	50.1	54.8	61.8	68.7	23 %	11 %

5.2.2 Methodology and key assumptions

The emission projections for Norway presented in this report are based on various sources and methodology. For energy-related emissions, the projections are largely based on macroeconomic model simulations supplemented by available micro studies. The macroeconomic model is described in more detail in Annex A. Projections of CO_2 emissions from the petroleum sector and for all non-CO_2 emissions from all sources are based on sector- and plant-specific information collected from the industries concerned. Key assumptions and methods are described in more detail below.

Macroeconomic assumptions and CO_2 emissions from the mainland economy

Table 5.2 lists key macroeconomic assumptions that underlie the Norwegian emission projections. In the baseline scenario average annual GDP growth is estimated at 2.0 per cent from 2003 to 2010 and at 1.8 per cent from 2010 to 2020. Growth in the mainland economy, i.e. total GDP excluding petroleum activities and ocean transport, is estimated at 2.5 per cent from 2003 to 2010 and 2.3 per cent from 2010 to 2020. On average, value added from petroleum extraction, pipeline transport and ocean transport is assumed to fall by 0.6 per cent per year, while investments in the petroleum sector may decrease some 8 per cent annually. This outlook is contingent on the assumption that petroleum extraction reaches a peak at about 288 million Sm^3 oil equivalents in 2008, before gradually dropping to about 262 million Sm^3 oil equivalents in 2010 and 198 million Sm^3 oil equivalents in 2020.

Domestic consumption of petroleum products is expected to increase by 1.9 per cent per year from 2003 to 2010 and by 0.8 per cent per year from 2010 to 2020. Growth in electricity consumption is expected to be somewhat stronger, at 2.4 per cent per year from 2003 to 2010 and 1.3 per cent from 2010 to 2020. These forecasts are based on continued improvements in average energy efficiency (see Annex A). Total domestic electricity production is assumed to increase from 107 TWh in 2003 to 129

Table 5.2 Macroeconomic developments and energy use. Baseline scenario

	Billion NOK	Annual average growth rate		
	2003	1990-2003	2003-2010	2010-2020
Gross domestic product	1561.9	3.2	2.0	1.8
- Mainland Norway	1246.1	2.8	2.5	2.3
- Manufacturing	140.6	0.5	3.1	2.7
- Petroleum activities and ocean transport	315.8	4.9	-0.6	-2.2
Private consumption	719.0	3.2	3.3	3.2
Government consumption	356.2	3.2	1.2	0.8
Gross fixed capital formation	271.0	2.7	1.2	1.8
- Mainland Norway	207.6	3.8	3.0	2.1
- Petroleum activities and ocean transport	63.4	-0.1	-7.8	-0.6
Number of persons employed (1000)	2298.3	0.9	0.5	0.5
Net domestic energy use[1)]				
- Petroleum products (Mtonnes)	6.7	0.7	1.9	0.8
- Electricity (TWh)	105.0	0.6	2.4	1.3

1) except use in energy producing sectors and ocean transport.

1 See http://www.sft.no/publikasjoner/luft/2079/ta2079.pdf.

TWh in 2010 and 154 TWh in 2020, while net imports are assumed to decline from 8 TWh in 2003 to 7 TWh in 2010 and 1 TWh in 2020. The baseline scenario is based on the assumption that the international quota price in the Kyoto period from 2008-2012 will have only minor effect on long-term energy prices.

In Norway, nearly all production of electricity is currently based on hydropower. The potential for increased electricity supply from hydropower is, however, limited. Future increase in electricity demand must, therefore, to a large extent be met through other domestic sources (including wind and wave power, district heating plants and gas-fired power stations) or imports. The projections up to 2010 include about 3 TWh from new wind power production stations and some 5 TWh from gas-fired stations. From 2010 to 2020, electricity demand is technically assumed to be met by increased domestic electricity supply from gas-fired power stations.

CO_2 emissions from the petroleum sector

The Norwegian Pollution Control Authority, The Norwegian Petroleum Directorate and The Norwegian Oil Industry Association have set up a joint database for discharges to the sea and emissions to the air from petroleum operations. From 2004, all operators of petroleum activities on the Norwegian Continental Shelf report discharge and emission data directly to this database. This facilitates both the operators' and the authorities' ability to produce analyses of historical discharges and emissions in a way that is more comprehensive and consistent than was previously the case. Emissions to the air are, in most cases, calculated on the basis of the quantity of gas and diesel used in combustion processes on the installation. The emission factors used in these calculations are provided through the Norwegian Oil Industry Association (OLF).

Emission projections are based on information on activity levels collected from the petroleum industry. The petroleum authorities annually prepare both short- and long-term forecasts for petroleum production. Short-term production forecasts are based on input from the operators, adjusted for fluctuations in the rig market, expected gas sales and probable starting time for projects. The Norwegian Petroleum Directorate is responsible for the long-term forecasts of Norwegian petroleum production.

Emissions of other greenhouse gases

Projections of emissions of other greenhouse gases than CO_2 are mainly based on sector- and plant-specific information, collected by the Norwegian Pollution Control Authority from the industries concerned:

- *Methane emissions.* The model for calculating inventory figures for methane emissions from Solid Waste Disposal Sites (SWDS) has recently been revised by the Norwegian Pollution Control Authority (SFT, 2005).[1] As a consequence, estimated methane emissions from SWDS have been almost halved (for 2002 estimated methane emissions from SWDS were revised downwards by 45.6 per cent). The revised model complies with the Revised IPCC 1996 Guidelines for National Greenhouse Gas Inventories and the IPCC Report on Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories as approved by the UNFCCC. From 2009, deposition of wet organic waste on landfills will be prohibited. The effect of this measure is not taken into account in the baseline scenario, neither is the effect of licensing requirements for collection and combustion of methane from landfills. Methane emissions from the agricultural sector are expected to remain stable as the emissions are little affected by short term economic cycles.

- *N_2O and SF_6 emissions.* Projections of N_2O emissions from nitric acid production and sulphur hexafluoride (SF_6) from magnesium production are based on expected levels of production and emission supplied by Norwegian producers. Emission projections of perfluorocarbons (CF_4 and C_2F_6) from aluminium production are also projected on the basis of reports from the producers. These projections incorporate the mitigation effects of the agreement between the Ministry of the Environment and the aluminium industry.

- *HFC emissions.* Emission projections of HFCs are prepared by the National Pollution Control Authority, drawing on available research. A tax on import and production of HFCs and PFCs was implemented in 2003.[2]

2 For an analysis of the effect of a tax on imports and production of HFC and PFC, see SFT (2001). "Reduksjon i utslippene av HFK, PFK og SF6 : Utredning av avgift som virkemiddel", http://www.sft.no/publikasjoner/luft/1754/ta1754.htm.

5.2.3 Sensitivity to changes in key macroeconomic assumptions

Projections of greenhouse gas emissions are subject to wide margins of error. The macroeconomic forecasts are uncertain, as are predicted developments in energy demand. Moreover, possible structural changes both within and between industries may have considerable impact on emissions. The impacts of policies and measures are also difficult to assess precisely, and must to a large extent be based on limited past experience as reflected in existing models.

For Norway, developments in CO_2 emissions from the oil and gas extraction industry are important, but difficult to project. Future emissions will largely be determined by the production level. The main uncertainties relate to technical conditions like geology, technology and exploration success. Up to 2009, the uncertainty in oil production is estimated to be +/- 15 per cent and depends on the ability of the reservoirs to meet demand and on the number of new projects.

Emission projections of CO_2 are in general sensitive to changes in key macroeconomic assumptions, including GDP growth, technical progress and prices on oil and gas:

- The impact of future *GDP growth* on greenhouse gas emissions can be illustrated by a comparison of the current and the previous baseline scenario. Average annual GDP growth up to 2010 has been increased by 0.3 percentage points compared with the previous baseline. As a consequence, the estimated CO_2 emissions have been revised up by about 3.6 million tonnes for the period 2003 to 2010. The result is however i.a. contingent on the exact sectoral distribution of the revised growth pattern.

- Higher *growth in total factor productivity* would increase greenhouse gas emissions, according to simulations on the macroeconomic model MSG. If productivity growth for all production factors in all production sectors turns out 0.5 per cent higher annually over the period 2011-2020 than assumed in the baseline scenario, total greenhouse gas emissions would increase by about 3 million tonnes of CO_2 by 2020. Higher energy consumption is the main factor behind the estimated increase. At the same time, higher productivity growth would lead to a higher GDP level in 2020, which reduces the Norwegian petroleum wealth as a share of GDP. The Norwegian petroleum wealth will, therefore, cover a smaller share of total imports (as a share of GDP), implying a need for more goods-producing and emission intensive industries in Norway. Lower annual productivity growth would have a similar negative impact on greenhouse gas emissions.

- As in other countries, *higher petroleum prices* will have a direct negative impact on economic activity in the short run and shift private demand towards products with relatively lower petroleum content. Moreover, as a small and open economy, economic activity in Norway is sensitive to the international business cycle. Slower growth internationally could, therefore, have a significant negative impact on economic activity in Norway.

  However, to the extent that oil extraction activities are stimulated by higher oil prices, the negative impulse on overall activity and greenhouse gas emissions would be dampened. Furthermore, higher income from the petroleum sector leads to strengtened public finances. According to the state guidelines, all oil revenues are transferred to the Government Petroleum Fund. The annual use of petroleum income over the state budget should over time equal the expected real return on the fund, estimated at 4 per cent. In line with these guidelines, higher petroleum prices should lead to a gradual and sustainable increase in the use of income from the petroleum sector, resulting at some point in a more expansionary fiscal policy stance.

  All in all, the negative short-term impact of higher petroleum prices on economic activity and emissions is likely to be smaller in Norway than in oil-importing countries, and could even be positive.

  Over time, higher national income will lead to changes in the production structure of the economy. As resources are shifted from goods production to services, emissions from industry are likely to be reduced somewhat more than in oil-importing countries. Although higher oil and gas prices are unlikely to lead to a significant shift from oil to electricity for heating purposes, macroeconomic model simulations suggest a moderate decline in the overall emissions in Norway in the medium to long run.

5.3 Assessment of aggregate effects of policies and measures

Estimating the effect of policies and measures *ex post* is subject to considerable methodological difficulties, including the establishment of a hypothetical baseline and the provision of relevant data. So far there has only been a limited amount of quantitative analysis in Norway of the impact of various policies and measures after they have been implemented. Effects are monitored more systematically in some sectors than in others. The assessment of aggregate effects of policies and measures, which is required by the UNFCCC guidelines (part E, paragraph 39-41), can therefore only be partial and to some extent qualitative, building on information on the main policies and measures.

Table 5.3 shows the estimated effects of selected measures that have been implemented or adopted. These estimates are based on information derived from studies by the Norwegian Pollution Control Authority, Statistics Norway, the Norwegian Petroleum Directorate as well as various consultancy firms. In the absence of these policies and measures, emissions of greenhouse gases would be approximately 8.5 to 11.1 million tonnes CO_2 equivalents higher in the baseline scenario in 2010. Compared with the 1990-level, these estimates represent an increase in greenhouse gas emissions of 17-22 per cent. Further details are given in chapter 4. The list of measures is not complete, and the estimates are uncertain. In particular, the effects of policies and measures aimed at enhancing energy efficiency, encouraging the use of new renewable energy sources, as well as the effect of measures related to transport and agriculture, are not covered by the analysis.

The estimated effects of some recently adopted measures not included in the baseline scenario are also presented in table 5.3. These measures include the emissions trading scheme for the period 2005-2007 covering some 15 per cent of all greenhouse gas emissions, as well as measures addressing emissions from the waste sector (see chapter 4).

According to the baseline scenario, Norway faces an average annual ”deficit” of about 11 million tonnes CO_2 equivalents for the period 2008-2012, compared to the commitment under the Kyoto Protocol. However, recently adopted measures not included in the baseline projection lower the “deficit” to approximately 10 million tonnes.

Table 5.3 Effect on domestic emissions of selected measures that have been implemented or adopted since 1990. Milliones tonnes CO_2 equivalents.

	1995	2000	2003	2005	2010
Directly related to climate change:					
CO_2 tax offshore[1)]	0.6	3.0	3.0	3.0	3.7[3)]
CO_2 tax onshore [2)]		0.8	0.8	0.8	0.8[3)]
Requirement to collect landfill gas	0.25	0.4	0.45	0.5	0.6
Other measures in the waste sector		0.07	0.2	0.25	0.3
Tax and recycling schemes on HFC			0.2	0.3	0.5
Climate change agreement with aluminium industry [4)]	0- 1.6	0.6- 3.0	1.2- 4.0	1.4 - 4.0	1.4 - 4.1
Agreement on SF_6 emissions			0.05	0.06	0.06
Other regulations:					
VOC regulation offshore			0.17	0.2	0.25
VOC regulation at the Sture terminal		0.01	0.17	0.02	0.005
Voluntary reductions:					
SF_6 reduction, magnesium production	1	1.4	0.5 [5)]	0.5	0.5
N_2O reduction , production of nitric acid	0.4	0.3	0.3	0.3	0.3
Use of bicarbon in cement production		0.02	0.03	0.1	0.1
Sum effect of implemented measures in baseline	2.3-3.9	6.6-9.0	7.1-9.9	7.4-10.0	8.5-11.1
New policies and measures post 2004					
Emission trading scheme 2005-2007				0-0.5	0-0.5[6)]
Consensus with the processing industry					0.6
Additional measures addressing the waste sector					0.15
Total emission reductions	2.3-3.9	6.6-9.0	7.1-9.9	7.4-10.5	9.3-12.4

1) Based on reports from companies operating on the Norwegian Continental Shelf and the Norwegian Petroleum Directorate.
2) Based on an equilibrium analyses for 1990-1999. Bruvoll.A and B.M.Larsen (2004) “Greenhouse gas emissions in Norway. Do carbon taxes work” Energy Policies 32 (4), 493-505, and assessment made for the Third National Communication.
3) The role of the CO_2 tax scheme may change from 2008 as a consequence of a revised national emission trading system for 2008-2012.
4) Lowest number reflects direct effect of the agreement, while highest estimate includes voluntary measures taken before adopting the agreement in 1997.
5) A part of a factory was shut down in 2001. The associated emission reductions are not included.
6) A revised national emission trading scheme for 2008-2012 may include other effects.

New policies

The Norwegian Kyoto commitment will be met by a combination of national measures and the use of the Kyoto mechanisms. The government will put forward to the Parliament a proposal for a revised national emission trading scheme for the Kyoto period (2008-2012) and changes in other measures.

From January 2006, domestic aviation, domestic shipping and supply ships are liable to the same CO_2 tax rate as other users of mineral oil. The removal of the tax rebate may reduce emissions by around 0.05 million tonnes according to the Supplementary White Paper to the Parliament No 1 (2005-2006).

The government has stated its intention to contribute to the realization of gas-fired power plants with carbon capture and storage through economic measures and by supporting the development of new technologies. The government will see to that new licences for gas-fired power plants are based on carbon capture technology. In the baseline scenario, CO_2 emissions from gas-fired power stations are estimated at 1.1 million tonnes in 2010 and 9.7 million tonnes in 2020.

The government will introduce climate action plans for all relevant sectors of society, including specific targets for each sector.

In the energy sector, the government will continue to stimulate renewable energy and energy saving through the national energy agency Enova SF. The policy declaration from the present government parties states that Enova's targets for energy saving and new renewable energy will be increased. In the declaration, the government parties also state the intention to introduce a mandatory market for green energy certificates or other instruments to assist the implementation of new renewable energy sources. The declaration also contains an intention to increase the use of water-borne heating and establish well-functioning financing mechanisms for district heating and bioenergy.

The government will also contribute to increased international cooperation on the development of environmentally friendly technology, energy systems and new renewable energy as well as support environmental research programmes including environmentally friendly gas technology.

The government will promote the use of biofuels (see section 4.5.1.) Funds have in recent years been allocated to projects on the development and testing of low emission technologies including production and use of hydrogen and biofuels. The government also plans to increase allocations to public transport.

The Norwegian Pollution Control Authority has started a pilot study assessing the potential for taking climate change into consideration in the existing Norwegian statutory framework. The project will provide a basis for considering making changes to acts and regulations that have unintended negative impacts on the climate.

The Commission on Low Emissions was established in early 2005. The Commission will deliver a report in 2006 with a description of how Norway can cut its emissions by 50-80 per cent by 2050. Based on the report from the Commission, the government will consider long-term targets for the reduction of greenhouse gas emissions.

5.4 Projections of CO_2 sequestration in forest

In 2003, annual net carbon sequestration in Norwegian forests has been estimated at about 17 million tonnes of CO_2 (see Section 4.8). As a result of forest management practices, annual net CO_2 removals increased the following 10-15 years and are expected to reach a level of nearly 24 million tonnes of CO_2 by the end of the first commitment period. This result is based on information from the forest inventory, assuming continuation of the current level of harvesting, no significant changes in natural die-off, and no new policy. Long rotation periods make growth projections relatively certain for the first few decades, while there is some uncertainty in the projection with regard to future harvest rates and natural decay.

5.5 Projections of precursors and SO_2

Nitrogen oxides (NOx), non-methane volatile organic compounds (nmVOC) and carbon monoxide (CO) have an indirect effect on the climate through their influence on greenhouse gases, in particular ozone. Sulphur dioxide (SO_2) also has an indirect impact on climate, as it increases the level of aerosols with a subsequent cooling effect. Emissions of these gases are on this basis included in the inventory and in the projections of greenhouse gases.

Table 5.4 shows projected emissions of NOx, nmVOCs and SO_2 consistent with the baseline scenario. The estimates are based on the same assumptions as for the other gases, as described in

Section 5.2. To meet the NOx commitment by 2010, the government is elaborating on a differentiated tax on NOx emissions.

Table 5.4 Anthropogenic emissions of NO, nmVOCs and SO_2 Baseline scenario. Thousand tonnes

	1990	2003	2010[1)]	2020
Nox	223.7	220.2	200.8 (156)	162.3
SO_2	52.3	22.0	26.9 (22)[2)]	28.8
VOC	294.4	300.1	168.8 (195)	147.2
NH_3	20.4	23.0	23.6 (23)	23.1

1) Norwegian commitments according to the Gothenburg Protocol are shown in brackets.
2) The agreement between the authorities and the processing industry is assumed to bring the emissions under the Gothenburg commitment of 22 000 tonnes within 2010.

6. IMPACTS AND ADAPTATION

6.1 Introduction

In 1997, the Research Council of Norway set up a research programme to study regional climate development in northern Europe in a scenario with global warming (RegClim). Now in its third phase RegClim involves about 30 scientists from 5 institutions in Norway (met.no, UiO, UiB, NERSC, IMR). The activities include preparation for impact studies by downscaling of global climate scenarios, and conducting research in areas of considerable uncertainties such as the role of aerosols and ocean currents. Norway is a sub-Arctic country with a long coastline facing a relatively warm ocean surface to the west as well as a long mountain chain. Results from IPCC indicate that man-made climate change is prone to be relatively large in the Arctic, but at the same time associated with considerable scatter between climate models. The main reason both for the Arctic amplification of global climate warming as well as the spread, is the Arctic cover of sea ice. Whether this scatter is predominately due to model errors or natural chaotic variations, is difficult to tell. Nevertheless, the scatter influences the estimated upcoming climate development in Norway. The spread needs to be taken into account by downscaling data from several models and interpret the spread as a range of regional risks connected with climate change. This is done in RegClim.

RegClim has recently published results for climate change in Norway for the period 2071-2100 compared to 1961-90. Earlier RegClim has reported on scenarios for the first 50 years of the 21st century. In the 110-year perspective, assuming the quite optimistic SRES B2-scenario, RegClim concludes from this scenario that the annual average temperature increases between 2.5 and 3.5°C. The increase is particularly large for winter minimum temperatures in the north (up to 4°C), whilst the summer maximum increases between 2 and 3°C with largest increase in the south. Precipitation changes are probably the more dramatic of the signals. Increases are between 5 and 20 per cent annually, and during fall over 20 per cent over considerable parts of the westward facing coastline. In the south-east increases are largest in winter (15-20 per cent), whilst this part of the country experience dryer conditions in summer (15 per cent decrease), which reflects the conditions projected for summertime central and southern Europe. The precipitation is calculated to come during considerably more intense events, increasing the impression of more high-impact weather and associated impacts. The present-day annual maximum event is projected to occur up to 3 times as often. Wind changes are less pronounced in these calculations. Between 4 and 8 more days per year with stronger winds than 15 m/s is calculated in coastal areas and over the North Sea and Skagerrak. The frequency of very strong winds (25 m/s) is not projected to increase.

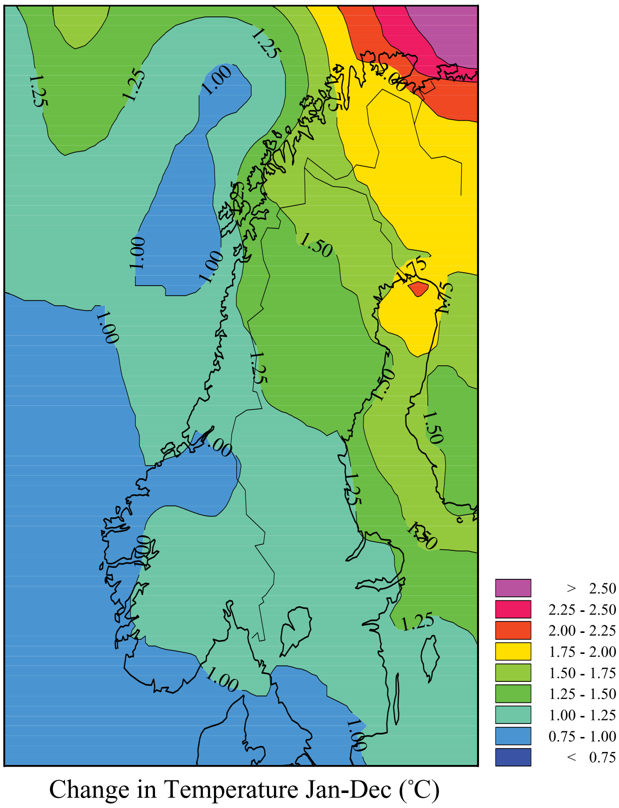
Although more RegClim scenarios are underway, the present results are quite robust according to present level of understanding. Data from the global models in Max-Planck-Institute in Hamburg and the Hadley-Centre in UK are combined. Each of the two models show contrasting results, but are both believed to be realistic according to natural variability. This is underpinned by results from the project's own Bergen Climate Model, which is used to study possibilities for reduced influx of warm surface waters in the Nordic Seas. Only a 5-15 per cent reduction in the currents responsible for this influx is predicted. As a consequence, a considerable reduction in the Arctic Sea ice cover is projected towards the second half of the 21st century. See Figure 6.3. RegClim's study of aerosol effects clearly shows that if aerosol pollution decreases (due to emission reduction protocols for other environmental concerns), regional climate change in Northern Europe will be accelerated. Furthermore, the B2 scenario for greenhouse gases is on the lower side compared to most other SRES scenarios, and the climate sensitivities of the two global models are smaller than the majority of other global climate models. Hence, there is a considerable risk that RegClim's results are underestimates rather than the opposite.

The RegClim scenarios also indicate that the impact of climate change will vary from one part of Norway to another. Norway spans more than 10 degrees of latitude, with a very long coastline and mountainous terrain, and some regions of the country may therefore be more vulnerable to climate change than others. Both the ecological and the socio-economic impacts of climate change will probably vary across the country. More information can be found at the RegClim website at: www.regclim.nilu.no.

To some degree, however, all aspects of the Norwegian economy, environment and society are vulnerable to climate change. Extreme weather conditions like the very heavy snowfalls Northern Norway has experienced in several recent winters and the intense rainfall that caused flooding and landslide in Bergen in the autumn 2005 have clearly increased public awareness of climate change and the need for adaptation measures.

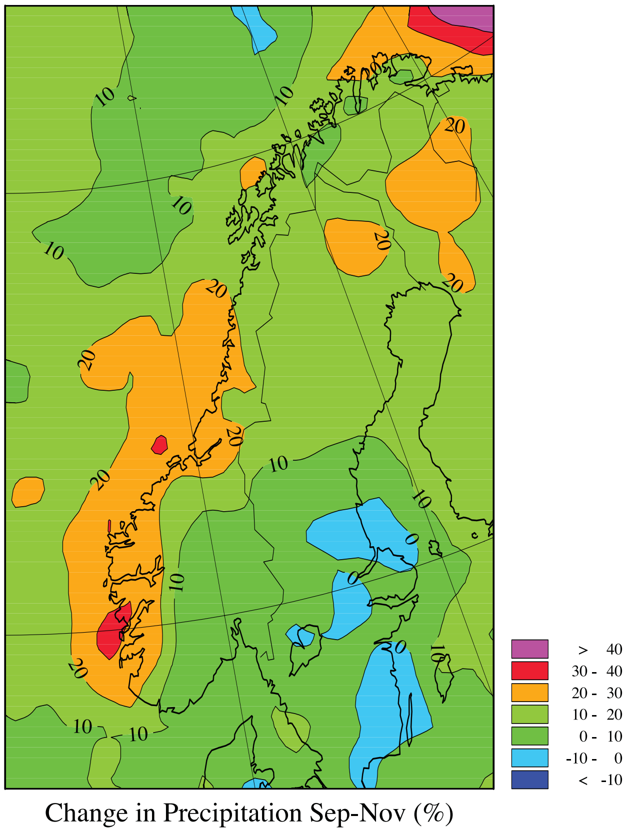
In recent years, support for research on climate change and its impacts has increased substantially. The government is also in the process of making a national strategy for adaptation, see Section 6.4.

Figure 6.1 Projected changes in mean annual temperature (°C)



Source: RegClim

Figure 6.2 Projected changes in precipitation September-November (%)



Source: RegClim

6.2 Impacts of climate change on biodiversity and natural ecosystems

6.2.1 Terrestrial ecosystems

The expected changes in the Norwegian climate include temperature rise, changed precipitation patterns and some wind effects. A temperature rise per se would be expected to lead to a shift of climate zones in both altitude and latitude. Many plant and animal species will need to migrate, but many species migrate more slowly than the rate at which the climate is predicted to change. In addition, more precipitation is expected, and in winter this will fall as snow at higher altitudes/latitudes. This means that some climatic zones will not merely shift upward/northwards but actually change, as the snow probably will melt out later and lead to shorter growing seasons (although possibly warmer).

As a consequence, species may be exposed to a climate to which they are not adapted, and over time it is therefore expected that climate change may cause changes in the species composition, abundance and distribution of plants, invertebrates and vertebrates. Species with a higher temperature optimum that migrate upwards may outcompete natural alpine species. As a result of climate change and differences in species' capacity for migration, the distribution and population size of species native to mountain forests and other alpine habitats may decrease, or shift upwards. Extreme climatic events such as storms, drought and frost in late spring are also expected to increase in frequency and might be as significant as the rate of temperature change as regards alterations in species composition and ecosystem processes. However, as the expected climate changes are different for different parts of Norway and for different seasons, the actual results in specific areas are difficult to predict.

It is assumed that climate change may have a severe impact on the flora and fauna of bogs and marshes. In Eastern Norway and Finnmark, such habitats may change character through changed precipitation patterns and higher temperatures, which may slow down their formation and speed up decomposition. Suitable habitats for species that are dependent on bogs and marshes may therefore become scarcer and more patchily distributed than is the case today. Alpine areas, bogs and marshes are expected to alter most during changes in the climatic conditions as described above. Changes in climate may therefore endanger species that are found in such areas. Many invertebrates that are capable of migration have an extensive distribution, and can probably cope with climate change as indicated through adaptation. However, climate change will expose insects adapted to cold environments to warmer conditions that may affect their development. Many of the vertebrates found in Norway have generally good dispersal abilities and will presumably tolerate a wide range of climatic conditions. They are able to migrate faster than vegetation in response to climate change. However, habitat transitions are likely to occur at different rates and it is difficult to predict the extent to which vertebrates will become established in newly formed habitats created by climate change. Climate change may also make it possible for new species to extend their range northwards into Norway. The immigration of new species may have unpredictable effects on ecosystems.

In sum, climate change might result in substantial changes in wildlife and vegetation. The extent to which the changes result in loss of biodiversity will depend on the extent to which species and ecosystems are able to adapt to the changes. The most dramatic consequences may be expected for species that are at the southern or lower limit of their natural arctic and alpine habitats. Similarly, species that are currently at their northern limit are likely to flourish, provided that suitable habitats are available and that they tolerate the changes in snow distribution in winter.

6.2.2 Fresh water ecosystems

The predicted temperature rise may lead to changed living conditions in freshwater. The stratification period in summer will be longer and more distinct, which is likely to favour cyanobacterial blooms. High altitudinal and latitudinal lakes are regarded as particularly sensitive to variations in climate, and species respond immediately to changes in ice regime. With the higher precipitation expected, higher nitrogen concentrations caused by increased runoff from soil, changes in physicochemical and hydrological conditions, and a higher carbon dioxide concentration may lead to changes in competition between some species of primary producers and consumers. The degree to which species will disappear with changed living conditions is uncertain.

For specialized species of phytoplankton, zooplankton, vertebrates and cold stenothermic glacial relicts, the forecasted climate change could be critical in some localities. Fresh water systems are isolated, and some species of fish and crustaceans may be unable to migrate to alternative habitats. In addition, there is a risk for new/introduced invasive species to survive the new conditions and outcompete native species.

6.2.3 Marine ecosystems

It is expected that a rise in temperature will have some impact on marine ecosystems, though most marine species are capable of moving from unfavourable to more favourable growing and spawning areas. Climate change may therefore result in changes in the distribution and stock size of several plankton and fish species.

Increased water temperatures are very likely to lead to a northward shift in the distribution of many species of fish, to changes in the timing of their migration, to a possible extension of their feeding areas, and to increased growth rates. Increased water temperatures are also likely to lead to the introduction of new species to most sea areas. A temperature rise is unlikely to lead to the extinction of any of the present fish species, but some species may disappear in some areas but they are likely to be found in new areas. Changes in the timing of biological processes are likely to affect the overlap of spawning for predators and their prey (match/mismatch). A competition may occur when/if new species are introduced into an ecosystem. Many arctic specialists have relatively narrow habitat and other niche requirements. Their likely response to a possible increase in competition from more opportunistic/generalist species in a warmer Arctic is unclear.

The immigration of new phytoplankton species may cause toxic algal blooms. In the Barents Sea, higher sea temperature and a smaller area of ice in summer may contribute to greater biological production.

The expected increase in precipitation and run-off will lead to more extensive transport of nutrients and organic material to coastal waters, which again will lead to higher production and possibly eutrophication.

An increase in storm activity could increase the demands of the technical installations in the aquaculture industry and ports and sea transport infrastructure. An increase in extreme weather will lead to an increased risk of shipping accidents and oil spills along the Norwegian coast. We will also see an increased risk of farmed salmon escaping and posing a threat to wild fish in Norwegian rivers.

6.3 Impacts of climate change on vulnerable sectors

6.3.1 Primary industries

Agriculture

A temperature increase will probably have positive effects on crop production because the growing season will be extended in most parts of the country. An extended growing season may make it possible to harvest some crops for silage more frequently. Introduction of new crops might also be possible in some parts of the country.

However, negative effects may also be expected in the agricultural sector. More frequent and intense precipitation can present difficulties with regard to both spring farming and the harvest. It will also lead to difficulties with regard to surface runoff management and erosion patterns. A rise in precipitation may exceed the capacity of the soil to absorb moisture and thus lead to loss of agricultural land and increase in surface runoff, which again may have potential negative effects on fresh water ecosystems and drinking water quality. Increased temperature and precipitation might also increase problems with both existing and new pest and plant diseases, especially in south-eastern Norway.

Forestry

Forestry is likely to benefit from climate change, as increased concentrations of carbon dioxide and higher temperatures are expected result in higher production. With a temperature increase of 3 °C, it is estimated that forested areas will expand about 250 km northwards and about 500 metres further above sea level. A warmer climate is also likely to change the composition of the forest. The species most adaptable to climate change will prevail. One likely result is that conifer forest will replace mountain birch forest in lower alpine areas, while the birch might move further upwards. In general, both forest production and forest area can be expected to increase as a result of climate change. Some of the benefits could, however, be offset by more damage from wind, pests and diseases. The forestry sector could also experience problems with species adaptation because of long rotation periods, reduction in wood quality, more difficult operational conditions and possibly other difficulties.

Fisheries and aqua culture

There is a great need for more research on the consequences of the climate change for the fisheries.

However, a likely consequence of warmer waters is a change in the composition of species in different sea areas. In some areas the commercial value may be reduced, while in other areas it might increase. It is also likely that changes in the distribution areas for some species may have impact on fish quotas in the economic zones of some countries.

For the aqua culture industry the warmer waters might make it possible to breed new species, such ad turbot, with an economic advantage. However, it might also lead to more frequent incidents involving pests and algal blooms might create substantial problems. A higher frequency of extreme weather conditions might also create higher cost for maintaining technical equipment.

6.3.2 Infrastructure, housing and other buildings

Increased precipitation and a higher frequency of extreme weather can lead to higher cost of building, maintaining and repairing infrastructure and buildings.

When new buildings and infrastructure are built, the risk of increased precipitation, winds and extreme weather conditions is of importance for the planning. Materials and structures of new buildings can be better prepared for the climate changes. New buildings can be placed so that the increased risk of flooding and landslides is taken into consideration. The risk of landslides and flooding is mapped out in ever more areas.

Predictions of landslides and avalanches can no longer be based on historic data. These predictions have to take the changing climate into account. The climate changes can lead to new types of landslides as well as risks of landslides in new locations. This leads to the need of new protection measures and increased drainage to keep roads and railways safe. These increased risks also result in a more frequent closing of roads and other infrastructure, which can lead to significant economic losses. Some communities risk being isolated at times, especially during the winter season, if roads must be closed.

The public road administration has started a project to evaluate the consequences of climate change for the road sector. The results from this project will be taken into account when developing new guidelines for the building, maintenance and drainage of the roads. Also the Norwegian railroad network is working to improve their warnings systems regarding extreme weather and landslides.

Large parts of the Norwegian coast are also vulnerable to the climate changes. Increased water levels and changes in the size of the waves can affect shipping lanes, piers and jetties as well as buildings near the coats. The coastal administration is taking this into consideration in their planning. The shipping industry is vulnerable to storms, large waves and other extreme weather conditions. Early and precise weather- and wave forecasts are crucial to avoid dangerous situations and effective operation of the ships.

Research is being undertaken through the research programme Klima 2000, to develop solutions for construction and materials that are more durable. It can become necessary to increase the technical specifications for buildings due to climate changes.

6.3.3 Local planning, civil protection and emergency planning

Adaptation to climate change is currently not as integrated a part of local and regional planning as is necessary. The main challenge is to make sure that planners have the relevant information available and use it in their spatial planning. This could be made possible if climate models were scaled down to local and regional levels and made available for planners along with information on different possibilities for adaptation. In that way local and regional plans can take into account increased precipitation and winds as well as increased risk of flooding, landslides and avalanches. It would also be possible to consider an increase of water levels when planning coastal areas.

The Planning and Building Act is currently under revision and the aim is to make it a tool to ensure that climate change is taken into consideration in local and regional planning.

A higher frequency of extreme weather can lead to higher frequency of weather related emergency situation. A higher summer temperature can also lead to an increased risk of forest fires. This must lead to a higher level of preparedness for civil protection and emergency situations. It is important that the civil defence, the defence, the fire brigade, the rescue service and other agencies charged with emergency operations are made ready to face the additional challenges.

The melting of the icecap may lead to a longer period of open waters in the north-west passage. This can lead to increased traffic, in particular of oil transports. This naturally increases the risk of oil spills along the coast and calls for a higher level of preparedness.

6.3.4 Energy and petroleum production

Energy production in Norway is influenced by the increased precipitation because most of our electrical energy is hydropower. It is predicted that there will be an increase of water levels in the winter and spring seasons, however summer water levels are predicted to be lower. The difference between the seasons is mainly due to increased temperatures, which leads to a change of the time for snow melting.

A research project called Climate and Energy is planned to make calculations of the change in energy production as a result of climate change. An earlier study indicates that it might be possible to increase energy production at hydropower installations in Norway. At the same time the higher temperatures might decrease the need for energy for heating. However, it should be pointed out that the climate changes also makes the weather conditions less predictable which in turn will reduce the predictability of electricity production.

In general much uncertainty is tied to the climate changes and it is necessary to take these uncertainties into consideration when evaluating the vulnerability of the energy sector and proposing cost effective adaptation measures.

The off shore petroleum production will be affected by increased winds and waves as well as an increase in extreme weather conditions. In the case of storms and at the risks of large waves off shore installations take precautions by moving equipment to higher levels or shutting down production. An increase in the frequency of extreme weather can thus lead to more frequent production shut down. This will give the petroleum sector some economic loss.

6.3.5 Health

The warmer climate can have the effect that ticks, snails and other disease carriers can have a greater dissemination. In Norway the tick (Ixodes Ricinus) is the most serious threat. Today, the tick's dissemination is limited mainly to some coastal areas. With the climate changes predicted by RegClim the tick could spread to other areas, including areas which are more densely populated. The same is true of other disease carrying species such as bats.

An increase in temperature with an increase of heat waves can result in higher death rates among older and weaker people, especially in the north where people are not used to the heat.

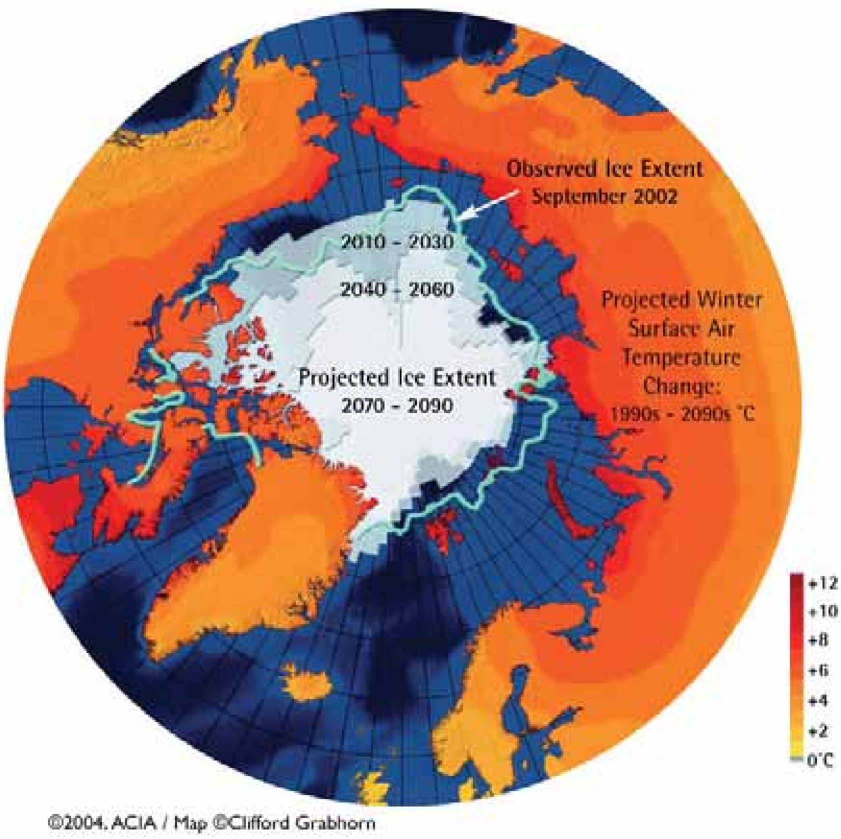
Flooding, landslides and storms can of course lead to more emergency situations with deaths and injuries as a consequence. But flooding and landslides can also cause damage to the sewers and the drinking water system, which can lead to an increase of infectious diseases.

6.3.6 Insurance

The climate changes can lead to greater frequency and extent of weather related damage to property. This can lead to increased number and size of insurance payments, which again can lead to higher insurance premiums. If the extent of damage increases significantly there might be a need for structural changes such as stronger involvement from authorities to develop adequate mechanisms for risk transfer.

6.3.7 Arctic

Figure 6.3 Projected change of ice extent at the north pole



Source: ACIA

The report from the Arctic Climate Impact Assessment (ACIA), which was initiated in 2001 by the Arctic Council, finalized in 2004 and printed in 2005, emphasizes that the Arctic now is experiencing some of the most rapid and severe climate change on earth. The Norwegian Ministry of the Environment has initiated a national follow-up programme of the ACIA-report for the period 2005-2009, with the aim to improve the knowledge relevant for adaptation strategies for the most vulnerable societal sectors and to fill the knowledge gaps as described in the ACIA report. This work will be done in such a way that it easily can be expanded to cover other Arctic countries in the region. The secretariat for this national programme is located at the Norwegian Polar Institute.

6.4 Adaptation measures

Norway is in the process of developing a national strategy for adaptation to climate change. The process is lead by the Ministry of Environment but it involves almost all other ministries.

The government recognizes that a number of organizations in both the public and the private sectors should take part in this process. Regional and local level will also have to be included. As described above, some of the most immediate adaptation priorities fall to organizations responsible for planning and developing major infrastructure, such as transport networks, flood defences and buildings. The Ministry of Environment has alerted and informed the sectoral authorities to ensure that climate change considerations are taken into account in planning processes wherever relevant.

As demonstrated in Section 6.3, many sectors are well under way in their response to climate change and research to determine the best measures for adaptation. The national strategy will see all the measures in relation to each other and point out sectors where more work has to be done.

Compared to many other countries, especially less developed countries, Norway is relatively robust with respect to climate change and climate variability. The country is not particularly vulnerable to sea level rise, it is among the wealthiest in the world and the population is used to a harsh and variable climate. Nevertheless, as the RegClim results show, climate change will affect Norway, and it will affect some regions, sectors, ecosystems and social groups more than others.

To improve understanding of climate change and its regional impacts it will be necessary to continue to support research on the impact of climate change through research programmes such as RegClim and international initiatives such as ACIA (Arctic Climate Impact Assessment).

7. RESEARCH AND SYSTEMATIC OBSERVATION

7.1 Funding of research and systematic observation – general policy

Norwegian public funding of research is for the most part channelled through the Research Council of Norway, which has a budget of app. NOK 4.6 billion in 2005. The Research Council supports basic research, strategic basic and applied research, research for innovation and technology, and covers all disciplines.

The most recent white paper on research in Norway (Report No. 20 (2004-2005) to the Storting; Commitment to Research) emphasizes that the relationship between energy and environment should be given special attention. This topic is one of the Research Council's strategic target areas for the future, and includes large research programmes on climate change, on energy systems and development, development of new energy technology and technology for CO_2 sequestration.

Climate change is a long-term, complex problem that affects all sectors of society. Climate research is therefore extremely important both as a basis for developing policy and as a climate policy instrument. The government plans a long-term effort to strengthen climate research in Norway. More specific proposals for increasing allocations to research into scientific, technological and social aspects of the problem will be put forward in connection with the annual budget deliberations.

One of the main priorities will be climate science, including our fundamental understanding of the relationship between natural and anthropogenic variations in climate, climate models and the consequences of climate change. Another priority is analyses of social constraints and various climate policy instruments. The third main priority in climate research is the development of technology to reduce emissions of CO_2 and other greenhouse gases, and includes the development of new renewable or alternative energy sources and more environmentally friendly and efficient use of energy. A new area which deserves increased attention, and which involves information work and the development of expertise as well as research, is research related to emergency preparedness and adaptation to climate change.

In recent years, several different technological concepts have been presented for the removal and sequestration of CO_2 generated by power plants. In all these concepts, the process of CO_2 removal is energy-intensive and costly. However, there is reason to believe that further research and development will make it possible to reduce energy losses and the cost of the process. A majority of the Storting has approved the construction of gas-fired power plants in Norway. This gives Norway more reason to play an active part in efforts to develop technology that can in the long term reduce CO_2 emissions from the use of natural gas.

It is important for Norway to continue and strengthen its participation in international research cooperation, particularly within the EU, OECD and IEA. The work of the IPCC on synthesising the status of knowledge on climate change is also of great importance in this context. The report from the Arctic Council on climate change and its consequences in the Arctic – the Arctic Climate Impact Assessment – has identified needs for further research, and been a stimulus for increased activity.

Norway does not have a national Global Climate Observing System (GCOS) programme today. However, in 2000 the Research Council of Norway established a research programme on monitoring of marine and terrestrial systems. The programme covers both the development of monitoring technology and the practical application of novel technologies in resource monitoring. An expansion of the programme to include monitoring of environment and climate parameters is under consideration. Long time series of climate data are being collected by many different Norwegian institutions. Continuation of these series requires sustained efforts. In order to prevent termination of particularly important series, an initiative has recently been taken to make an overview of time series of climate data that are important for climate research. Much of the national funding for research on climate change is channelled through various programmes under the Research Council of Norway. These programmes define the priority areas of research in Norway. Projects will often be co-funded from other sources, both public and private.

A survey of the Research Council's budget showed that in 2005, the contribution to research related to climate change, including adaptation and mitigation of climate change was approximately NOK 268 million. This is an increase of about 137 per cent since 1998, when climate related research financed through the Research Council of Norway amounted to NOK 113 million. In addition, research in related topics gives important contributions. This includes e.g. basic research in materials technology, which supports research on i.a. hydrogen storage. University based research is not included in this figure, as far as universities fund this kind of research themselves and not through activities supported by the Research Council or other funding sources. Also, there are considerable research efforts in the private sector, particularly related to carbon capture and storage. Several petroleum companies fund this kind of research. Norwegian climate researchers also participate actively in international research cooperation, such as research projects under the EU Framework programme and the Global Change programmes (IGBP, WCRP).

7.2 Research programmes related to climate change

In the following, the research priorities and examples of projects of the climate programmes currently in progress under the Research Council of Norway are briefly outlined.

The framework for the main thrust of Norwegian research related to climate change is provided by the climate research programmes of the Research Council, the first of which was established in 1989. Recently (2004) the Research Council launched a new 10-year large-scale programme called *NORKLIMA: Climate change and its impacts in Norway.* The programme will run until 2013. The programme was established by combining three existing activities: (i) Programme on Climate and Climate Change (2002-2011), (ii) Programme on Effects of and adaptations to climate change (2002-2011), and (iii) Special research funds for "Polar climate research" (2002-2006). The programme defines a series of scientific areas to be further addressed. These are based on the IPCC Third Assessment Report, on an evaluation of important national and global research challenges, and on input from Norwegian research experts.

The main goal of NORKLIMA is to provide the necessary new knowledge related to: the climate system, the change in climate in the past, present, and future and direct and indirect effects of climate change on nature and society, as a basis for adaptation policies and measures. An overall objective is to ensure that Norwegian climate research maintains the highest international standards and to enable Norwegian researchers to conduct research in priority areas. The total annual budget available to NORKLIMA is about NOK 85 million, and in 2005 the programme is funding ca. 60 projects.

NORKLIMA encourages international collaboration and coordination with international research programmes. International cooperation is currently channelled efficiently through the EU framework programmes. Such cooperation also takes place through participation in international programmes, in particular under the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP). In addition, the programme supports participation by Norwegian scientists in international research assessment panels such as the IPCC and ACIA.

The Research Council of Norway is also funding a national centre of excellence in climate research: *The Bjerknes Center for Climate Research (BCCR)* in Bergen is a joint research venture between the University of Bergen, the Institute of Marine Research and the Nansen Environmental and Remote Sensing Center. Its work is coordinated by the University of Bergen. The scientific focus of the group is on ocean-ice-atmosphere climate processes, and on the climatic evolution of the North Atlantic, the Nordic seas, the Arctic Ocean and surrounding regions in the past, present and future. For this, instrumental and proxy data and small-scale, basin-scale and global-scale coupled atmosphere-ocean models are used.

Another research centre conducting research on climate change is *CICERO (Center for International*

Climate and Environmental Research - Oslo) which was founded by the Norwegian government in 1990. It is an independent research center associated with the University of Oslo with a mandate to both conduct research and provide information about issues of climate change. With expertise in both the natural and the social sciences, CICERO conducts interdisciplinary research on four main areas (1) Atmospheric and climatic effects of emissions and emissions reductions (2) Impacts of climate change: Vulnerability, adaptation and costs, (3) Climate agreements: Design, implementation and costs, and (4) Climate policy: Instruments for national implementation.

7.2.1 Climate processes and climate system studies, including paleoclimate studies

NORKLIMA includes three large, coordinated projects within these themes:

Past Climates of the Norwegian Region (NORPAST) aims to advance the knowledge of patterns and variability of past climate in the Norwegian Region (Norway and adjoining continental margin and fjords) and to contribute to the understanding of climate forcing factors. The studies focus on quantitative climate reconstructions during the last deglaciation, the Holocene and the Recent Past, by investigating a limited number of high-resolution sites from terrestrial and marine archives; by improving paleoclimatic proxies; and by synthesising existing and new data. The project is being coordinated by the University of Tromsø.

Norwegian Ocean Climate Project (NOClim), which focuses on improving our understanding of processes which govern oceanic heat transport towards the Nordic Seas, and which provide the basis for atmospheric heat transport from the Atlantic sector towards northern Europe. The project is executed by combining theory and numerical modelling with analyses of recent instrumental data and reconstructions from proxy data. The main goals are 1) to elucidate how stable the Atlantic Meridional Overturning Circulation (AMOC) is to human induced greenhouse warming, 2) to identify whether rapid climate transitions in the past were associated with changes in the overturning rate in the Nordic Seas, and 3) to investigate whether the balance of evidence (from observations, process understanding and models) indicates that abrupt changes are underway or likely to happen in the near future. The project is being coordinated by the University of Bergen. The project has links to the new UK Rapid Climate Changes programme. NOClim and the UK programme were developed in close collaboration between Norwegian and British scientists.

Aerosols,Ozone and Climate (AerOzClim) The main objective of AerOzClim is to improve our understanding of aerosol-climate and ozone-climate interactions, by continue to develop and apply global models in combination with analysis of observations, to study processes involved, and to provide improved parameterisations of climate models. The studies include: 1) Process studies of poorly described processes in models, in order to reduce large uncertainties connected with estimates of the direct aerosol effect, 2) Methods to calculate process-allocated aerosol life cycles, with parameterized radiative properties, water-activity and cloud-droplet impacts, implemented in an atmospheric Global Circulation Model(GCM), 3) Collection of additional data and analysis of processes affecting ozone loss and climate change in the stratosphere, and in the UTLS region, 4) Development of a model tool for ozone chemistry/climate interactions, and 5) Implementing the parameterised processes in GCMs and performing coupled climate/chemistry model studies. The project is being coordinated by the University of Oslo. The research undertaken in AerOzClim is supplemented by research on the climate effects of reducing black carbon emissions, on the impact of aircraft emissions on atmospheric chemistry, and modeling and observational studies of aerosols.

There are also studies linking biogeochemical cycles with the climate system. Soil-plant-atmosphere interactions in the cycles of nitrogen and carbon are covered in several studies, also including microbiological processes. Fluxes of carbon and nitrogen from terrestrial to freshwater and marine ecosystems are also studied, aiming at improving understanding and prediction of the global carbon cycle and of the consequences climate change has on these fluxes.

7.2.2 Modelling and prediction, including general circulation models

The three coordinated projects listed in Section 7.2.1 also comprise modelling and could also be included here. Another coordinated modelling project is RegClim:

Regional Climate Development under Global Warming (RegClim). Its overall goal is to estimate, using statistical and dynamic methods, probable changes and uncertainties in the regional climate in Northern Europe, bordering sea areas and major parts of the Arctic, given that there is global climate change, and to quantify their uncertainties due to choice of methods, global scenarios, and to uncertain processes influencing our region's climate, in particular those causing the warm and ice-free Nordic Seas, and the effects of aerosols. RegClim provides climate scenarios for Norway and surrounding areas that are used in the climate effect projects in NORKLIMA. The project is being coordinated by the Norwegian Meteorological Institute.

7.2.3 Research on the impacts of climate change

Climate impact research constitutes a major component of NORKLIMA, and research is going on concerning: 1) Climate change and its impacts on abiotic systems and the built environment, and 2) Climate change and its effects on ecosystems – both natural and cultivated NORKLIMA focuses on the impacts of climate change on the physical environment, including the built environment, water resources, flooding, snow and ice conditions, landslides and avalanches, erosion, glaciers, fjords, water temperature and sea level. Such abiotic factors are a key part of the framework for ecological systems, agriculture and society. Additionally, the programs aim at identifying and quantifying the direct and indirect effects of climate change on marine, limnic and terrestrial ecosystems in terms of species distribution, interaction between species, relevant biogeochemical functions and productivity. The objective is to improve understanding of the effects of projected climate change on ecology and production, and biosphere-climate feedback. Current research activity on this topic includes projects on ecosystem changes in the Arctic (both terrestrial and marine ecosystems), in the Barents Sea and other marine ecosystems, and in forest ecosystems. The Arctic is an area of particular concern, as climate changes are expected to be more pronounced and occur at a faster rate in this area than on lower latitudes. Research on impacts of climate change in the Arctic includes research on immigration of species, on population ecology of seals and polar bears and on population dynamics of interacting species. More general ecological research, e.g. on vertebrate population dynamics responses to climate change, is also done. With respect to marine ecosystems (both in the Arctic and other areas), ongoing research covers inter alia linkages between climate variability and climate change to oceanographic changes, and the consequences of this on productivity and ecosystem processes. More detailed studies on the distribution, recruitment and food change dynamics concerning important species like cod and herring are also undertaken. This research is closely linked to research described under Section 7.2.4, socio-economic analyses.

7.2.4 Socio-economic analysis, including analysis of both the impacts of climate change and response options

Within this topic, NORKLIMA analyses the impacts of climate change and climate-driven change in ecosystems and the natural resource base on society. The objective is to identify regions and sectors that may be particularly vulnerable to climate change in the next 30 to 50 years and identify elements of a national strategy for adaptation to projected climate change. An important concern for NORKLIMA is to gain a better understanding of what impacts climate change may have on Norwegian society and how we best can adapt to climate change. A large study identifying climate change vulnerability, and socio-economic perspectives on policies and impacts, is underway. The study is using regional climate scenarios as a basis for analysing vulnerability and capacity to adapt to climate change, across regions and municipalities. The objective of this type of study is to look at the overall impacts in a region or community, across all sectors, and identify possible adaptation responses. Institutional aspects of the development of adaptation strategies are also important.

More specific studies of the impacts of climate change both on economic sectors and on regions and local communities are also of priority. There is ongoing research on economic impacts of climate change on Norway's fisheries and marine resources, on agriculture and forest ecosystems. Fisheries, agriculture and forestry are important economic sectors in Norway, and their natural resource base is expected to be influenced by climate change. Hence, it is a concern for society to identify the magnitude of these changes and develop appropriate responses. This type of research is closely linked to the natural science-based research on climate processes and climate system studies, and on modelling and prediction of climate change.

At the same time, the programme plans to focus on climate impacts in other countries, particularly developing countries, both because they are more vulnerable than Norway and because impacts in these countries may in turn have clear impacts on Norwegian society.

The energy sector is a dominating economic sector in Norway. Oil and gas dominate exports, whereas domestic energy supply is dominated by renewable energy (hydropower). Research and technology development are of priority in both these fields of energy production. There is also a considerable research effort into other technologies for renewable energy production.

Environmental agreements and other international agreements will substantially alter the framework conditions for the domestic development of energy systems. Similarly, changes in technology and market conditions present new challenges. Over the past 15 years, social science expertise has laid down important conditions for policy making in the interface between energy and the environment and for the development of a market-based system for trade in electricity. In future, there will continue to be a great need for knowledge about the opportunities and instruments for social governance with a view to environmental considerations, security of supply, resource management and economic development, at the same time as the processes of internationalisation and the opening of markets will continue.

The large research programme RENERGI (Clean Energy) is one of a limited number of new major research programmes in which the Research Council deploys a wide range of instruments and resources. The main focus of the programme is on renewable energy production, energy efficiency and end-use, energy systems, hydrogen, and social science related to energy and climate change. The programme period is 2004-2013.

One important aim for RENERGI is to improve the social science knowledge base of Energy Markets, Energy Policy and International Agreements, and provide a framework for social scientific research on energy and the environment, including climate issues. The main focus of this post of the programme is on economics and political science, but the research also involves several other disciplines. The total budget for RENERGI is currently NOK140 million/year, approximately 10 per cent of the budget is allocated to the social science part of the programme.

The social science part of RENERGI covers two main topics:
- Energy Markets
- Energy Policy and International Treaties

Research areas for Energy Policy and International Treaties:
- Public instruments;
- The effects of public instruments
- Negotiating processes;
- Knowledge about the development of international energy markets;
- The enforcement of agreements

The aim of the project *Enforcement, Compliance and Participation: Alternative designs for a climate agreement,* is to enhance knowledge of a climate agreement regarding other aspects than efficiency. The project asks to what extent alternative models for a climate agreement raise other challenges for enforcement, compliance and participation than the cap-and-trade regime of the Kyoto Protocol. Some of the main research questions are the ability of pressure groups to influence participation and compliance in Norway and the EU, what is the relationship between the design of the enforcement mechanism and the number of signatories in a climate agreement, and to what extent can alternative designs of the enforcement mechanism motivate the United States to join the Kyoto cap-and-trade regime.

Principal objectives for the project *The EU Emissions Trading Scheme: Key conditions and prospects for effectiveness* are to contribute substantive and theoretical knowledge about the formation and change of EU environmental politics in general and the EU Emissions Trading Scheme (ETS) in particular; and to assess prospects for effective implementation of the associated directive at EU and national levels. Sub-goals are to disseminate this knowledge to practitioners in Norway and abroad in a form that they find useful; and to engage in the scholarly debate about the formation and effectiveness of this specific institution.

The main objective of the project *International Climate policies and induced technological change* (Frisch centre) is to get a better understanding of the interplay between environmental policies such as climate agreements and technology development, and to disseminate this knowledge to relevant user groups and the academic society. Special attention is given to the effectiveness of different policy instruments and technology diffusion under international climate treaties.

Also other social science research programmes support research relevant to climate change, climate policies and related social and economic questions. The research programme *Conditions, governance and* *measures for a sustainable development* (RAMBU) aims at identifying and analyzing conditions and strategies for sustainable management of environmental natural resources, development of measures for a sustainable development and enhancement of knowledge and use of knowledge for sustainable development and sustainable practices.

Climate change policies have considerable focus in the programme, supporting the development of national and international climate policy in Norway. Ongoing research includes the following topics:

- A sustainable climate development: Long-term target, global agreements, and economic consequences
- Sustainable development and climate policies in a world of economic globalisation - how could Norway make a difference?
- Coping with the threat of climate change: technological strategies and cultural responses
- The Kyoto Protocol: Effects and further development
- The Kyoto Protocol, carbon sequestration and poverty reduction

In the latter project, the framework conditions for successfully implementing land use change and forestry projects under the Clean Development Mechanism are analyzed, and the consequences for carbon sequestration, poverty reduction, incentives for farmer economies and on macroeconomic level are described. The project is based on field work and data from Tanzania, Uganda, the Philippines and Nepal. With respect to the dual outcome of carbon sequestration and income, results show that income growth will follow and sustain tree-planting projects in poor agricultural areas, but local food production is considerably reduced and replaced by food import as carbon is crowding out local food production. Hence, the establishment and sustainability of such projects depend upon the presence of a food market. A macro level study on Tanzania indicates that tree planting in larger scale crowds out more profitable economic activities and lowers the overall growth rate. Results are dependent on assumptions concerning, among other things, barriers to land use change and carbon prices.

7.2.5 Mitigation and adaptation technologies

KLIMATEK, a government-funded Norwegian national technology programme, was started in 1997 as the result of a political initiative to promote the development and demonstration of technology that can reduce emissions of greenhouse gases in Norway. The programme was merged with other programs in 2002. From 2005 a new programme (CLIMIT) dedicated to gas power with CO_2 capture and storage (CCS) has been established. KLIMATEK covered all greenhouse gases, but projects were mainly focusing on CO_2 and methane. Initially, priority was given to projects in the offshore petroleum sector and in the process industry. At present, the CLIMIT programme is focusing on CO_2 capture and storage from power generation based on natural gas.

There is an increasing interest in CCS both from coal and gas power plants internationally. Both EU and the USA have strong focus on developing new technology for CO_2 capture and geological storage of CO_2. Norwegian companies and research institutions are playing a major role in this international collaboration.

From the beginning of the programme in 1997, KLIMATEK, and now CLIMIT, have allocated around NOK 350 million from the government. In addition, industry companies have participated with a similar amount. The annual budget from the government has been NOK 50 million in the last few years.

Projects supported by CLIMIT include the following:

- Development of a novel membrane gas/liquid contactor for exhaust gas cleaning using amine absorption. The technology has been demonstrated at a pilot plant at Statoil's gas processing plant at Kårstø, Norway. Contractor: AkerKvaerner.
- Saline aquifer storage in the Sleipner field - an international project on modelling and monitoring activities related to the first large-scale demonstration of offshore underground CO_2 storage. Cooperation with the EU and the IEA Greenhouse GasR&D Programme. Contractor: Statoil.
- New Advanced Zero Emission Power Production (AZEP) technology based on combination of oxy fuel gas turbine with membrane separation of air. Contractor: Norsk Hydro
- Participation in the second phase of the international energy company initiative to capture CO_2 from fossil fuel power production, the "Carbon Capture Project" (CCP). Norwegian activities focus on natural gas and CO_2 storage in geological reservoirs. Contractor: Norsk Hydro.
- Long-term research on novel power cycles, membrane technologies, combustion and absorption/adsorption processes, novel reforming processes, fuel cells, geological storage of CO_2

etc. Participants: Norwegian independent research organizations and universities.

The large energy programme RENERGI (described in Section 7.2.4) comprises different fields of short, medium and long term research, limited to energy production and transmission, and to stationary and mobile energy use. In relation to climate change, both renewable energy production and hydrogen are of interest.

Renewable energy sources comprise a wide range of technologies. Norwegian energy companies, suppliers and research groups occupy a strong position in the field of hydropower. Competence in this aims at further development and upgrading of the system, as well as the development of small-scale hydropower plants.

Norway is rich in renewable energy. Available sources include hydro, wind, solar power and bio energy, as well as energy from the ocean such as wave energy, energy from salt gradients and tidal energy. The development associated with silicon as the basis for solar cells has turned out to represent a successful amalgamation between Norwegian raw materials and competence. Norwegian research groups may also have advantages when it comes to adapting renewable energy technology to the Norwegian climate. For example, wind power technology has made considerable headway, but there is still room for new products and services related to the use of windmills in Arctic climates, offshore.

RENERGI will encourage research communities, business and industry to collaborate to identify areas of potential growth in renewable energy production.

Possible target areas may be:
- The optimisation and environment-friendly development of hydropower installations.
- The use of solar heating in buildings.
- Bio fuel production and exploitation, based on wood and waste.
- Offshore wind power and other wind power adapted to conditions in Norway.
- The exploitation of energy from the ocean in areas of technology in which Norway is especially well qualified.

Along with electricity, hydrogen will probably play a key role as an energy carrier in a future energy system. Over the past few years, there has been considerable international focus on the development of hydrogen as an energy carrier. This has been motivated by environmental considerations and the need for security of supply. Norsk Hydro, Norway's gas industry and the Norwegian shipping industry have sophisticated expertise in the field of hydrogen.

Formidable challenges must be resolved along the entire hydrogen value chain, including production, storage, transport and end use. The RENERGI programme is financing more than 30 projects within the field of hydrogen. Several of these are oriented towards hydrogen for transportation as it is in the transport sector Norway must focus to reduce emissions of greenhouse gases in a long term perspective.

Since the successful use of hydrogen could imply major changes in the energy system, it will also be important to use social science methods to shed light on prospects for the future, to determine what is required to adopt such technologies and to understand the barriers represented by the introduction of new technology.

The visions described for hydrogen are based on very long-term perspectives. Efforts under the auspices of RENERGI will therefore be long-term and of considerable importance to basic human resources development. The common visions established at the international level will pave the way for industrial progress and the testing of hydrogen technology in the years ahead. RENERGI's prioritisation of such research is predicated on long-term interest in the field on the part of major industrial players.

Initially, the programme will give priority to projects that build further on the knowledge found in Norway, and where the application of the results is of relevance to the gradual development of hydrogen as an energy carrier. It will be important not least to rank priorities in fields in which Norwegian research can play a role in broader international co-operation:

Possible areas may be:
- The production of hydrogen using natural gas or water electrolysis;
- Hydrogen storage;
- The development of fuel cell components and systems for the use of hydrogen;
- Hydrogen-relevant materials research;
- Systems integration for hydrogen, including security issues and social assumptions;
- The use of hydrogen in the transport sector.

7.3 Systematic observation

A summary of the status of national plans, programmes and support for ground- and space-based climate observing systems is provided in the following.

7.3.1 Meteorological and atmospheric observation

The Norwegian Meteorological Institute has included 10 existing meteorological surface observing stations and one upper air station as part of GCOS. The stations report to the WMO international data exchange according to standard procedures. Norway does not have a separate national GCOS programme.

The Norwegian Meteorological Institute operates 6 upper air stations, including at the Arctic islands Jan Mayen and Bjørnøya, making upper air soundings twice daily. In addition the Norwegian Meteorological Institute operates the weather ship station Mike at 66 N 02 E, which makes upper air soundings 4 times per day and surface observations every hour. The weather ship is also made available for making oceanographic observations and CO_2 samples (also some other gases for the US Environmental Laboratories).

The surface based meteorological network for real time synoptic observations comprises approximately 160 land based stations. An increasing number of these stations have been automated and are making hourly observations.

In addition the Norwegian Meteorological Institute operates a number of automatic meteorological stations at the northern part of Svalbard and has equipped approx 10 oil rigs and approx 20 ships in the Norwegian and Barents seas from which meteorological observations are collected. Many of these stations report on an hourly basis. One automatic station located on the ice in the Arctic is made available to the International Arctic Buoy Programme (IABP), in which the Norwegian Meteorological Institute has participated during approximately 20 years.

A synoptic meteorological station has also been made available for operation at the Troll station in the Antarctica.

The Norwegian Meteorological Institute has operated meteorological observing stations for more than 100 years at a number of locations. The climate data base of the Norwegian Meteorological Institute therefore includes very long records of climate data.

Real time data from the Norwegian meteorological stations are exchanged internationally through the WMO international data exchange and are sent to the World Data Centres according to standard procedures.

The Norwegian Institute for Air Research has the main responsibility for greenhouse gas monitoring in Norway. The concentrations of a wide range of greenhouse gases are monitored at the Zeppelin Station in Ny-Ålesund, Spitsbergen. They include a wide range of halogenated species (including CFC, HFC and HCFC gases), methane, and tropospheric and stratospheric ozone. This is part of the WMO Global Atmosphere Watch (GAW) system, the Network for Detection of Stratospheric Change (NDSC) and the Advanced Global Atmospheric Gases Experiment Network (AGAGE). The Institute hosts the European part of the NDSC database and also runs the European database for stratospheric ozone (NADIR), which contains data from several projects on stratospheric ozone founded by the European Commission.

The Zeppelin station is also basis for measurements of CO_2 and particles performed by Stockholm University, funded by the Swedish Environmental Protection Agency. The only important greenhouse gas which is not monitored at the Zeppelin station is N_2O due to lack of instrumentation.

Data on the halogenated greenhouse gases are now receiving particular attention. The Norwegian Institute for Air Research is coordinating the EU-funded project entitled “System for observation of halogenated greenhouse gases in Europe” (SOGE). The project involves careful calibration of observations from four European sites (Mace Head, Jungfraujoch and Monte Cimone in addition to the Zeppelin Mountain on Spitsbergen). The observations from SOGE are linked to two international research programmes, i.e. the Network for the Detection of Stratospheric Change (NDSC) and the Advanced Global Atmospheric Gases Experiment (AGAGE).

Norway is participating in the development of the European Climate Assessment and Dataset (ECA&D), a project intended to produce a consistent climate database covering most of Europe. The project is part of the European Climate Support Network (ECSN) which involves collaboration between the national meteorological services in Western Europe (EUMETNET). Norway is also contributing to the Nordic Climate Data Set (NKDS). This dataset contains high-quality monthly climate series back to the 1890s, and is established in the project NORDKLIM within the framework of the national meteorological services in the Nordic countries (NORDMET).

Table 7.1. Participation in global atmospheric observing systems

	GSN 1)	GUAN 2)	GAW 3)	Other 4)
How many stations are the responsibilities of the party?	10	1	1	175
How many of those are operating now?	10	1	1	150
How many of those are operating to GCOS standards now?	10	1	1	110
How many are expected to be operating in 2009?	10	1	1	175
How many are providing data to international data centres now?	10	1	1	5)

1 GCOS Surface Network
2 GCOS Upper Air Network
3 Global Atmosphere Watch of WMO
4 Standard manual and automatic synoptic meteorological stations used for general weather forecasting and climatology.
5 Depends on type of data centre. Most of them provide data to GPCC, approximately 45 are exchanged globally and providing essential data according to WMO Resolution 40 (WMO Cg-XII).

7.3.2 Oceanographic observations

A reporting and coordinating mechanism for WMO operational marine activities, the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), was established in June 2001. The Global Ocean Observing System (GOOS) will build on data provided by the Commission. The oversight of marine international observation programmes is done by JCOMMOPS, situated in France.

JCOMMOPS provides coordination at the international level for oceanographic and marine observations from drifting buoys, moored buoys in the high seas, ships of opportunity and sub-surface profiling floats. JCOMMOPS operates under the auspices of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM). For more information please look at: http://wo.jcommops.org/cgi-bin/WebObjects/JCOMMOPS

Open ocean drifting buoys have passed the number of 1250, and the number of sub-surface profiling floats reached 2041 in September 2005, towards its target of 3000 in 2007. Norway contributes with 8, EU 10, and USA 1049 at the present stage. The Voluntary Observing Ship programme and a few other programmes are on decline. The density of moored buoys is concentrated around the ENSO detection areas in the tropical belts of the Atlantic and the Pacific Oceans.

The Institute of Marine Research has taken the initiative to establish a Norwegian council for operational oceanography in order to coordinate Norwegian activities with international GOOS-related activities (IGOOS, EuroGOOS, ICES/IOC Steering Group on GOOS and others). Together with other Norwegian institutes, it takes part in various GOOS meetings and GOOS-related projects. The Institute also takes part in meetings of the International Oceanographic Data and Information Exchange (IODE) under the IOC, where international standards and quality control are discussed.

The Institute of Marine Research has an extensive monitoring programme on physical and biological oceanographic parameters. Temperature and salinity observations are made at nine fixed coastal stations from Skagerrak to the Barents Sea with vertical profiles. In addition, the Geophysical Institute at the University of Bergen is making oceanographic measurements from the weather ship M in the Norwegian Sea. In cooperation with the Norwegian Meteorological Institute, which operates the weather ship M, they are also planning to start a programme for monitoring of sea/air CO_2. Sea surface temperature observations are made at 4 m depth continuously along the course of the coastal steamer between Bergen and Kirkenes (24 positions) and between Stavanger and Aberdeen (9 positions). Temperature, salinity, nutrients, phytoplankton and zooplankton are in addition observed from 10 standard sections 2-12 times per year. All together, approximately 4000 CTD casts are worked out yearly in the North Sea, the Nordic Seas and the Barents

Sea. The hydrographical observations are regularly submitted to International Council for Exploration of the Sea (ICES).

An extensive program for currents measurements at the western entrance of the Barents Sea has been carried out since 1997. 5 moorings with 10 current meters have been deployed. In 2005, two bottom mounted ADCP have been used, and there is a plan to expand with another ADCP.

Two types of drifting buoys are used. 26 RAFOS floats measuring deep water circulation in the Norwegian Sea were deployed in 2005. The project will be terminated in 2007.

Institute of Marine Research (IMR) in Norway is so far, as we know, the only institute in Norway that have deployed Argo floats. The institute has deployed nine Argo floats (Apex type) in the Norwegian Sea. Three floats were deployed in June 2002 and six floats in August 2003. All floats drift at 1500 m depth, in deep water masses. The parking depth at 1500 m depth was chosen due to the bottom topography for the area. The CTD-profiling is performed from the parking depth at 1500 m depth to the surface every ten days. There are no other sensors than pressure, temperature and conductivity on the floats. Except for one float that was deployed in 2002, the floats are still operative. All floats have worked well giving good data and new insight of the current patterns.

Regarding the "Delayed mode" we have in the past not done anything special with that. However, just recently we made an agreement with IFREMER where they will do the quality check for us. IFREMER will then, afterwards, make the high-quality data and the meta-data available on the internet. Unfortunately we do not have any high-resolution data in the vertical. At present, we have ordered two new Argo floats (APEX) that will be deployed in the Norwegian Sea next year, probably in March. Both these floats will also, in addition, include fluorescence and oxygen sensors.

The Norwegian Polar Institute (NPI) maintains a monitoring programme in Framstrait, monitoring the oceanic output from the Arctic Ocean to subpolar seas. The programme is a collaborative effort with Alfred Wegener Institute for Polar and Marine Research (AWI). The latter institution is responsible for monitoring the input of heat and salt to the Arctic, while NPI monitors the export of freshwater. Since 1990, ice thicknesses have been continuously monitored with two to four upward looking sonars. Since 1997, the observations have included sea ice drift measurements, current meters and temperature and salinity observations. The programme thus observes the liquid and solid (sea ice) phase of the Arctic freshwater output, and the state of the Arctic sea ice cover in terms of thickness. The monitoring programme is part of the international Arctic Sub Arctic Ocean Fluxes (ASOF) programme, under which all major connections between the Arctic Ocean proper and sub Arctic seas are monitored. The data are submitted to the AWI data base on a regular basis, which again is responsible for a coordinated data submission to the International Council for the Exploration of the Sea (ICES).

The Joint Assessment and Monitoring Programme (JAMP) adopted by OSPAR 2005 (MASH 05/6/Info. 2) is developed to provide the basis for a consideration of OSPAR's requirements for monitoring the species and habitats.

Implementation Plan of the JAMP Assessments scheduled on species and habitats as contributions to the Quality Status Report (QSR) 2010 (MASH 05/6/2) includes an assessment in 2008 of the changes in the distribution and abundance of marine species in relation to changes in hydrodynamics and sea temperature (JAMP Product BA-3).
It also includes an assessment in 2009 of the status of the species and habitats that have been placed on the OSPAR List of threatened and/or declining species and habitats, in light of both the relevant selection criteria and relevant ecological quality objectives (JAMP Product BA-4). Directorate for Nature Management (DN) is responsible for coordinating and reporting when this process has developed further.

SEAPOP (Seabird Population Management and Petroleum Operations) is a national seabird mapping and monitoring programme. The programme which is developed in collaboration with research institutes, oil industry and management (DN) will provide improved data on seabirds, which, in addition to contribute to implementation of ecosystem management also will give valuable information on possible impact from climate change on biodiversity. Highest priority is now given to the Lofoten-Barents Sea area. At a full scale the programme will include additional data and the rest of marine ecoregions along the Norwegian coast.

A Working Group for marine biodiversity was appointed by DN in 2002 and resulted in 2005 in a proposal, not yet implemented, for a National Programme for monitoring biodiversity in coastal areas. The aim of the programme is to coordinate existing and planned monitoring activities on biodiversity to meet the demands of an ecosystem approach. Implementation of the programme seems to be necessary to meet the need of reference data to help the understanding of impact monitoring data and of climate impact on marine biodiversity. This work is now continued for the open seas and has a broad representation of participants from management and research.

There is a serious need of data and mapping of species and habitat at a regional and local level and activity has now started as a part of the National Programme.

MAREANO is an integrated mapping programme for the Norwegian seas and coastal areas carried out by the Institute of Marine Research (IMR), the Geological Survey of Norway (NGU) and the Norwegian Hydrographic Service (SKSK). The programme initiates a detailed mapping of the physical, chemical, biological environment of the sea-bottom areas.

Norway has large natural resources in the coastal and shelf regions that are managed by different bodies within the government, counties and local communities. The MAREANO programme will collect and compile knowledge of the coastal region and the shelf areas in an integrated database, and make it available on the Internet using state-of-the-art GIS technology .The goal is to provide society with up-to-date, quality controlled data for management, sustainable development and exploitation.

7.3.3 Terrestrial observations

Norway participates in the Global Terrestrial Observing System (GTOS) by reporting data from 8 study areas of birch forest. There is no national climate change monitoring programme in Norway. Climate change issues are, however included to a varying degree in the programmes listed below.

Ongoing monitoring programmes of special interest with respect to climate change:

- Terrestrial Monitoring Programme (TOV) (Directorate for nature management DN)
- Monitoring of palsa peatlands (Directorate for nature management)
- Vegetation monitoring in protected coniferous forests (Norwegian Institute of Land Inventory NIJOS)
- Forest monitoring programme (state/vitality of forest ecosystems) (ICP-forest) (Norwegian Forest Research Institute and Norwegian Institute of Land Inventory NIJOS)
- National Forest Inventory (inventory on permanent plots all over the country at 5-year intervals) (Norwegian Institute of Land Inventory)
- Monitoring of cultural landscapes (3Q) (Norwegian Institute of Land Inventory)
- Environmental monitoring on Svalbard and Jan Mayen. (Norwegian Polar Research institute)

Norway has participated in ACIA (Arctic Climate Impact Assessment) under the Arctic Council. ACIA includes both marine and terrestrial systems. ACIA includes research and observations related to the climate system as well as marine and terrestrial systems. An overview report with conclusions from the ACIA programme was published in November 2004 whereas the comprehensive scientific report has just recently been published (October 2005). Norway has established a national project (2005-2009) to follow up the ACIA-report on a national level. The main object of the project is to improve the knowledge on projected climate change and related consequences for Norway, identify particular vulnerable sectors and ecosystems and identify relevant adaptation strategies (see Section 6.3.7).

Existing national plans

A national plan for biodiversity monitoring was adopted in 1998. This plan includes different threats against biodiversity, including climate. Recommendations from this plan have been implemented in a varying degree in ongoing national programmes. An interministerial national programme dealing with surveying and monitoring including reporting biodiversity data has been established (2003-2010).

There is general agreement in Norway that climate monitoring and climate research need to be closely linked. Most of the research on climate change and effects is now organised within the NORKLIMA programme by the Research Council of Norway. The total annual budget available to the NORKLIMA programme (2004-2013) is about NOK 85 millions.

Climate parameters monitored in Norway

The programmes described above are not, with the exception of ACIA and NORKLIMA, designed solely to observe the effects of climate change. However, some of them include indicators of climate change, while others include general indicators which also may be used to evaluate the effects of climate change.

The most useful indicators from these programmes with respect to climate responses are probably mass balance of glaciers and snow distribution on Svalbard, changes in vegetation communities in sub alpine birch forests, coniferous forests and on Svalbard, changes in populations of passerine birds and small mammals in sub alpine birch forests, changes in forest growth and vitality in coniferous forests. Land use changes are monitored in a programme on cultural landscapes (the 3Q programme) and the National Forest Inventory.

Reporting of terrestrial observations to international networks/programmes

- The data from 8 study areas (birch forests) in the Terrestrial monitoring programme (TOV) are reported to the Global Terrestrial Observing System (GTOS).
- The various data for changes in forests are reported to ICP Forest (ECE).
- Data from 2 stations are reported to Scantran (Scannet) (Finse, Ny-Ålesund).
- Data from 1 station is reported to Envinet (Ny-Ålesund) (within EU programme).
- Forest monitoring (state/vitality of forest ecosystems). Reporting to ICP Forests under the UNECE.
- Forest monitoring (forest resources, Pan-European Criteria & Indicators etc.). Reporting to UNECE/FAO.

All of the sites listed above are operating now and are expected to be operating in 2006. The Norwegian Polar Institute (NPI) monitors glacier mass balance annually on 3 glaciers on Svalbard, all near Ny-Ålesund. These are long-term measurements; the shortest time series starting in 1986, and the longest in 1966, the latter being the longest Arctic mass balance time series extant. In addition, NPI monitors other glaciers over shorter terms; currently an additional three glaciers' mass balance is measured. These data are reported annually to the World Glacier Monitoring Service (WGMS). As a contribution to the Global Environment Monitoring System (GEMS/GTOS) of the United Nations Environment Programme (UNEP) and to the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the WGMS of the Commission on Cryospheric Sciences of the International Union of Geodesy and Geophysics (CCS/IUGG) and the Federation of Astronomical and Geophysical Data Analysis Services (FAGS/ICSU) today collects and publishes worldwide standardized glacier data.

7.3.4 Space-based observing programmes

There is no national space-based observing programme in Norway. However, Norway is participating in the earth observation programmes of the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

The programmes of EUMETSAT, with Norwegian participation, are a geostationary satellite programme, a polar orbiting programme, with the first meteorological polar orbiting satellite to be launched in 2006, and an altimetry programme which is under preparation. Especially the polar orbiting satellites of EUMETSAT will provide a wide range of useful data providing input to weather forecasting and climate monitoring (atmospheric temperature and moisture profiles, air-sea interaction, ocean winds, sea ice, clouds, ozone mapping etc).

The Norwegian Meteorological Institute has a central role in application of satellite data for ocean and sea ice forecasting. Norway, represented by the Norwegian Meteorological Institute, also participates in the European Centre for Medium Range Weather Forecasting, which is dedicating resources in assimilation of satellite data in its numerical weather prediction models, and will also make use of satellite data for GMES related activities.

EUMETSAT has chosen Spitsbergen for location of the polar command station in the ground segment for its polar orbiting programme.

The Arctic island of Spitsbergen and the northern parts of mainland Norway are well suited for ground stations to receive data from polar orbit satellites. Two stations have been established, one in Tromsø (at 69° 39` N), which receives regional data, and one in Longyearbyen, Spitsbergen (at 78°13'N). The latter, the Svalbard Satellite Station or SvalSat, is the northernmost civilian ground station in the world. The extreme location of SvalSat means that it has the unique capability of being able to provide satellite contact with polar orbiting satellites during all orbits. For earth observation satellites this means an opportunity to perform a global data dump for each orbit at a single site. The primary focus at the station in Tromsø is earth observation activities (downloading, processing, analysing, disseminating and storing data from polar orbiting satellites). The equipment in Tromsø comprises three independent multi-frequency receive antenna systems in L/S/X band.

8. Financial resoursces and transfer of technology

8.1. Financial support (non-ODA)

8.1.1 Co-operation through multilateral channels

Norway has provided substantial funds for climate change activities through a number of multilateral organisations, among them OECD, UNEP and UNDP. The main channels for Norway's non-ODA multilateral and regional support are, however, GEF, UNFCCC Secretariat, the Prototype Carbon Fund (PCF) and the Nordic Environment Finance Corporation (NEFCO).

Global Environment Facility

The Norwegian government's contribution to the Global Environment Facility (GEF) for the period 2001-2003 has been in the order of USD 21.6 million (see table 8.1). This includes the appropriate shares of the Norwegian contributions to GEF-II (USD 6.3 million in 2001) and GEF-III (USD 15.2 million for the period 2002-2003).[3] Norway reported 65 per cent of the contributions to GEF in 2001 and 75 per cent in 2002 and 2003 as Official Development Assistance (ODA). Norway's total commitment to GEF-II and GEF-III is approx. USD 57 million. According to GEF estimates, 36 per cent of total GEF allocations are spent in the climate change focal area.

United Nations Framework Convention on Climate Change

Norway has contributed substantial funds to the secretariat to help establish the technical and institutional framework needed for the Kyoto Protocol to be an effective and credible instrument. This has been done through extra-budgetary support for the operations of the Executive Board of the CDM, as well as capacity-building efforts through, i.a., seminars on the Clean Development Mechanism in developing countries. Such funds have been made available both through multilateral channels (UNCTAD, UNEP, etc.) as well as in bilateral co-operation (i.a. China and South-Africa). Extra-budgetary funds have also been granted for the establishment of registry systems under the Protocol and for advancing the work on issues related to inventories (adjustments, etc.). Part of these grants has been for the secretariat's activities, other parts to finance participation from eligible Parties, in particular from non-Annex I countries. Funds have also been made available for other convention related activities such as assessment of implications of financing mechanisms related to the Kyoto Protocol, organisation of COPs and other convention related meetings, including support for participation from developing countries.

Prototype Carbon Fund

Norway is committed to investing USD 10 million in the World Bank's Prototype Carbon Fund (PCF). The PCF finances projects that produce high quality greenhouse gas emission reductions for the purposes of the Kyoto Protocol. For the period 2001-2003 Norway invested in total USD 1.03 million in the PCF.

Nordic Environment Finance Corporation

In 2001–2003, Norway contributed USD 5.32 million to the Nordic Environment Finance Corporation (NEFCO), which is a risk capital institution financing environmental projects in Central and Eastern Europe. Its purpose is to facilitate the implementation of environmentally beneficial projects, including climate change related projects. In 2003, an intergovernmental agreement to establish a testing ground for JI in the Baltic Sea Region was concluded. The aim is to stimulate an early follow-up of the Kyoto Protocol and to help the countries of the Baltic Sea Region to position themselves favourably in respect of fulfilling their commitments under the Kyoto Protocol. A Testing Ground Facility, a fund

3 Norwegian contributions are provided in Norwegian kroner (NOK). To comply with UNFCCC reporting guidelines the amounts have been converted to USD at the official OECD conversion rate of the relevant year.

administered by NEFCO, has been set up to provide financial assistance to concrete projects, primarily by purchasing emission reduction credits. In 2003 Norway invested USD 1.14 million in the Testing Ground Facility.

Other non-ODA multilateral support

In addition to the support explained above, non-ODA multilateral funds have also been provided through UNEP for conducting a study and presentation of knowledge and research on climate change in Africa. Moreover, support has been provided to OECD Annex I Expert Group for various activities on climate change and to UNDP for climate change activities in China.

8.1.2 Funding of bilateral climate change-related activities (non-ODA)

Activities Implemented Jointly (AIJ)

The aim of the AIJ is to raise awareness of project-based international co-operation as a means of reducing global emissions of greenhouse gases (GHG). The co-financing arrangements have made it possible to expand the scope of projects. Norway has been involved in several AIJ projects in different parts of the world and in different sectors. Whereas most of the funds were allocated and reported in the third national communication, some of the projects are still on-going. Norway has been involved in the following AIJ projects (with Norwegian financial contributions):

- Development of municipal utilities – Heating system in Fagaras, Romania (USD 0.7 mill in 2002)
- Energy efficiency in charcoal production, Burkina Faso (USD 2.4 mill)
- Introduction of energy efficient light bulbs, Mexico (USD 3 mill)
- Fuel switch from coal to gas-fires boilers, Poland (USD 1 mill)
- Fuel switch in boilers in the Slovak Republic (USD 0.15 mill)
- Energy efficiency in Shanxi, China (USD 4.65 mill)
- Forest conservation and replanting in Costa Rica (USD 1.7 mill)

Other bilateral funding of projects related to climate change

Norway has supported China in developing their first National Climate Change strategy. The strategy includes both mitigation and adaptation measures. This initiative is followed up by a project financed by the World Bank and Italy with an aim to develop a broader and more in-depth strategy on climate change. Norway has also supported the establishment of the Secretariat of Renewables and Energy Efficiency Programme (REEEP) in Beijing, which focuses on energy efficiency and renewables, with a link to CDM. REEEP Asia (renewable energy & efficiency partnership) involves co-operation with Japan, South Korea and Mongolia. The work is focussed on policy measures to promote renewables and energy efficiency in the region and to some extent support to pilot projects. This project supports the secretariat and its work to influence policy development in the field of renewables and energy efficiency in China.

Norway has also supported international initiatives seeking to outline viable routes for a climate regime post 2012. This includes contributions to International Institute for Sustainable Development (IISD), Center for Clean Air Policy (CCAP) and World Resources Institute (WRI). Funds have also been provided to CCAP for building capacity to support climate change mitigation and CDM project implementation, for building capacity in Mexico to assess renewable energy policy options and for preparations for COP8 and beyond with regard to clean air development mechanisms. Moreover, support has been provided to the Arctic Monitoring and Assessment Programme for preparation of the Arctic Climate Impact Assessment. Support has also been provided to the CTI Common Fund.

In addition, support to numerous small and medium sized projects aiming at improving energy efficiency in both small and medium sized enterprises and households has been provided under the Action Plan for the candidate countries to the EU (2001-2004).

Norway has also supported a number of research institutions in Norway, including CICERO, Econ, Fridtjof Nansen's Institute, as well as Chatham House and Wilton Park (UK) and Teri (India) on various issues related to climate change.

In the period 2001-2003, the Norwegian government contributed a total of USD 2.7 million for non-ODA climate change related activities (see table 8.1).

Table 8.1: Financial contributions to the Global Environment Facility (GEF) and other climate change funds, projects and activities - non-ODA (USD million).*

	2001	2002	2003	Total
Global Environment Facility (GEF) [2]	6.35	7.15	8.06	21.56
Financing of climate change activities (non ODA)	0.31	1.16	1.22	2.69
Nordic Environment Finance Corporation (NEFCO)[3]	1.15	1.33	2.84	5.32
Prototype Carbon Fund (PCF)	0.47	0.45	0.11	1.03

1 Contributions converted to USD at the official OECD exchange rate for the year contributions were made, as follows:
2001: USD 1 = NOK 8.9930
2002: USD 1 = NOK 7.9856
2003: USD 1 = NOK 7.0791
2004: USD 1 = NOK 6.7393
2 Contributions to GEF in total. 35 % was reported as non-ODA in 2001 and 25 % in 2002 and 2003.
3 Contributions to NEFCO are not exclusively for climate change activities

8.2 Financial support (ODA) – Norwegian development co-operation

Norway's development assistance programme is expanding. Annual contributions classified as Official Development Assistance (ODA) have increased from NOK 12 143 million (USD 1 350 million) in 2001 to NOK 14 505 million (USD 2 049 million) in 2003. Norwegian ODA is higher than the agreed United Nations target of 0.7 per cent of GNP. Norway's average ODA for the period 2001 – 2003 corresponds to 0.87 per cent of GNP. Norway's development assistance budget is set to rise further over the coming years to a total of NOK 16 619 million (0.95 per cent of GNP) for the financial year 2005, and to 0.96 per cent in 2006.

Table 8.2: Norwegian government funded development assistance (ODA) in USD million and NOK million and as a percentage of GNP.

	2001	2002	2003	2004	Total/average
ODA (USD)*	1 350	1 701	2 049	2 199	7 299
ODA (NOK)	12 143	13 585	14 505	14 817	55 050
ODA %	0.80	0.89	0.92	0.87	0.87

*Converted from NOK at the official OECD exchange rate for the relevant year (see table 8.1)
Source: The Norwegian Agency for Development Cooperation

To comply with new directions from the OECD/DAC, Norway has collected statistical data on ODA which show how the objectives and requirements of the UNFCCC are being met. So far OECD has not decided whether this new reporting arrangement will be made permanent. Figures for 2001 – 2003 indicate that Norway contributed USD 179 million to activities where the principal or significant objectives were related to the fulfilment of the Climate Change Convention (see table 8.3). Please note that funding is registered when a financial commitment was made, and that the statistics do not reflect the actual payments, which may have taken place later.

Table 8.3 Bilateral and multi-bilateral ODA funding commitments for new climate change related activities (USD million).

	2001	2002	2003	Total
Significant objective	56.21	51.77	45.72	153.70
Principal objective	10.25	3.50	11.40	25.15
Total	**66.46**	**55.27**	**57.12**	**178.85**

Source: The Norwegian Agency for Development Cooperation

8.2.1 Strategy for Environment in Development Co-operation

The Norwegian strategy for environment in development co-operation (1997-2005) is based on the government white paper "A Changing World" (Report No. 19 (1995-96) to the Storting) and the guidelines set out there, as well as on the follow-up of the international commitments in Agenda 21. One of the objectives of Norwegian development assistance is to contribute to international co-operation in order to address the global challenges we are facing.

The main objective of Norway's development assistance in the environment field is to contribute to the sound management of the global environment and biological diversity. Four areas have been given priority in the strategy:

- Development of sustainable production systems and management of natural resources
- Conservation and sustainable use of biological diversity
- Reduced pollution of soil, air and water
- Protection of cultural heritage and the cultural assets of the natural environment

Besides this, assistance for the implementation and follow-up of international environmental conventions and agreements is also given high priority.

The environmental assistance aims to integrate environmental concerns into all Norwegian-supported development assistance, and to some extent also establish environment-specific programmes. Such programmes focus primarily on enhancing the recipient countries' capacity and willingness to integrate environmental concerns into their own development plans and strategies.

The government is currently preparing an action plan on how to address environmental issues in development co-operation. It will be finalised in 2006. This plan will be based on the recent government white paper on development co-operation entitled "Fighting Poverty Together" (Report No. 35 (2003-2004) to the Storting). Management of natural resources, biodiversity and access to clean water and energy will be the main focus areas in the new action plan. However, climate change related issues will also be highlighted in the action plan.

8.3 Capacity-building, adaptation and technology transfer

Norway makes substantial contributions to the aid programmes of UN development agencies and international financial institutions, as well as through regional and bilateral co-operation programmes. Such contributions include funding for projects in developing countries related to the implementation of the United Nations Framework Convention on Climate Change.

8.3.1 Capacity-building

Besides supporting developing countries' efforts to implement international environmental commitments, one of the main objectives of Norway's environment strategy is to improve developing countries' ability to themselves identify the measures necessary to promote sustainable development. This includes strengthening their institutional capacity and expertise by providing technology and financing for improved administration and planning in the environmental field. It also involves support for the preparation and implementation of national environmental strategies and plans, as well as development of legislation and standards.

Below are some of the capacity-building activities relevant for the Convention on Climate Change that receive support from Norway:

- Support through the secretariat for participation from developing countries to COPs and other convention related meetings (workshops, etc.), as well as other activities related to capacity building.
- Assistance with developing Designated National Authorities (DNAs) in various developing countries (i.a. Algeria, Nigeria, Iran)
- A number of initiatives for capacity building in China aimed at government, research and other institutions at national and regional levels. Such initiatives include support for capacity building in national and provincial institutions to prepare for engaging in CDM co-operation, support to improve knowledge and competence in China about co-benefits of reducing emissions of climate gases and support through the World Bank Trust Fund on Environment and Sustainable Social Development to China, SEPA and the Industrial Pollution Prevention Initiative to activities addressing China's challenges in administrating air, land and water resources.
- Support through the World Bank for "Diesel Pollution Reduction – Strategies for Cities" in Thailand. The initiative aims to enhance the capacity of local stakeholders to understand the factors affecting in-use diesel vehicle emissions and to assess affordable policies and measures.
- Support through the World Bank for the

programme "Clean Air Initiative in Sub-Saharan African Cities" – in-depth studies on air pollution in five African cities and development of action plans for each city.
- Support for an IEA-study on the development of indicators to assess and report on energy use and CO_2 emissions in various sectors in India, as part of IEA's strategy to assist the government of India in building capacity to assess trends in energy use and CO_2 emissions.
- Support through IEA for capacity building to improve energy statistics, particularly in developing countries.
- Support through OECD Annex I Expert Group for various activities relating to developing countries
- Through the bilateral co-operation programme on the environment with the Republic of South Africa and Namibia funding has been provided for various capacity building activities relevant to climate change, including assistance in developing monitoring systems for air pollution, environmental law and reporting and the energy sector.
- Moreover, Norway has provided financing for projects on sustainable forestry and agro-forestry development in various parts of the world. Activities include institutional strengthening, reforestation, etc. as well as transfer of technology on conservation of biodiversity. Support to a number of research institutions on various issues related to climate change has also been given.

8.3.2 Adaptation

Sustainable development that takes the environment, poverty reduction and economic development into account is also the best way to adapt to a changing climate and mitigate its impact. This includes the development of better agricultural systems and sustainable management of natural resources.

Norway's support for adaptation activities of developing countries that are particularly vulnerable to the adverse effects of climate change is mainly channelled through the general contributions to multilateral development institutions, including through the UNDP and international financing institutions (see table 8.5). Through the general contribution to GEF, Norway is supporting the GEF pilot programme on adaptation. Moreover, Norway has been active in establishing the various climate change funds in GEF, including the LDC fund and the Special Climate Change Fund, both dealing with adaptation activities. Norway has contributed NOK 9 million, the equivalent of USD 1.4 million, to the LDC Fund and NOK 10 million and NOK 10 million, the equivalent of USD 1.5 million, to the Special Climate Change Fund earmarked for adaption and technology transfer purposes in developing countries. Support has also been provided to the UNFCCC Secretariat, OECD Annex I Expert Group, and others for activities related to adaptation.

At the resumed Sixth Conference of the Parties in Bonn, many donor countries made a political declaration reaffirming their commitment to funding for climate change activities in developing countries. Norway has so far contributed NOK 29 million, the equivalent of USD 4.4 million, of the USD 410 million per year combined contribution in the period 2005–2008.

Through bilateral and regional development co-operation programmes Norway is supporting various projects related to identification of land areas where natural disasters such as floods, landslides, etc. are likely to occur, including identifying preventive and protective measures. Flood control measures are often also integral parts of hydropower development projects (see 8.3.3. below).

8.3.3 Technology transfer

Transfer of technology and know-how in order to promote development, availability and efficiency of energy constitutes an important element of Norwegian ODA and has significant environmental co-benefits that are consistent with the promotion of the Convention.

Norway contributes to the international transfer of energy-related technology by supporting investment in infrastructure and production capacity in the energy sector of developing countries. Such investment support is frequently supplemented by institutional and human resource development measures that improve the technological expertise of the recipient country. Norway supports investments in energy technology that are given political priority by the recipient country and that are economically viable and competitive. Activities include improvements of electricity grids, improved utilisation of petroleum resources and other measures to improve energy efficiency. The intention is to make a positive contribution to sustainable development in fields where Norwegian technology and know-how have a comparative advantage. Norway supports investment and capacity building related to hydropower development in particular, but also to solar energy and other renewable energy technologies. This helps to reduce emissions of greenhouse gases. Norway is also involved in gas flaring reduction initiatives bilaterally (e.g. in Iran and Nigeria) and in co-operation with the World Bank's Global Gas Flaring Reduction Public Private Partnership. In the period 2001-2003, approx. 4.5 per cent of total ODA has been earmarked for energy projects. Table 8.4 illustrates Norwegian bilateral and multi-bilateral funding commitments for energy projects for the years 2001 – 2003 for each relevant DAC sub-sector.

Table 8.4 Bilateral and multi-bilateral ODA funding commitments of energy projects (USD million).

Selected relevant DAC sub-sectors from DAC main sector 230 - Energy	2001	2002	2003
10- Energy policy and management	8.16	11.99	17.93
20- Power generation/non-renewable	0	0	0.21
30- Power generation/renewable	2.59	18.24	4.78
40- Electricity transmission/distribution	47.45	16.37	16.68
50- Gas distribution	0	0	0.08
62- Gas-fired power plants	0	0	0.12
64- Nuclear power plants	0	0	0.25
65- Hydroelectric power plants	0.17	63.52	9.06
67- Solar energy	0.02	0	0
70- Biomass	0	0	0.16
81- Education and training	1.45	2.13	2.74
82- Research	0.28	0.13	1.38
Total DAC sector 230 - Energy	**60.09**	**112.39**	**53.37**

Source: The Norwegian Agency for Development Cooperation

In addition, Norway voluntarily supports a number of International Energy Agency (IEA) projects that aim to provide information and analysis on, and transfer of environmentally sound and climate friendly energy technologies.

Norway provided approx. USD 4.5 million to the UNDP's Thematic Trust Fund for Energy and Environment in the reporting period. Although contributions to this fund are not earmarked, some of the funding has been utilised for new renewable energy initiatives.

Through the bilateral co-operation programme with Vietnam Norway has undertaken to design and establish an Air Quality Monitoring and Planning System at Ho Chi Minh City Environmental Protection Agency, as well as undertake the necessary training for maintenance and calibration and provide support in collecting adequate data. The aim of the project is to improve the air quality through reduced emissions of gases, dust and benzene from vehicles and industry that are dangerous to the environment and human health.

A significant part of technology transfers take place through various forms of co-operation between private sector enterprises in Norway and in countries in other parts of the world. The government does not have an overview of such private sector activities.

Table 8.5: Multilateral contributions to multilateral institutions and programmes (USD million). ODA funding only.*

Institution or programme	**Contributions**		
	2001	**2002**	**2003**
Multilateral institutions			
World Bank/IBRD	18.14	63.65	24.76
African Development Bank	0.86	1.16	1.27
Asian Development Bank	0	0.25	7.72
Inter-American Development Bank (IADB)	1.06	0.44	0.47
United Nations Development Programme	79.34	85.72	99.64
* Specific programmes - of which:			
* UNCDF	3.37	0	0
* Multidonor energy fund	0	2.51	0
* Other specific programmes	0	12.84	13.42
United Nations Environment Programme	2.56	7.58	7.92
* Montreal Protocol	0	0	1.25
UNFCCC			
*Supplementary Fund	0	0	0.57
Other Multilateral scientific, technological and training programmes:			
Asian Development Bank - special funds (ASDF)	6.08	6.85	0
Inter-American Development Bank - special funds	0	2.18	1.55
African Development Fund	33.75	40.32	48.90
Nordic Development Fund	4.92	10.99	11.39
Total multilateral assistance	150.08	234.49	218.86

*This table only provides an overview of multilateral contributions to the institutions listed above.

A considerable part of Norwegian contributions to the institutions are earmarked or multi-bilateral funding. Such funding relevant for the Convention on Climate Change is included in table 8.3

Source: The Norwegian Agency for Development Cooperation and Ministry of Foreign Affairs

9. Education, training and public awareness

9.1 Introduction

The text of the UNFCCC refers directly to education, training and public awareness, and these issues have been important elements in the Norwegian climate policy in the 1990s. Several activities have been initiated to give the general public a better understanding of climate change and its effects. This in turn should result in support for policy measures to deal with climate change and also encourage public participation in climate-related measures. The government will continue to develop and expand programmes in these areas, and it will do so in close co-operation with other government agencies, professional and educational bodies and the private sector.

9.2 Education

In both primary and secondary school, issues related to energy, energy-use and climate change are integrated in the education curricula to promote an early awareness of the adverse effects of climate change. Several examples from the education curricula could be given, and here are a few:

Primary school:

- Grade 3: "The physical world picture"
  Pupils should have the opportunity to observe and describe various weather features, and measure temperature, precipitation and snowfall

- Grade 4: "Substances, properties and use"
  Pupils should trough simple experiments have the opportunity to learn how heating substances and mixtures of substances can lead to reversible or permanent changes and the formation of new substances

- Grade 7: "Substances, properties and use"
  Pupils should have the opportunity to work with a simple model of the water cycle, and through experiments learn about freezing, melting, evaporation and condensation; and learn about the formation of clouds and precipitation. Pupils should have the opportunity to learn about the major weather systems and the terms used in weather forecasts

Secondary school

- Grade 8-10: "The physical world picture"
  Pupils should have the opportunity to acquaint themselves with the earth's renewable and finite sources of energy, the relevant technologies, and future prospects with regard to energy resources for instance using information technology and to learn about the greenhouse effect and the effects of the ozone layer

Extensive support material has been developed to give teachers the best possible guidelines for their work in this area – in particular through the Norwegian Environmental Education Network (www.miljolare.no). The Network is organised as a co-operation between schools at all levels, research institutions and environmental authorities. Participating schools monitor a study site in their neighbourhood. The goal is to combine good environmental education with collecting data that can be useful to others. The results of the investigations are collected in a central database, searchable from the Networks web pages. The network works as a meeting ground between students, teachers, environmental management, research institutions and voluntary organisations. The institutions offer professional support and ideas to the teacher on how to organise the environmental education. Since 1990 a lot of schools have implemented energy-efficiency programmes, and the results have been good.

In the autumn of 2006, new curricula will be introduced in both primary and secondary levels.

Tertiary education

There are several general courses at higher and lower levels at universities and technical colleges, and within both the natural and the social sciences of relevance for climate change. Of particular relevance are courses within geophysics, oceanography and chemistry. As examples we might mention Master in Energy and Environment at the Norwegian University of Science and Technology (NTNU), the courses in Meteorology and Oceanography on the BA level at the University of Oslo (UiO) and the University of Bergen (UiB) and the course in Environmental Physics (Renewable Energy) on the BA level at the University of Life Sciences (UMB). Every year, there are quite a few students that take a doctor's degree within the field of atmospheric chemistry and other themes that approach climate oriented questions.

9.3 Information

The Ministry of Environment uses all available channels and information activities to provide different target groups with relevant information. The Environmental Information Act entered into force 1 January 2004. It provides all citizens with a legal right to obtain environmental information, both from public authorities and from public and private enterprises.

The act involves new obligations for private enterprises to hold information about factors relating to their operations that may have an appreciable effect on the environment and to supply such information to citizens on request. All areas of economic activity are included. It gives citizens the right to demand information on everything from production processes to the content of the products that are used and sold. Information on substances or product attributes harmful to health and the environment shall be available at all stages of production and use and be readily available for the users of the products.

Information on substances or product attributes harmful to health and the environment shall be available at all stages of production and use and be readily available for the users of the products. Not all products create environmental problems in Norway, but production and distribution abroad may be environmentally harmful. The new Act gives citizens the right to ask also for this kind of information.

An appeals board has been established to ensure that the Act is complied with and to consider complaints related to the follow up of this Act in private enterprises. Half of the members of the appeals board are people with an industry background, and the other half is people with a background in an environmental organisation, a consumer organisation or media. The existence of the Appeals Board ensures proper evaluation and control of whether requests for information are treated in accordance with the Act.

The Ministry of Environment has over the recent years built up extensive information resources on the Internet. On its web pages (www.miljo.no) news, publications, press releases and other relevant information are published on a daily basis. The site covers all environmental fields including an extensive page on climate change.

Another important web-site is the State of the Environment Norway (www.environment.no).
The Ministry of the Environment has assigned the production of State of the Environment Norway to the environmental authorities. The Norwegian Pollution Control Authority has the overall editorial responsibility. The State of the Environment Norway aims to provide you with the latest facts on the state and development of the environment. The service covers nine main topics which are further divided into several subtopics. Each topic is presented in a simple and easy-to-follow way and provides access to more detailed scientific presentations. On most of the pages you will also find further information about legislation and international agreements, environmental targets, references and relevant links.

In the biannual publication "the Government's Environmental Policy and the State of the Environment", the government presents its main aims and strategies in all key areas of the environmental policy. In addition, the report gives an updated review of emissions of pollutants, the state of the environment and existing and planned measures. The report is also followed by a broad debate about the government's environmental policy in the Storting.

Great emphasis has been put on making the report readily accessible to the general public and politicians. A summary of the report is made available in English immediately after publication. The publication is free of charge and available on the Internet. See www.odin.dep.no/md/norsk/dok/regpubl/stmeld/bn.html. Since it was first published in 1999, the report has thus become a key tool for relevant information to decision makers, business and industry, NGOs and the general public about the state of the environment and the government's environmental policy.

Statistics Norway, an independent institution administratively placed under the Ministry of Finance, annually compiles statistics on important natural resources and different types of environmental pressures or pollution such as air emissions, waste and wastewater. Statistics Norway has also developed methods and models for analyzing the interactions between the economy and the natural environment. The annual publication Natural Resources and the Environment [http://www.ssb.no/english/subjects/01/sa_nrm/] provides a great deal of environmental information about Norway's main natural resources in an easily understandable way.

The air emission inventory is produced by Statistics Norway in collaboration with the Norwegian Pollution Control Authority. The emission inventory is based on both emission figures calculated by Statistics Norway (estimated from activity data such as fuel consumption and emission factors such as tones CO_2/tonn fuel) and measured or estimated emission figures reported from large point sources to the Norwegian Pollution Control Authority. Statistics Norway is responsible for the emission models, the activity data, the emission calculations and for filling in the reporting tables to the UNFCCC, while the Norwegian Pollution Control Authority is responsible for the emission factors, the point source data and the actual reporting. Statistics Norway publishes all statistics on their website. New statistics are analyzed and presented as soon as they come out. More detailed figures are available to the public in an interactive database free of charge.

The Ministry of the Environment contributes financially to the information activity of the research institute CICERO's (Center for International Climate and Environmental Research – Oslo). As an interdisciplinary research institute with a specific focus on climate change, CICERO plays a key role in providing information about climate change and climate policy. CICERO was established in 1990 as a private non-profit organization with the University of Oslo as founder. Its work is based on two main objectives:

- To develop the research basis for initiatives in national and international climate policy.
- To keep politicians, government, business, educational systems, media, the public and the international community informed about the development of international climate policy.

Active involvement in the public debate on climate issues is of special importance for CICERO. Six times a year, CICERO publishes the popular climate science magazine Cicerone, which has a circulation among ministries, directorates, the business sector, research institutions and schools. Cicerone reports on developments in both science and policy related to climate change, and is written in popular scientific form to reach a wide audience. CICERO has also extensive publications related to the IPCC Third Assessment Report, and the key parts of this report have been translated into Norwegian and published through Cicerone and CICERO reports, all of which may be downloaded by the public free of charge. CICERO also provides regular updates on major events in the international climate negotiations. Twice a week CICERO issues a web-based climate news service in English and Norwegian.

CICERO has recently developed the interactive educational climate program "On Thin Ice", which disseminate key findings from the Arctic Climate Impact Assessment (ACIA). The program was developed together with the Natural Science Center at the University of Oslo and is targeted at high school students.

For several years CICERO has arranged the Climate Forum, which brings together representatives of industry and business as well as government and researchers. The Climate Forum is organised to provide information on development trends in international climate research and policies, and to improve the dialogue between the various parties involved. In addition, CICERO often organises international conferences.

9.4 Consumer information

Providing information about the environmental effects of products throughout their life cycles is an essential part of efforts to promote sustainable consumption patterns. The Nordic environmental label (Nordic Swan Label) is the official eco-label in Norway, Sweden, Denmark, Finland and Iceland. The label is awarded only to those products in a product range that fulfil strict criteria for environmental impact throughout their life cycles. The Swan Label has been developed through cooperation between governments and business, environmental and consumer organizations, and the overall aim of the label is to stimulate both the supply of and demand for products with a reduced environmental impact. The label is available for around 60 product groups for which it is deemed that eco-labelling will be beneficial. Today, everything from detergent to furniture and hotels can carry the Swan label. The Swan is a widely recognized eco-label in the Norwegian market. Polls have shown that as many as 90 per cent of adults know that the Swan is Norway's official eco-label, and about equally many express that they prefer Swan-labelled products to those without the label.

Figure 9.1 The EU Flower

Norway, furthermore, takes part in the EU eco-labelling system (the Flower). The Norwegian foundation for eco-labelling is responsible for and actively promotes both label systems in Norway. There is a close and active cooperation and coordination between the Flower and the Nordic Swan.

The Swan Label is a member of the Global Eco-labelling Network (GEN), which is a non-profit association of eco-labelling organizations from around the world.

Figure 9.2 The Nordic Swan Label

Together with the other countries in the European Economic Area, Norway has introduced a system of energy labelling of household appliances. Since 1996 regulations relating to energy labelling of refrigerators, freezers and their combinations, tumble driers, washing machines and combined washer-driers, dishwashers, ballasts for fluorescent lighting, electric ovens and air-conditioners have been introduced in Norway. Further types of household appliances will be energy labelled in the future, and water heaters are next. Appliances are required to carry a label showing their energy efficiency class and energy consumption. Further information is contained in product brochures. Energy efficiency labelling is an important means of increasing public awareness of energy consumption by different appliances.

9.5 Green Government

Integration of environmental considerations in government operations is part of the work for making government functions more modern and effective. Project Green Government has been carried out to contribute to this. The central government functions should be an example for local authorities and the private sector. Experience has shown that significant economic and environmental benefits can be achieved by integrating environmental considerations in day-to-day operations.

The project Green Government aims to have environmental management introduced as an integrated part of the management system of all national government institutions and operations by the end of 2005. The system will be based on the principles formulated in ISO-14001 and EMAS, but adapted for easier use. Four focus areas have been selected: procurement, waste management, energy and transport. Each ministry is responsible for implementing environmental management internally and in its subordinate institutions. The Ministry of the Environment coordinates the activities of Green Government in collaboration with the Ministry of Modernisation. Courses and guidance material have been developed. More information (in Norwegian only) is available on http://www.gronnstat.no

9.6 Public Procurement Polices

Norway's policy for resource and environment conscious procurement has its legal basis in the Public Procurement Act from 2001. Section 6 of the Act, "Resource and environment conscious procurement" states: Central, municipal and county-

municipal authorities and legal persons (…..) shall when planning each procurement have regard to the resource implications and environmental consequences of the procurement.
The Ministry of Modernisation has published Guidelines on Eco-purchasing that clarify procurement officer's options of buying greener products. GRIP, the Norwegian foundation for Sustainable Consumption and Production has developed tools and guidelines have also been by. There has also been a number of local initiatives.

In 2005, the work on green public procurement has been broadened by establishing a so-called panel for green public procurement as an advisory body for the Ministry of the Environment. The main objectives of the panel will be to identify barriers and possibilities, suggest instruments and contribute to increase focus on green procurement. The members of the panel will be representatives from public authorities, relevant organisations, public purchasers, trade and industry. GRIP will be the secretariat for the panel.

In 2005, GRIP started up a five-year program on green public procurement. The overall aim of the program is to assist public procurement officers in seeking, identifying and selecting green goods and services, according to the Norwegian Procurement Act. Work is undertaken in the following areas to reach this aim:

- Give public procurement officers better knowledge of procurement regulations
- Methods, tools and criteria are being made available, primarily through the net
- Free personal advice is provided with special focus on environmental criteria and tender documents
- Cooperation between various organisations are being undertaken to join forces
- A national environmental prize (the Glass bear) has been established in the area of procurement.
- Training, courses, seminars and conferences are provided
- In depth knowledge is provided in the area of cars and transport, buildings, textiles, paper and printed matters and office equipment.

9.7 Networks and information centres

The energy agency Enova is responsible for the public information, training and education for promoting energy efficiency. An open line providing energy efficiency advice for the private sector is one of the main instruments. The establishment of energy efficiency networks for specific sectors is an important part of Enova's energy efficiency strategy. Analysis and benchmarking within the networks of different sectors has become an effective instrument. During the last few years, information campaigns in media with nationwide coverage have helped to raise awareness of energy efficiency issues in private households and among other energy users. For more information on ENOVA, see section 4.3.3.

Annexes

Annex A. Methodologies and key macroeconomic assumptions

This annex describes the methodology, macroeconomic model and key assumptions underlying the forecast presented in Chapter 5.

A1. Methodology and key assumptions

The emission forecasts are based on the macroeconomic projections presented in table 5.2 (Chapter 5) and table A1 below. The macroeconomic model MSG (Multi-Sectoral Growth) covers both the macroeconomic development and CO_2 emissions. CO_2 emission forecasts are mainly calculated using this model. In addition, model results are adjusted on the basis of available micro studies on CO_2 emission from the petroleum extraction sector, some of the most emission intensive manufacturing sectors and road transportation. The Norwegian Pollution Control Authority has on this background projected emissions of all greenhouse gases except CO_2.

All emission projections and the underlying macroeconomic development are based on the technical assumption that no new measures will be implemented neither in Norway or other countries.

Developments in energy prices and energy productions also play an important role for the projections. Petroleum extraction is assumed to reach a peak at about 288 Sm^3 oil equivalents in 2008, before gradually dropping to about 262 million Sm^3 oil equivalents in 2010 and 198 million Sm^3 oil equivalents in 2020. The producer price of crude oil is assumed to increase from NOK 212 in 2003 to NOK 254 in 2010, measured in 2003 prices, before stabilizing at NOK 180 per barrel thereafter. The wholesale price on electricity is assumed to increase from NOK 0.25 per KWh in 2003 to NOK 0.285 per KWh in 2010 measured in 2003 prices and decline to NOK 0.27 per KWh in 2020. Projected supply and demand of electricity in the baseline scenario are shown in table A2.

The estimated supply and demand of the different petroleum products in the calculations are shown in table A3 and A4. The combined effect of production factor substitution, changes in relative growth between different production and consumption sectors and autonomous energy efficiency improvements are shown in tables A5 to A7. The effect of substitution between production factors, e.g. energy and capital, due to differences in the development in relative prices, is captured by the dynamics of MSG. The rate of autonomous improvement in energy efficiency differs between sectors but is roughly 1 per cent a year after the base year for the model, which is 1999.

Tables

Table A1 Key macroeconomic assumptions

		Percentage annual growth	
	2003	2003/10	2010/2020
Population	4.6	0.5	0.5
Number of persons employed (1000)	2298.3	0.5	0.5
GDP (volume)	1561.9	2.0	1.8
-Petroleum activities			
and sea transport	315.8	-0.6	-2.2
-Mainland Norway	1246.1	2.5	2.3
- -Manufacturing	140.6	3.1	2.7
—of which energy intensive			
manufacturing	13.8	3.6	3.6
-Other goods production	124.8	3.9	2.4
-Private services	573.5	2.7	2.6
-General government	257.1	1.0	1.0
- Correction items	150.1	1.8	2.8
Private consumption	719	3.3	3.2
Government consumption	356.2	1.2	0.8
Gross fixed capital formation	271	1.2	1.8
Mainland Norway	207.6	3.0	2.1
Petroleum activities			
and sea transport	63.4	-7.8	-0.6

Table A2 Supply and use of electricity, TWh

	2003	2010	2020
Net domestic use	105	124	141
of which			
Excluding energy			
intensive manufacturing	75	86	101
+ Net export	-8	-7	-1
+ Power losses	10	12	14
= Production	107	129	154
Renewable energy sources	106	124	128
Other types of power	1	5	26

Table A3 Net domestic use of transport and heating oil. 1000 tonnes [1)]

	1999	2010	2020
Transport oil	5383	5883	6277
Heating oil	2692	2691	2967

1 Including energy-sectors and excluding sea transport. The classification in
MSG may differ from energy accounts. That is why no account figures for 2003 is supplied.

Table A 4 Supply and use of petrol and autodiesel [1] 1000 tonnes

	1999	2010	2020
Total supply	15107	12099	11925
-Production	14194	10887	10462
-Import	914	1212	1463
Export	9601	6093	5525
Statistical differences/ changes in inventories	123	123	123
Net domestic use	5383	5883	6277
Energy intensive manufacturing	7	9	10
Rest of economy	5376	5873	6268

1 pure model simulation results.

Table A5 Electricity per unit of production. GWH/million 1999 NOK

	1999	2010	2020
Total	0.089	0.082	0.078
Mainland Norway	0.106	0.095	0.085
Energy intensive manufacturing	1.961	1.746	1.285
Rest of mainland economy	0.076	0.067	0.062

Table A6 Heating oil per unit of production. Tonnes pr million 1999 NOK

	1999	2010	2020
Total	2.183	1.773	1.631
Mainland Norway	2.558	2.016	1.770
Energy intensive manufacturing	8.322	8.133	5.986
Rest of mainland economy	2.463	1.913	1.689

Table A7 Petrol and autodiesel per unit of production. Tonnes pr million 1999 NOK

	1999	2010	2020
Total	4.366	3.875	3.451
Mainland Norway	5.192	4.476	3.789
Energy intensive manufacturing	0.433	0.418	0.312
Rest of mainland economy	5.271	4.544	3.855

A.2 The MSG model

Various versions of the MSG model have been used in the Ministry of Finance since the 1960s. MSG is a general equilibrium model developed by Statistics Norway. The main determinants of growth are capital accumulation, labour supply, availability of natural resources and the rate of technological progress. As all resources are fully utilized, the model is unsuitable for analyzing short-term adjustments problems like unemployment or extensive downscaling of specific industries due to changes in policy or international prices. Simulation results must therefore undergo adjustments to present more realistic projections of possible future situations.

The model is quite disaggregated and contains 40 private production sectors, 7 government sectors and 17 private consumption sectors. The main production factors are material inputs, labour, three types of real capital, two types of energy sources and various types of polluting and non-polluting transport services. A certain degree of substitution between production factors is assumed in the model depending on changes in their relative prices and the exogenous assumptions about factor productivity developments.

Producers enjoy some market power at home which is, a feature supported by empirical analyses of the Norwegian economy. Producer behaviour at home is therefore characterized by monopolistic competition. On the world market, however, prices are fixed, suggesting that producers behave as price takers in the export markets. In each sector, real capital formation is determined so that expected return on capital equals an exogenously given return on capital.

A detailed emission model is incorporated into the MSG, turning it into an effective tool for assessing environmental consequences of changes in economic activity. Nine pollutants disaggregated by source and sector are specified in the model.

A.3 CO_2 sequestration

Net annual CO_2 sequestration in Norwegian forests is calculated according to the 1996 Revised IPCC Guidelines, employing the IPCC default method. The National Forest Inventory is the starting point for these calculations. The Norwegian Institute of Land Inventory (NIJOS) conducts measurements at permanent observation plots in forested areas of Norway in five-year cycles. These observations are the basis for calculating the annual growth and natural die-off. The figures for annual uptake and emissions of CO_2 in Norwegian forests are calculated from this survey. The figures cover biomass above and below ground, including tops and branches, bark, stumps and coarse roots.

The projections of CO_2 uptake in Norwegian forests are also built on the national forest inventory. The forecasted annual growth is calculated from data on age-class distribution and growing conditions, without great uncertainty for the first decades. The rate of natural die-off may be more uncertain in the future, mainly because the growing stock is increasing and there are more trees in older age-classes. For the period up to 2010, there are few indications that the depletion rate will change considerably. For this period, the greatest uncertainty is linked to the level of annual harvesting. The harvest rates are affected by many factors, including market demand and prices, changes in policies and expectations for the future. The projections in Chapter 5 are based on the assumption that the current level of harvesting will continue.

Annex B. Definition of acronyms

AAU	Assigned Amount Unit
ASAP	Automated Shipboard Aerological Programme
BAT	Best Available Techniques
CCAP	Center for Clean Air Policy
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CICERO	Centre for International Climate and Environmental Research
DNA	Designated National Authority
EEA	European Economic Area
ERU	Emission Reduction Unit
EU	European Union
GAW	Global Atmosphere Watch of WMO
GCM	Global Circulation Model
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIS	Gas-insulated switchgear
GOOS	Global Ocean Observing System
GSN	GCOS Surface Network
GTN-C	Global Terrestrial Network - Carbon
GTN-G	Global Terrestrial Network - Glaciers
GTN-P	Global Terrestrial Network - Permafrost
GTOS	Global Terrestrial Observation System
GUAN	GCOS Upper Air Network
GWP	Global Warming Potential
ICSU	International Council for Science
IEA	International Energy Agency
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IISD	International Institute for Sustainable Development
IOC	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JI	Joint Implementation
NEFCO	Nordic Environment Finance Corporation
NIJOS	Norwegian Institute of Land Inventory

NILU	Norwegian Institute for Air Research
NIR	National Inventory Report
NmVOC	Non-methane Volatile Organic Compound
NOK	Norwegian Kroner
NORAD	Norwegian Agency for Development Cooperation
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
PCF	Prototype Carbon Fund
RegClim	Regional Climate Development under Global Warming
RMU	Removal Unit
SOOP	Ship of Opportunity Programme
SWDS	Solid Waste Disposal Sites
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollar
VAT	Value Added Tax
VOS	Volunteer Observing Ship
WCRP	World Climate Research Programme
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WRI	World Resources Institute
WWW	World Weather Watch of WMO

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