Report

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

June 2002

MILJØVERNDEPARTEMENTET

Ministry of the Environment

Report

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

June 2002

MILJØVERNDEPARTEMENTET

Ministry of the Environment

Contents

1. Executive summary

This report is the third national communication on Norway's national circumstances, policies and measures related to climate change, according to the commitments under the Framework Convention on Climate Change. The first and second national communications were submitted in 1994 and 1997 respectively. The latest report on Norwegian greenhouse gas emissions was submitted in April 2001, and forms the basis for the presentation of inventory information here.

1.1 National circumstances

Norway has had minority governments for the past 15 years and currently has a Christian Democrat-Conservative-Liberal coalition government that has been in power since October 2001. Norway is part of the EU's internal market through the EEA agreement and to a large degree has the same obligations to implement EU legislation as the EU member states. Climate change has been a concern of Norwegian policy since the late 1980s, and policy proposals are generally developed through interministerial processes before they are put before the Storting (parliament).

Norway has a varied but mostly subarctic climate and the demand for energy for heating purposes is therefore high. Population density is low on average, but 77 % of the population lives in urban settlements. Agricultural areas account for 3 % of the mainland and forested areas for 29 %.

Norway has a quite different energy and industrial profile from other industrialized countries. Electricity production is almost entirely based on hydropower, and it covers about half of all energy use. Further developments of hydropower are expected to be quite limited. Electricity also forms an important basis for part of the energy- and emissions-intensive industry (metal smelting, carbides etc.). Offshore exploration for oil and natural gas is another important element of Norway's economic, energy and emissions profile. The expansion of the offshore sector has been one of the main factors behind the strong economic growth in the past decade, and the level of GDP per capita in Norway is one of the highest in the world. Nevertheless, Norway's per capita CO_2 emissions are fairly close to the European and lower than the OECD average.

Norway ratified the United Nations Framework Convention on Climate Change on 9 July 1993. Norway has signed the Kyoto Protocol and the government submitted a proposal to the Storting requesting its consent to ratification of the Protocol on 22 March 2002. Consent was given and Norway ratified the Protocol 30 May 2002.

1.2 Inventories of greenhouse gas emissions and removals

Norway's national greenhouse gas inventory covers emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), tetrafluoromethane (CF_4), hexafluoroethane (C_2F_6), sulphur hexafluoride (SF_6) and HFCs (HFC-134a, HFC-125, HFC-143a, HFC-23, HFC-32, HFC-152a and HCF227ea). Emission figures for 1990-1999 are presented, see Table 1.1. The calculation of greenhouse gas emissions measured as CO_2 equivalents is based on data for global warming potential (GWP), calculated for a time horizon of 100 years, from the 1995 IPCC Second Assessment Report.

The latest Norwegian national greenhouse gas inventory report (NIR) was submitted in April 2001. It 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). However, national specific estimation methodologies have been used when they better illustrate Norwegian conditions. All data and information presented here are consistent with the information provided in the annual inventory report.

Table 1.1 Emissions of greenhouse gases for the years 1990-1999. Sources: Norwegian Pollution Control Authority, Statistics Norway [1]

Mtonnes	CO_2 ktonnes	CH_4 ktonnes	N_2O tonnes	CF_4 tonnes	C_2F_6 tonnes	SF_6 tonnes	HFC 134a tonnes	HFC 125 tonnes	HFC 143a tonnes	Other HFCs Mtonnes	CO_2 eq.
1990	35.1	312	16.7	441	18	92				0.1	52.0
1991	33.5	316	16.2	369	14	87	0			0.4	49.7
1992	34.3	322	14.0	294	11	29	0.2			0.6	48.1
1993	35.8	328	15.2	290	10	30	1.7			0.8	50.1
1994	37.7	335	15.5	251	9	36	5.4	0.5	0.2	0.8	52.1
1995	37.8	337	15.7	229	8	24	10.1	2.4	1.5	1.0	51.9
1996	40.9	341	15.7	214	5	24	17.2	5.5	3.9	1.5	55.0
1997	41.2	343	15.6	201	8	23	26.2	9.7	6.8	2.7	55.2
1998	41.4	338	16.4	185	7	29	38.2	14.7	10.4	5.3	55.7
1999	41.6	337	17.2	164	6	35	50.2	19.9	14.7	6.9	56.2
1990-99	19 %	8 %	3 %	-63 %	-65 %	-62 %	-	-	-	-	8 %

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

CO_2 is the dominant greenhouse gas in Norway, accounting for almost 75 % of total greenhouse gas emissions in 1999. Measured as CO_2 equivalents, methane accounted for about 12 % of total GHG emissions and N_2O for about 9 % in 1999.

The energy sector accounts for about 2/3 of Norwegian greenhouse gas emissions. Road traffic and oil and gas extraction are the largest sources in this sector. A relatively large share of transport-related emissions originates from coastal shipping and the fishing fleet. Process-related industrial emissions from the production of metals, minerals and chemicals are the second-largest source.

In the period 1990-1999, total greenhouse gas emissions increased by 8 %, measured in CO_2 equivalents. The main increase was in emissions of CO_2, which rose by 19 %. The oil and gas industry accounted for 24 % of CO_2 emissions, road traffic for 22 %, stationary combustion for 20 % and industrial processes for 17 %. These sources also showed large increases in the period 1990-1999. Since electricity is generated almost exclusively from hydropower, emissions from stationary combustion are dominated by industrial sources. The increase in CO_2 emissions has to some degree been counteracted by a drop in emissions of PFCs and SF_6 from aluminium and magnesium plants. Emissions of CH_4 and N_2O have been relatively stable in the 10-year period, except for minor changes in emissions from the oil and gas industry and fertilizer production. Agriculture and waste treatment account for 88 % of CH_4 emissions. Agriculture and fertilizer production are the main sources of N_2O, but there has been a strong rise in emissions of N_2O from road traffic.

Emissions and removals from land-use change and forestry are also included in the inventory. The gross increment of carbon in Norwegian forests was estimated at 34.1 million tonnes of CO_2 in 1999. A total of 16.4 million tonnes of CO_2 was removed through harvesting or natural decay, which resulted in a net removal of 17.7 million tonnes of CO_2. The net sequestration of CO_2 in 1999 was equivalent to about 32 % of Norway's total greenhouse gas emissions that year.

1.3 Policies and measures

Norwegian climate change policy was most recently described in two white papers (Report No. 54 (2000-2001) to the Storting, submitted on 22 June 2001 and Report No. 15 (2001-2002) to the Storting, submitted on 22 March 2002). These white papers contain proposals for policies and measures that will ensure compliance with the Kyoto Protocol as well as proposals for policies and measures to be carried out before 2008. Both white papers will be debated by the Storting in spring 2002 and followed up in the state budget and by legislation as appropriate.

The first Norwegian measure that directly addressed greenhouse gas emissions, a tax on CO_2, was introduced in 1991. This tax is still in force and covers about 65 % of CO_2 emissions at various rates up to NOK 315 per tonne (USD 35). High rates apply

to petrol and activities on the continental shelf, and lower rates on the use of mineral oils. Exemptions apply mainly to emissions from energy- and emissions-intensive industries that are exposed to international competition.

A tax on final waste treatment was introduced in 1999. One reason for this was climate change concerns. The tax discourages landfilling and encourages energy recovery from waste. The government will consider further measures, including a ban on landfilling of organic waste. Other parts of the taxation system also provide incentives to limit emissions of greenhouse gases, e.g. in the transport sector. Licensing requirements under the Pollution Control Act are the other important policy instrument as regards landfills.

Discharge permits pursuant to the Pollution Control Act are required for major industrial developments. Permits have been granted for three combined-cycle gas-fired power-plants, but the developers have still not decided whether to make the investments. The government has stated that it wishes to create a framework that would promote a "CO_2-free" solution for these plants, and incentives are provided through exemption from the electricity tax. No further permits will be granted for the development of fossil-fuelled power plants before the first commitment period under the Kyoto Protocol.

The electricity tax offers incentives for most users to use less electricity and thus discourages the installation of new capacity based on fossil fuels. Wind power is only subject to the electricity tax at half the normal rate, and like other new renewables it is exempted from the investment tax. There are also grant schemes for new renewables and for energy efficiency measures. In the 2002 supplementary white paper on climate policy, the government introduced a target of a 25 % reduction of the use of mineral oils for heating in 2008-2012, as compared to 1996-2000.

In the offshore sector, flaring is subject to the CO_2 tax and is generally restricted. An environmental impact assessment is required before a new offshore development can be approved by the Storting. There is close cooperation between the industry and the authorities to investigate further measures to reduce emissions. The substitution of electricity supplies from onshore installations for electricity currently produced offshore is being considered. On the Sleipner field, about 1 million tonnes per year of CO_2 is separated from the wellstream and reinjected into an aquifer. Emissions of greenhouse gases have also been reduced by regulation of VOC emissions.

In the transport sector, fiscal and CO_2 taxes on fuels provide the strongest incentive to limit emissions. The purchase tax also provides an incentive to buy lighter, more energy-efficient vehicles. There are extensive subsidies for public transport. Catalytic converters on cars, intended to reduce local and regional air pollution, are increasing emissions of nitrous oxide as a side effect.

Most greenhouse gas emissions from energy- and emissions-intensive industries are not subject to the CO_2 tax. However, measures have been taken that have significantly reduced emissions from aluminium, magnesium and fertilizer production. The aluminium industry signed an agreement in 1997 requiring it to reduce greenhouse gas emissions per tonne of aluminium by 50 % in 2000 compared to the 1990 level (51 % was achieved) and 55 % in 2005. The government has proposed that emissions from these industries that are currently not subject to the CO_2 tax should be included in a mandatory domestic emissions trading scheme from 2005. If introduced, the scheme would cover about 30 % of all emissions in 2005–2007.

In March 2002 the government signed an agreement with the users of SF_6 other than the magnesium industry to reduce their emissions. It also proposed a tax on imports of HFCs and PFCs, and stated that it would consider a refund scheme for these gases delivered for recovery.

Emissions from the agricultural sector and emissions and sequestration of greenhouse gases in forests are mainly dependent on general agricultural and forestry policies.

1.4 Projections and the effects of policies and measures

Emissions of greenhouse gases are projected to rise by 22 % up to 2010 if present policies are continued and no new measures are implemented. This figure includes emissions of 2.1 Mtonnes CO_2 from gas-fired power plants. If no conventional gas-fired power-plants are built, the projected growth is 18 %. Emissions of CO_2 have already risen by about 19 % since 1990 and the total projected rise up to 2010 is 36 %. Oil and gas production account for the largest proportion of this rise, while transport and, if built, the gas-fired power plants will also contribute substantially.

Emissions of PFCs and SF_6 from industrial processes have already been cut substantially and are projected to be 64 and 88 % lower respectively than the 1990 levels in 2010. Emissions of N_2O are projected to increase by 16 % by 2010 and then stabilize. CH_4 emissions are projected to be 10 % higher than in 1990, which means that they will remain fairly stable at around today's level, but will probably drop after 2010 as a result of the policies and measures implemented. Emissions of HFCs were negligible in 1990, but are projected to grow as CFCs are phased out.

Implementation of additional policies and measures proposed in the two climate policy white papers could reduce emissions to substantially below the projected levels before the commitment period under the Kyoto Protocol.

Efforts have been made to estimate the effects of the policies and measures that have been implemented to date. These include the CO_2 tax, measures to reduce emissions from landfilled waste, and voluntary and mandatory measures taken by industry. For 1999-2000 it is estimated that the growth in emissions would have been at least 15-20 % higher in the absence of the policies and measures that have been put into effect. The effects of these measures will last and may become stronger over time.

1.5 Impacts and adaptation

A research programme started by the Research Council of Norway in 1997 is looking at regional climate development in northern Europe in a scenario with global warming (RegClim). According to the RegClim studies, climate change in Norway over the next 50 years is expected to give a mean temperature increase of 0.9°C in the summer and 1.6°C in the winter. The increase is expected to be most noticeable in the northern parts of the country. Precipitation is expected to increase by about 10% in the same period. Stronger winds and more frequent storms are also expected along some parts of the coastline. Thus, the RegClim scenarios indicate that there will be marked climate change in Norway over the next 50 years and that its impact will vary from one part of the country to another.

In natural ecosystems, climate change may result in substantial changes in animal and plant communities. Changes in both species distribution and species composition are expected, particularly for species presently at the limit of their distribution. A rise in sea temperature will probably lead to an overall increase in fish catches, but also to changes in species composition in Norwegian waters. The overall effect on fisheries is uncertain. An increase in storm activity may result in greater damage to fish farming installations, and also increase the 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, growing problems involving pests and diseases, loss of agricultural soil and an increase in surface runoff, which may in turn have negative effects on fresh water ecosystems and drinking water quality. Incidents such as flooding, landslides and storms will probably result in higher infrastructure maintenance costs.

Higher precipitation will result in higher electricity production at hydropower installations. However, the risk of more frequent flooding will increase costs of ensuring dam safety. The larger variations in inflow during the year will also reduce the predictability of electricity production.

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. Norway is currently in the process of developing adequate response strategies to the impacts of climate change, both sector by sector and an overall strategy. This process will be intensified in the years to come.

1.6 Research and systematic observation

Norway considers climate research to be important both as a basis for developing policy and as a policy instrument. One of the main research priorities is 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 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.

It is also 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 is also of great importance in this context.

Resources allocated to climate research have increased from 1998 to 2001. Recently the Research Council of Norway launched a new 10-year programme called *KlimaProg – Research Programme on Climate and Climate Change*. The programme will run until 2011 and its goal is to increase our understanding of the climate system and of both natural and human-induced climate variability.

The effects of climate change on the natural environment are currently being studied in research programmes on biological diversity and monitoring of marine and terrestrial systems. Norway has also taken an active part in a newly initiated programme under the Arctic Council (ACIA – the Arctic Climate Impact Assessment) that is intended to evaluate and synthesize knowledge of climate change and its consequences in the Arctic, and in a newly started research programme called "Ecological effects of climate change in arctic ecosystems" (ARKTØK).

Several social science research programmes are in progress, and are focusing on energy, environmental measures and technology, and climate change impacts and adaptations.

The main goal of the programme *KLIMATEK* is to promote demonstration of new technologies that can reduce emissions of greenhouse gases.

Norway does not have a national GCOS programme today, but the Norwegian Meteorological Institute sends data from the Norwegian meteorological stations to the WMO international data exchange and to the World Data Centres according to standard procedures. A wide range of greenhouse gases is monitored at the Zeppelin Station in Ny-Ålesund, Spitsbergen, by the Norwegian Institute for Air Research (NILU). This is part of the WMO Global Atmosphere Watch (GAW) system and the Network for Detection of Stratospheric Change (NDSC). Norway also reports to international terrestrial and oceanographic observation systems. A national plan for biodiversity monitoring, which includes effects of climate change, was established in 1998. Implementation is foreseen in 2003.

1.7 Financial resources and transfer of technology

As regards non-ODA resources, Norway makes a substantial contribution to the aid programmes of the UN development agencies and international financial institutions, including funding for projects in developing countries related to the implementation of the United Nations Framework Convention on Climate Change.

The Norwegian government's contribution to the Global Environment Facility (GEF) for the period 1997-2000 has been in the order of USD 30 million. Norway is also committed to investing USD 10 million in the World Bank's Prototype Carbon Fund (PCF) and voluntarily supports a number of IEA projects that aim to transfer environmentally sound and climate friendly energy technologies. Norway has supported projects under UNDP-GEF and UNITAR which help non-Annex I parties to prepare national communications and assessments of capacity-building needs. In the period 1997-2000, the Norwegian government contributed a total of NOK 187 million/USD 22 million to climate change and other environment-related projects, in addition to the development assistance allocations.

Norway's development assistance programme is expanding. From 1997 to 2000, annual contributions classified as Official Development Assistance (ODA) have increased from NOK 9 241 million (USD 1 306.7 million) to NOK 11 115 million (USD 1 263.6 million). Norway's average ODA for the period 1997 - 2000 corresponds to about 0.87 % of GNP, and is thus higher than the agreed United Nations target for official development assistance. The Norwegian government aims to raise ODA to 1 % of GNP during the present parliamentary period (2001-2005).

Transfer of technology and know-how in order to promote development and energy availability/ efficiency constitutes an important element of Norwegian ODA, and has significant environmental side effects that are consistent with promoting the Convention. Preliminary figures, based on the collection of data on ODA that is intended to fulfil the objectives of the UNFCCC, indicate that in 1998, 1999 and 2000, Norway contributed USD 175 million to activities where the principal or significant objectives were considered to be climate change.

1.8 Education, training and public awareness

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

The biannual white paper on the government's environmental policy and the state of the environment presents the Norwegian government's main aims and strategies in all key areas of environmental policy. Its publication is followed by a broad debate about the government's environmental policy in the Storting. Every effort is made to ensure that the white paper is readily accessible to the general public and politicians. Since it was first published in 1999, the white paper has become a key tool that gives central decision-makers, business and industry, NGOs and the general public relevant information on the state of the environment and the government's environmental policy.

The Ministry of the Environment also publishes news, white papers, reports, press releases and other relevant information on its website (www.miljo.no) on a daily basis. Another website that focuses on climate change is State of the Environment Norway (www.mistin.no).

Statistics Norway (SSB) compiles an annual overview of statistics on important natural resources and the state of the environment. *Natural Resources and the Environment* is widely used, and presents the environmental situation in an easily understandable way, at the same time as it includes considerable detail on a wide range of topics.

CICERO (the Center for International Climate and Environmental Research) plays a key role in providing information about climate change and climate policy. Besides its research activities, CICERO takes an active part in the public debate by publishing the newsletter CICERONE and arranging the Climate Forum, which brings together representatives of industry and business as well as government and researchers. The Ministry of the Environment contributes a large proportion of the funding for CICERO's information activities.

In both primary and secondary school, issues related to energy, energy use and climate change are integrated into the curricula to promote an early awareness of the adverse effects of climate change. Extensive support material has been developed to give teachers the best possible guidelines for their work in this area.

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. A system of energy labelling of household appliances was introduced in 1996, as a means of increasing public awareness of energy consumption by different appliances. Energy efficiency centres have now been established in every county in Norway. The centres provide customers with basic analyses and information on state-funded energy efficiency programmes, energy use and prices.

2. National circumstances

2.1 Government structure

Since October 2001, Norway has had a Christian Democrat-Conservative-Liberal coalition government. Like previous governments over the past 15 years, this is a minority 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 EFTA countries, Norway, Iceland and Liechtenstein. In addition, the agreement institutionalizes a regular consultation process with these EFTA countries, giving them opportunities to influence EU policy-making in areas such as environment, education and social policy. 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 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, see figure 2.1. 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.

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, see figures 2.2, 2.3, 2.4 and 2.5. Most of Norway has a subarctic climate. About 30 % of its area lies 0 – 299 metres above sea level, and this is where most people live and where agricultural production is most intensive. As much as 20 % of the land area lies at least 900 metres above sea level, see figure 2.1.

Agricultural areas account for only 3 % of the mainland, while about 29 % 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 % of the land is above the treeline. Currently, almost 8 % 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 % of the land area in 1900 to about 12 % today. Only about 5 % of the area of southern Norway is characterized as wilderness-like.

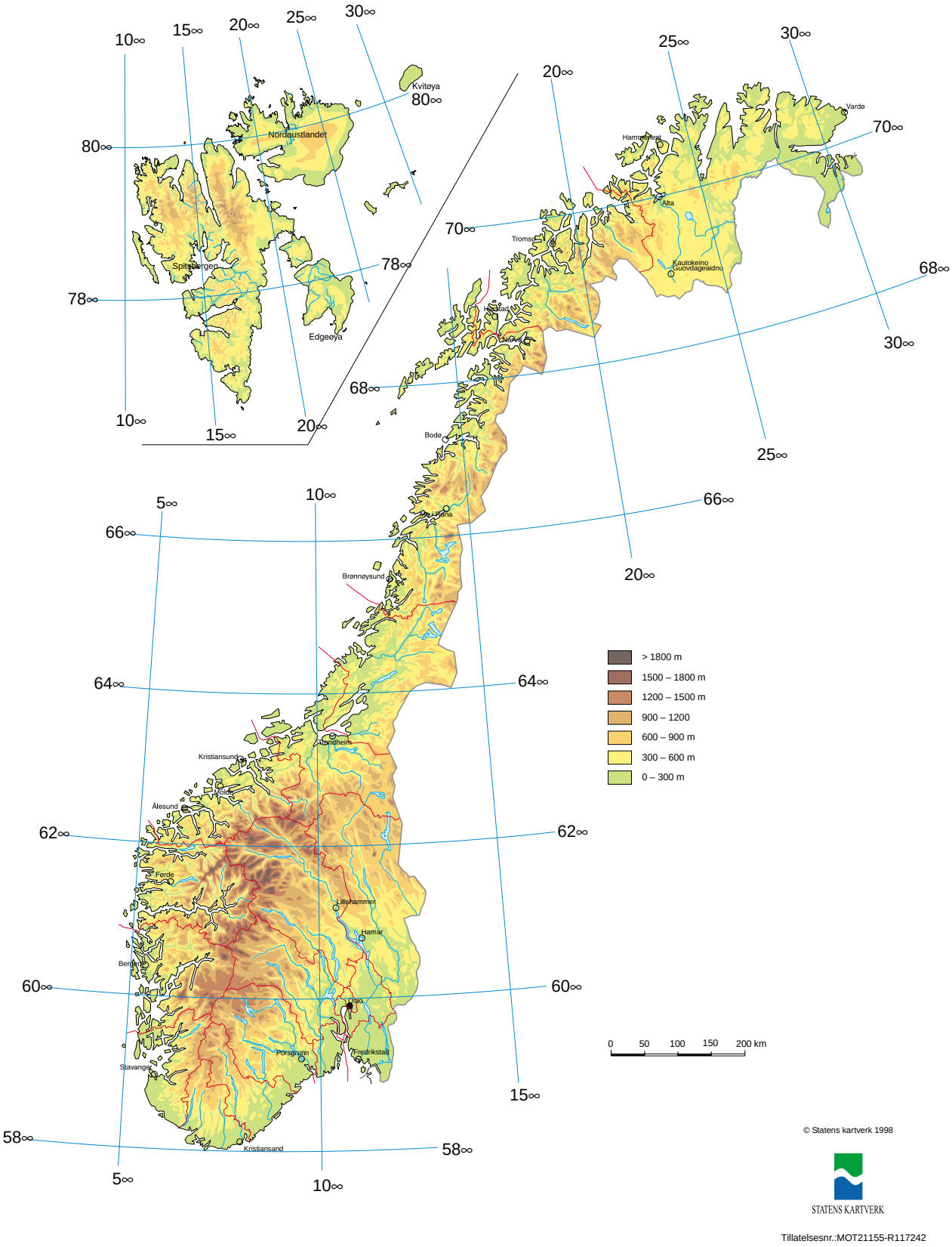


Figure 2.1 Map of Norway, including Svalbard, showing land use and mountainous area, latitude and longitude. Sourse: National Atlas of Norway. The Norwegian Mapping Authority.

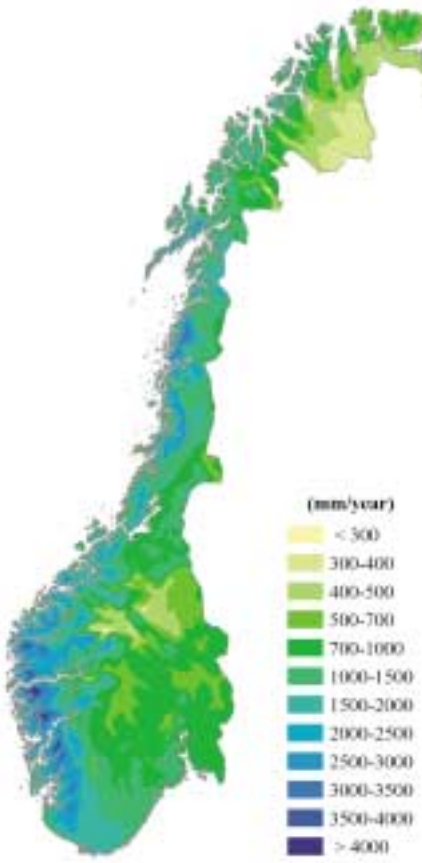


Figure 2.2 Norway's mean annual precipitation, 1961-90 (mm/year). Source: Norwegian Meteorological Institute.

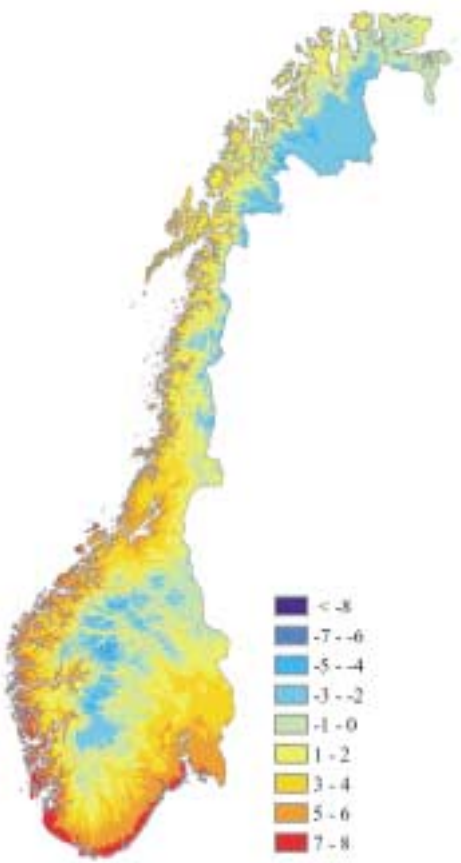


Figure 2.3 Norway's mean annual temperature, 1961-90 (°C). Source: Norwegian Meteorological Institute.

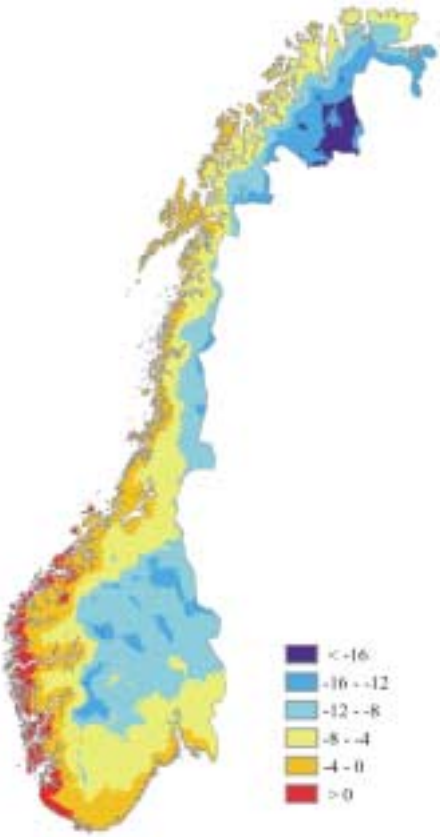


Figure 2.4 January mean temperature in Norway, 1961-90 (°C). Source: Norwegian Meteorological Institute.

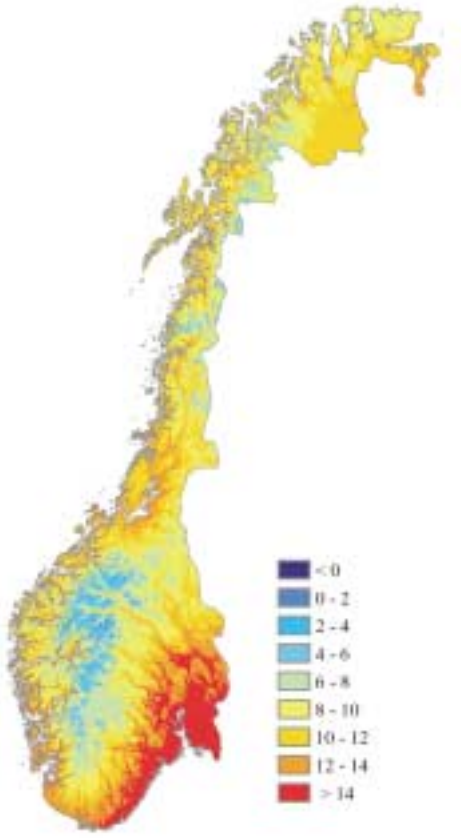


Figure 2.5 July mean temperature in Norway, 1961-90 (°C). Source: Norwegian Meteorological Institute.

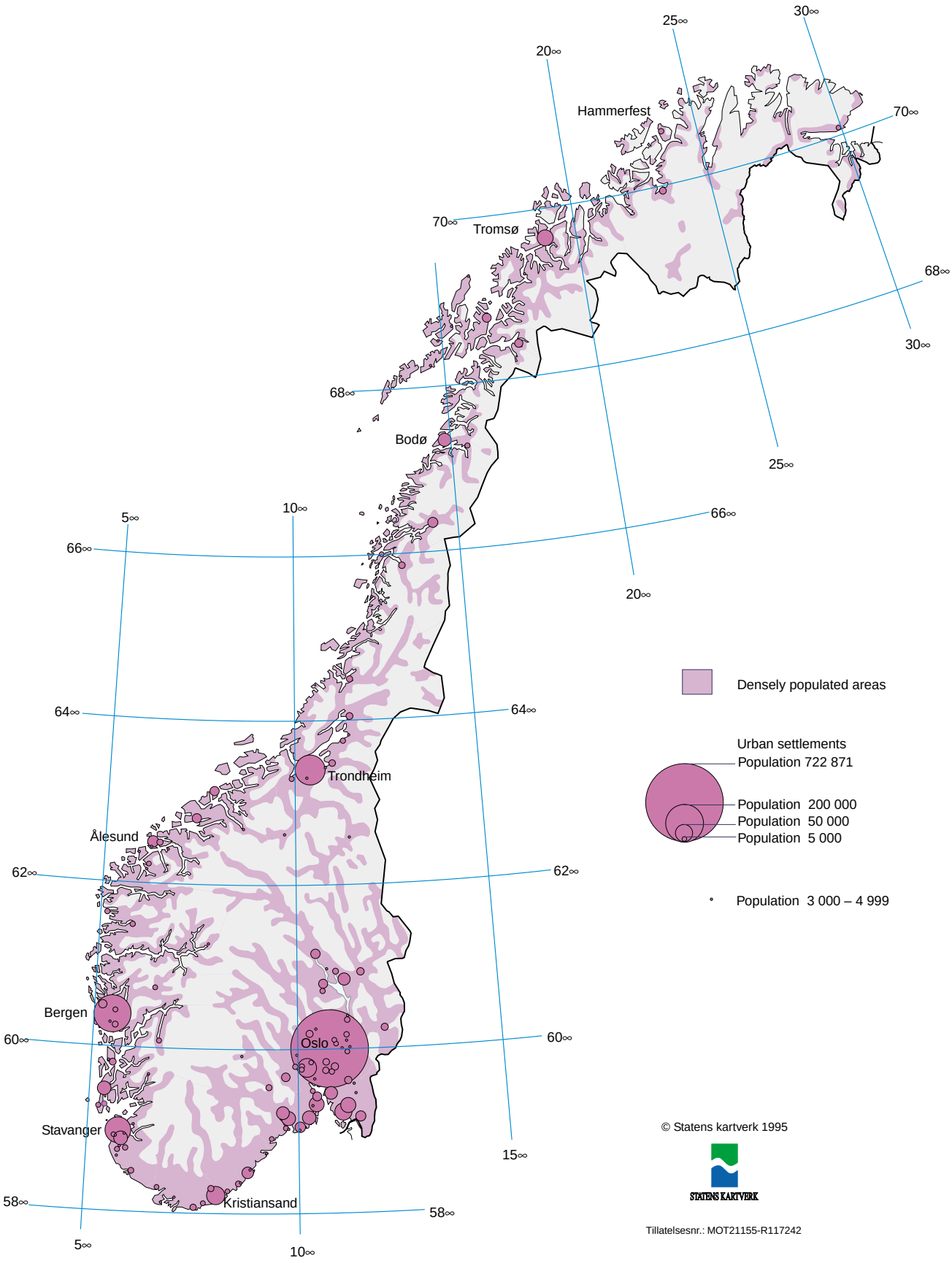


Figure 2.6 Densely populated areas and larger urban settlements in Norway.
Source: Statistics Norway, Norwegian Mapping Authority.

2.3 Population and urban profile

With a total area of almost 324 000 km^2 and only 4.5 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 % of the population lived in densely populated areas. One hundred years later, about 77 % of Norway's population lives in urban settlements, see figure 2.6. The number of large urban settlements is small – only 19 have more than 20 000 residents. Only four cities – Oslo, Bergen, Stavanger and Trondheim – have more than 100 000 residents. Currently, almost 30 % 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 increased every year for the past ten years (Figure 2.7). The Norwegian economy passed a cyclical peak in 1998, and since then growth has been weaker than in the mid-1990s. In 2000, GDP increased by 2.3 %. The expansion of offshore petroleum activities has been one of the main factors behind the growth in the 1990s. Otherwise, growth in both demand and production in mainland Norway has been relatively weak.

Production in the service sector has increased in the same period. This means that the mainland economy has become less greenhouse-gas intensive. However, the volume of both domestic passenger transport and goods transport by land has also risen steeply. The transport sector is a major source of greenhouse gas emissions and of local air pollution problems.

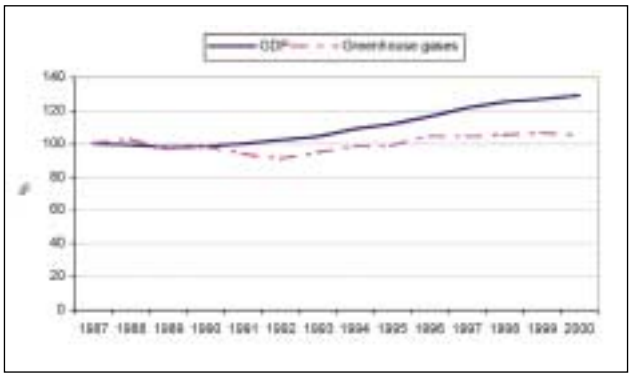


Figure 2.7 GDP and greenhouse gas emissions in Norway, 1987-2000. 1990 = 100.
Sources: Statistics Norway, Norwegian Pollution Control Authority.

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 therefore alter the external framework for the Norwegian economy and result in changes in the prices of important commodities.

Through the last century, the development of electricity production from hydropower has formed the basis for an energy-intensive industry (metal smelting, fertilizers, carbides etc.) that accounts for a much higher percentage of GHG emissions in

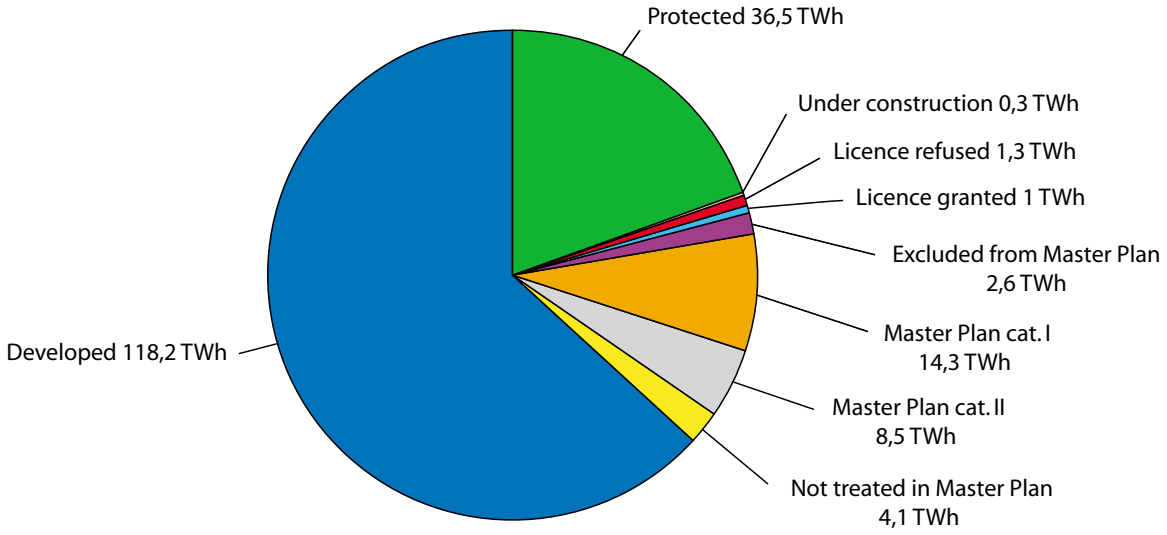
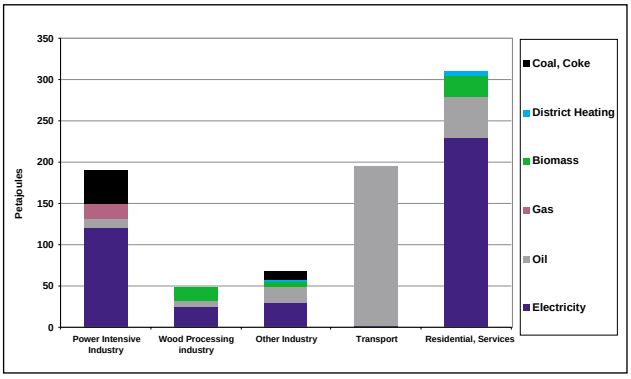


Figure 2.8 Norway's hydropower potential as of 1 January 2002, TWh/year. Total hydropower potential is 187.0 TWh.
Source: Norwegian Water Resources and Energy Directorate.

Norway than in other countries, despite the renewable energy base. Since about 1970, this characteristic emissions profile has been further reinforced by the growth of the oil and gas industry on the continental shelf and to some extent at land-based installations (refineries, gas processing, methanol production etc.). Oil and gas accounted for between 11 and 25 % of GDP and 30 to 47 % of export revenue in 1998-2000. The variations in these figures are mainly explained by fluctuations in oil prices and only to some extent by variations in production.

2.5 Energy

Electricity production in mainland Norway is based almost entirely on hydropower, which in Norway is not believed to cause emissions of greenhouse gases, but has other environmental impacts. There is limited potential for further development of hydropower production, see figure 2.8. The Norwegian electricity market has been deregulated, starting with the entry into force of the Energy Act in 1991.



Figur 2.9 Norwegian energy balance, 2001
Source: Ministry of Petroleum and Energy.

Following the liberalization of the electricity markets in the Nordic countries, Norway, Sweden, Denmark and Finland now have a common electricity market. The four countries have all introduced point tariffs, and there are no special charges for trade between Norway and the other Nordic countries. 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.

Given the current production capacity, production in a year with normal precipitation is calculated to be 118.7 TWh (including 0.8 TWh thermal power).

Electricity production in Norway in 2001 totalled 121.8 TWh. The net surplus of electricity imports in 2001 was about 3.6 TWh. 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 6-7 TWh.

Norway's most important industry measured in terms of export revenue is the extraction of oil and gas. In 2000, the revenue from exports of crude oil and natural gas rose by 89 % compared to the year before, mainly because of a price rise, and totalled NOK 310 billion, or 47 % of the country's total exports. The actual extraction of oil and gas rose by 7.1% compared to 1999.

Oil and gas production has increased steadily during the 1990s, and almost doubled by the end of the decade. This trend will probably continue for another 5-10 years, after which production is expected to level off and then start to decrease.

The petroleum sector (production and transport of petroleum) accounted for about 19 % of total greenhouse gas emissions in Norway in 1999. Pipeline transport of natural gas to the European continent is energy demanding and therefore generates CO_2 emissions. However, exporting gas may help to bring about a regional reduction in CO_2 emissions if the gas replaces coal in the importing countries.

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 2.9. 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). Nevertheless, because of the amount of renewable energy (hydropower and some biofuel) used in Norway, per capita CO_2 emissions are fairly close to the European average and 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. Since most of the available hydropower capacity is now in

use, any further rise in electricity consumption will have to be met by utilization of other energy sources or import from other countries.

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 1995, 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 (Figure 2.10.) 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.

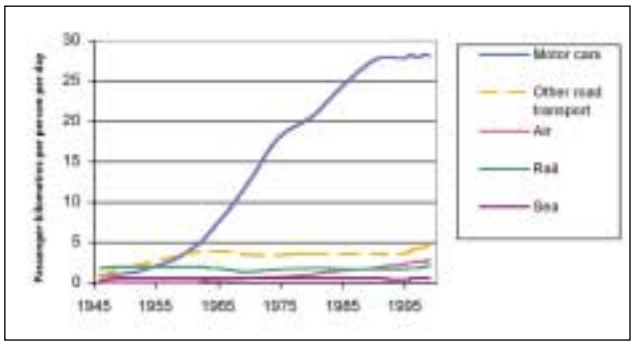


Figure 2.10 Passenger transport in 1945-2000, by mode of transport. Sources: Statistics Norway, Norwegian Pollution Control Authority.

From 1980 up to the end of 1999, the volume of goods transport measured in tonne-kilometres has increased by 56 %, and if oil and gas transport from the North Sea is also included, the increase is no less than 176 %. 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 (Figure 2.11).

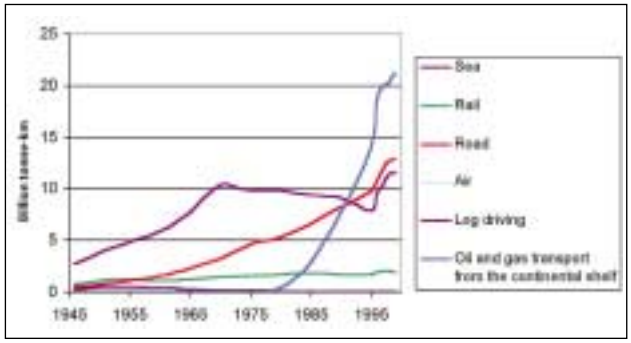


Figure 2.11 Goods transport in 1945-2000, by mode of transport. Sources: Statistics Norway, Norwegian Pollution Control Authority.

In 1999, 31 % of Norway' total greenhouse gas emissions were attributed to transport. Road traffic accounted for 17 % of the total, while other mobile sources (shipping, domestic air transport) accounted for 5 % (see figure 3.2). Emissions from the transport sector have increased slightly more than total emissions over the last few years despite being taxed fairly heavily. In 1999, CO_2 emissions from the transport sector were 23 % higher than in 1990 and 5 % higher than in 1998.

2.7 Agriculture and forestry

Norway has limited land resources available for farming. Only about 3 % 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 % of total greenhouse gas emissions in Norway, and these emissions have been stable over the past ten years.

Forests cover some 29 % 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 timber is considerable, corresponding to 4.3 % of total exports in 1999.

In 1999, the net increment (annual increment minus roundwood removals and calculated natural losses) in Norwegian forests was 11.6 million m^3, or 1.7 % of the total volume. The increase in the net biomass of forests including roots, bark etc. has resulted in an annual uptake of CO_2 by forest that in recent years has corresponded to about 32 % of Norway's total greenhouse gas emissions.

3. Greenhouse gas inventory information

3.1 Overview

Norway's national greenhouse gas inventory reports (NIR) are prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories, and the estimation methods generally 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 on 15 April 2001. Some of the results from the report are described in this chapter. All data and information are consistent with the information provided in the annual inventory report.

The national inventory report covers emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs, such as tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6)), sulphur hexafluoride (SF_6) and HFCs (HFC-134a, HFC-125, HFC-143a, HFC-23, HFC-32, HFC-152a and HCF227ea) from 1990 to 1999, see Table 3.1. The emissions are described according to source categories included in the Common Reporting Format. Emissions and removals from land-use change and forestry are also covered. A more detailed description of data and methodology is presented in the national inventory report.

Table 3.1: Emissions of greenhouse gases for the years 1990-1999.
Sources: Norwegian Pollution Control Authority, Statistics Norway [1]

	CO_2 Mtonnes	CH_4 ktonnes	N_2O ktonnes	CF_4 tonnes	C_2F_6 tonnes	SF_6 tonnes	HFC 134a tonnes	HFC 125 tonnes	HFC 143a tonnes	Other HFCs tonnes	CO_2 eq. Mtonnes
1990	35.1	312	16.7	441	18	92				0.1	52.0
1991	33.5	316	16.2	369	14	87	0			0.4	49.7
1992	34.3	322	14.0	294	11	29	0.2			0.6	48.1
1993	35.8	328	15.2	290	10	30	1.7			0.8	50.1
1994	37.7	335	15.5	251	9	36	5.4	0.5	0.2	0.8	52.1
1995	37.8	337	15.7	229	8	24	10.1	2.4	1.5	1.0	51.9
1996	40.9	341	15.7	214	5	24	17.2	5.5	3.9	1.5	55.0
1997	41.2	343	15.6	201	8	23	26.2	9.7	6.8	2.7	55.2
1998	41.4	338	16.4	185	7	29	38.2	14.7	10.4	5.3	55.7
1999	41.6	337	17.2	164	6	35	50.2	19.9	14.7	6.9	56.2
1990-99	19%	8%	3%	-63%	-65%	-62%	-	-	-	-	8%

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

Norway's emissions of greenhouse gases, measured as CO_2 equivalents, totalled about 56.2 million tonnes in 1999. CO_2 emissions account for approximately 75 % of the total, see Figure 3.1.

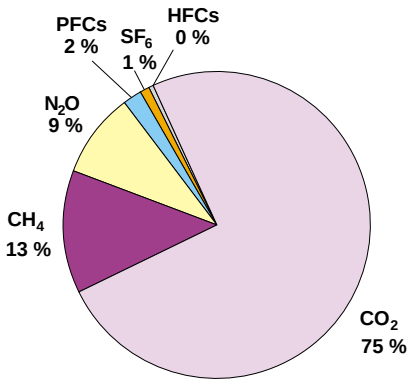


Figure 3.1 Greenhouse gas emissions in 1999 by gas. Sources: Norwegian Pollution Control Authority, Statistics Norway.

Industrial processes, oil and gas production, road traffic and stationary combustion were the largest sources of greenhouse gas emissions in Norway in 1999 (see Figure 3.2).

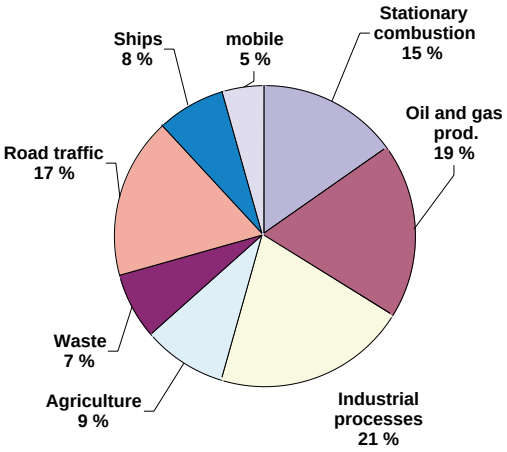


Figure 3.2 Greenhouse gas emissions in Norway in 1999, by source category. Sources: Norwegian Pollution Control Authority, Statistics Norway.

For the period 1990-1999, the increase in emissions expressed in CO_2 equivalents was about 8 %, see Figure 3.3. The increase is mainly explained by general economic growth, which has resulted in higher CO_2 emissions from most sectors. This trend has to some degree been counteracted by reduced emissions of PFCs and SF_6 from aluminium and magnesium plants. Emissions of CH_4 and N_2O have been relatively stable over the same period, except for minor changes related to emissions from the oil and gas industry and fertilizer production. There has been a strong rise in emissions of N_2O from road traffic as a result of the introduction of catalytic converters.

Preliminary emission estimates for the year 2000 indicate a small decrease of approximately 1 % in overall national emissions of greenhouse gases compared to 1999. This is assumed to be a result of the mild winter in 2000, and of the reduction of petrol and diesel stocks by the oil companies in anticipation of a reduction in the CO_2 tax on these fuels from 1 July 2001. It is thus doubtful whether this decrease represents a change in the long-term emission trend.

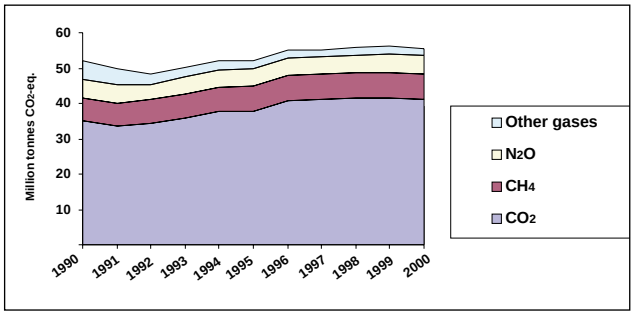


Figure 3.3 Greenhouse gas emissions in 1990–2000 by gas. Sources: Norwegian Pollution Control Authority, Statistics Norway.

3.2 CO_2 emissions

CO_2 emissions totalled 41.6 million tonnes in 1999. 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, see Figure 3.4. A relatively large share of the transport-related emissions originates from coastal shipping and the fishing fleet. Since electricity is generated almost exclusively from hydropower, emissions from stationary combustion are dominated by industrial sources.

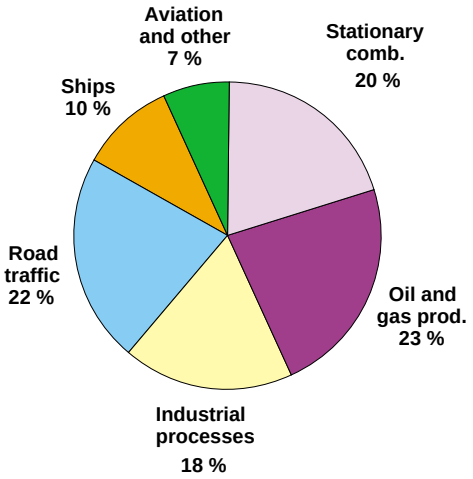


Figure 3.4 CO_2 emissions in 1999 by source category. Sources: Norwegian Pollution Control Authority, Statistics Norway.

From 1990 to 1999, total CO_2 emissions increased by 19%, see Figure 3.5. The increase is mainly a result of the growth in oil and gas production, including transport of natural gas in pipelines, and higher emissions from mobile sources.

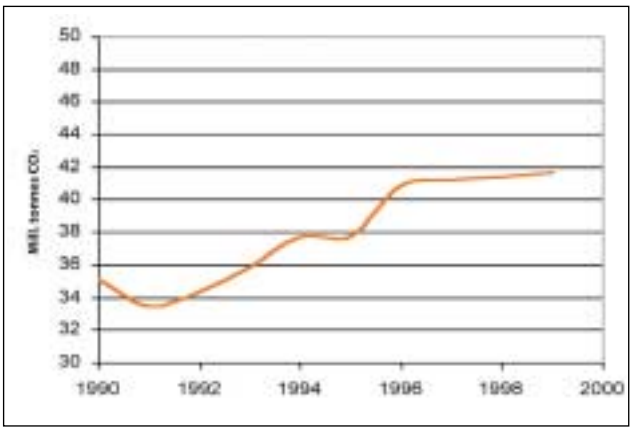


Figure 3.5 CO_2 emissions in 1990-1999.
Sources: Norwegian Pollution Control Authority, Statistics Norway.

3.3 CH_4 emissions

CH_4 emissions totalled 340 000 tonnes in 1999. About 88 % of the total originated from waste treatment and agriculture, see Figure 3.6. These sources are relatively stable from year to year, and are little affected by short-term economic cycles. Combustion and evaporation/leakage in the oil and gas industry accounted for 8 % of total CH_4 emissions, while minor sources included emissions from petrol cars, domestic heating and coal mining.

Emissions have now stabilized after a moderate increase in the first half of the 1990s, see Figure 3.7. This reflects the trend in emissions from the oil and gas industry over the period. Emissions from waste treatment 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 last three years, a small decrease in emissions from landfills has been reported. Norwegian agricultural production has been fairly stable during the 1990s with only a modest increase in CH_4 emissions.

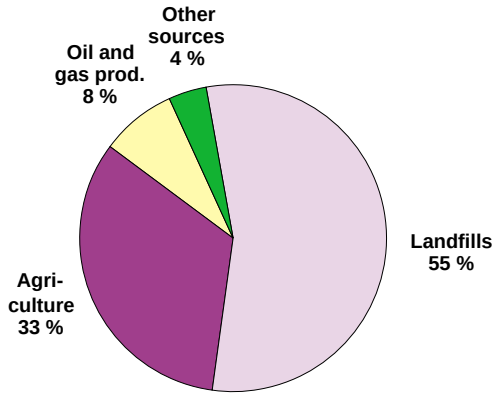


Figure 3.6 CH_4 emissions in 1999 by source category.
Sources: Norwegian Pollution Control Authority, Statistics Norway.

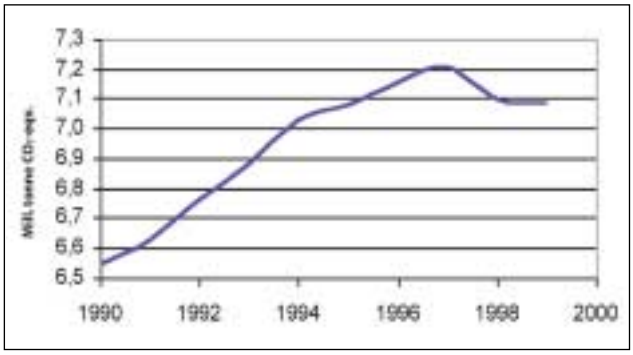


Figure 3.7 CH_4 emissions in 1990-2000.
Sources: Statistics Norway, Norwegian Pollution Control Authority.

3.4 N_2O emissions

Anthropogenic emissions of N_2O in 1999 were estimated at 17.2 ktonnes, which is 3 % higher than the 1990 level. Emissions from agriculture (manure and nitrogenous fertilizer) account for half of Norwegian emissions of N_2O, see Figure 3.8. These emissions have been rather stable throughout the 1990s, see Figure 3.9. The other major source is the two plants that manufacture nitrogenous fertilizer. Changes in production processes led to a reduction in emissions at the beginning of the 1990s, but there was a moderate increase in the following years as a result of increased production volumes. Emissions from mobile sources are increasing considerably because of the introduction of catalytic converters, and currently account for 11 % of total N_2O emissions.

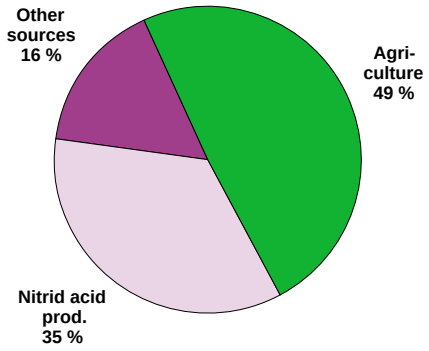


Figure 3.8 N_2O emissions in 1999 by source category.
Sources: Norwegian Pollution Control Authority, Statistics Norway.

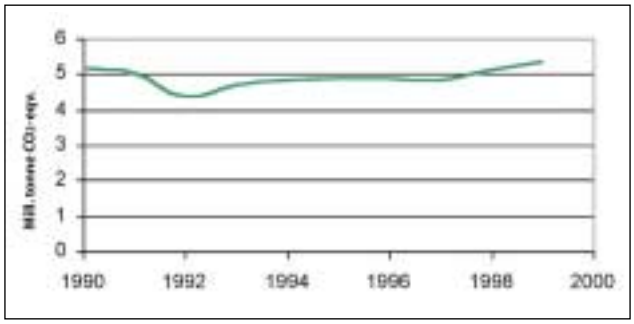


Figure 3.9 N_2O emissions in 1990-1999.
Sources: Norwegian Pollution Control Authority, Statistics Norway.

3.5 PFC emissions

Emissions of PFCs (CF_4 and C_2F_6) from Norwegian aluminium plants in 1999 were calculated to be approximately 1.13 Mtonnes CO_2 equivalents. These plants account for more than 99.9 % of Norwegian PFC emissions. From 1990 to 1999, emissions of PFCs were reduced by 63 %, see Figure 3.10. This is explained by improvements in technology and process control, which have brought about a reduction of PFC emissions per tonne aluminium produced of approximately 70 % from 1990 to 1999.

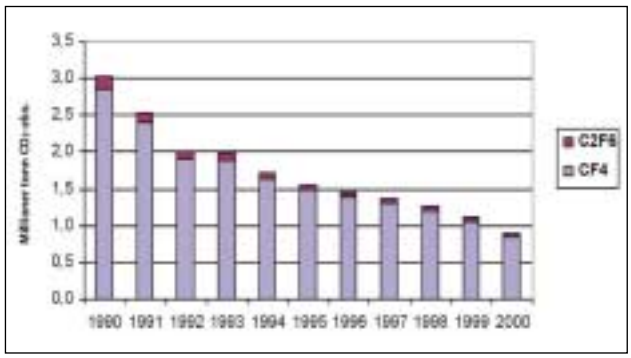


Figure 3.10 PFC emissions in 1990 - 2000.
Sources: Norwegian Pollution Control Authority, Statistics Norway.

3.6 SF_6 emissions

SF_6 emissions in 1999 were estimated at 0.83 Mtonnes CO_2 equivalents. The largest emission source in Norway is magnesium production (86 %), where SF_6 is used to cover the surface of liquid magnesium to prevent it from oxidizing. Emissions were reduced in the first half of the 1990s by improvements in technology and process management. In the period 1990-1997, emissions were reduced by 75 %, see Figure 3.11. From 1997 to 1999 they rose again by 67 % as a result of higher production and an increase in the share of primary production as opposed to production based on recycled metal. Similar use of SF_6 in the aluminium industry has been phased out because of process changes (from Soederberg to pre-baked anodes).

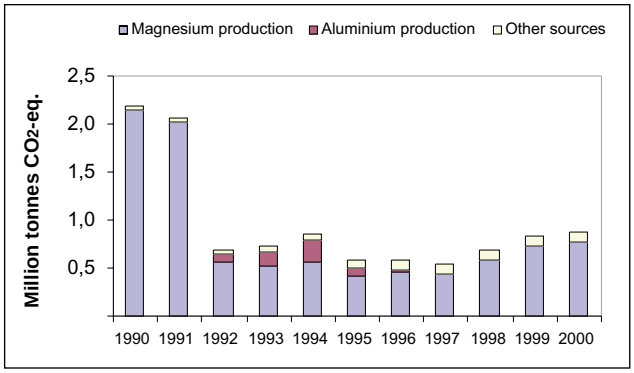


Figure 3.11 SF_6 emissions in 1990 - 2000.
Sources: Norwegian Pollution Control Authority, Statistics Norway.

3.7 HFC emissions

Actual emissions of HFCs in Norway were about 0.18 Mtonnes CO_2 equivalents in 1999. In 1990, there were only insignificant emissions. As the phasing out of CFCs, HCFCs and halons continues, further strong growth in consumption of HFCs is expected. HFC-134a, HFC-125 and HFC-143a are the most important compounds, see Figure 3.12.

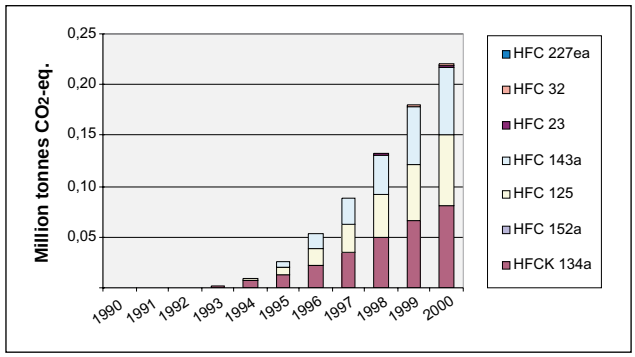


Figure 3.12 HFC emissions from 1990 to 2000.
Sources: Norwegian Pollution Control Authority, Statistics Norway.

3.8 Emissions from international aviation and marine bunker fuels

In 1999, CO_2 emissions from ships and aircraft in international traffic bunkered in Norway amounted to 3.7 Mtonnes. From 1990 to 1999, CO_2 emissions from ships in international traffic bunkered in Norway increased by 80 %. For aviation the increase in CO_2 emissions was 67 % in the same period.

3.9 Emissions and removals from land-use change and forestry

The gross increment of carbon in Norwegian forests was estimated at 34.1 million tonnes of CO_2 in 1999. A total of 16.4 million tonnes of CO_2 was removed through harvesting or natural decay, which resulted in a net removal of 17.7 million tonnes of CO_2, see Figure 3.13. The sequestration of CO_2 in forest soil and harvested wood products is not included in this figure. This considerable accumulation of CO_2 is due to a large increment in the standing volume of forests resulting from the forest policy Norway has pursued for more than fifty years. The net sequestration of CO_2 in 1999 was equivalent to about 32 % of Norway's total greenhouse gas emissions that year.

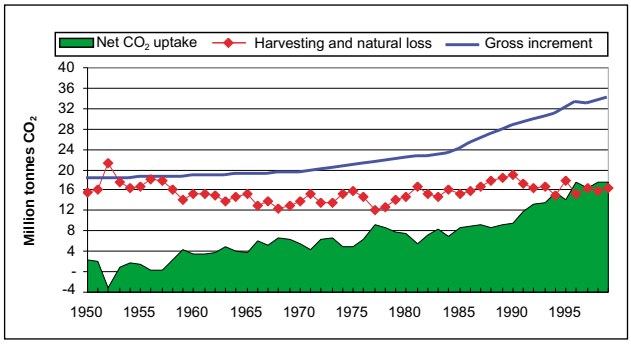


Figure 3.13 CO_2 sequestration in Norwegian forests from 1950 to 1999. Sources: Norwegian Pollution Control Authority, Statistics Norway.

4. Policies and measures

4.1 Overall policy context

Climate change and emissions of greenhouse gases have been a concern of Norwegian policy since the late 1980s, and the first measure that directly addressed such emissions, a tax on CO_2, was introduced in 1991.

Norway's climate policy is founded on the objective and commitments of the Climate Convention, the Kyoto Protocol and the scientific understanding of the greenhouse effect set out in the reports from the 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.

On 22 March 2002, the present government submitted a proposal to the Storting (parliament) requesting its consent to ratification of the Kyoto Protocol. The government's aim is to make it possible for Norway to ratify the protocol in spring 2002 and thus contribute towards its entry into force by the World Summit in Johannesburg in August-September 2002. The ratification proposal was submitted in conjunction with the submission of a white paper proposing a more proactive climate policy (Report No.15 (2001-2002) to the Storting).

In the design of further policies and measures, Norway is basing its national climate policy on the assumption that the Kyoto Protocol will enter into force. It is therefore necessary to devise a policy to ensure that the national commitments under the Protocol are met. For the first commitment period, particular efforts are being made to develop policies and measures that will ensure that Norway complies with its quantitative emission reduction commitment. Norway is also taking action to respond to other commitments in the Protocol, which can be reported against the requirement to show "demonstrable progress" by 2005.

On 22 June 2001, the previous government submitted a white paper (Report No. 54 (2000-2001) to the Storting) on Norwegian climate policy. It contained an account of Norway's climate policy, including a description of existing policies and measures, as well as policy proposals. Policies and measures in relevant economic sectors were addressed in the white paper. Particular emphasis was put on a proposal for a broad-based domestic emissions trading system from 2008 that would apply to about 80 % of all emissions and be compatible with the international emissions trading system under the Kyoto Protocol. The introduction of such a system when the Protocol enters into force has broad political support in the Storting.

On 22 March 2002, the current government, which took office in October 2001, put forward a supplementary white paper on climate policy (Report No.15 (2001-2002) to the Storting). This government wishes to pursue a more proactive climate policy. It added several proposals for policies and measures for the short term, but also supports the main thrust of the 2001 white paper, especially as regards long-term policy. The main element in the supplementary white paper is a proposal for a domestic emissions trading system for the period 2005-2007 where the previous white paper suggested agreements with industry. The supplementary white paper also proposes other policies and measures as described throughout this chapter. These include measures in the waste, transport, offshore petroleum and energy sectors, measures to reduce emissions of fluorinated gases, and the development of new technologies.

The Storting is expected to debate both white papers during spring 2002 and to give general directions regarding the proposal for a domestic emissions trading system and other proposals. The government will use this as a basis for drawing up a legal bill for the emissions trading system for consideration and subsequent implementation by the Storting. Other policies and measures will be followed up in the state budget.

Table 4.1 Environmentally related taxes[1] in effect in Norway in 1997, 1999, 2000, 2001 and 2002
(This table does not include taxes/charges levied at regional or local level)

Applies to:	Type	1997	1999	2000	2001	2002	NOK/tonne CO_2
Petrol tax, NOK/litre	– basic rate, leaded (>0.05g/l)	4.76	5.03	5.13	4.85 4.53 [2]	4.62 4.62	
	leaded (<0.05 g/l)	4.26	4.50	4.59	4.31 3.99 [2]		
	unleaded	4.02	4.25	4.34	4.06 3.74 [2]	3.81	
	– CO_2 tax	0.87	0.92	0.94	0.72	0.73	315
Mineral oil NOK/litre	**CO_2 tax** [5] – Sulphur tax (per 0.25 % sulphur content >0.05ppm) – basic tax on heating oil	0.435 0.07	0.46 0.07	0.47 [3] 0.07 [4] 0.19	0.48 0.07 0.382	0.49 0.07 0.389	186
Autodiesel [5] NOK/litre	– basic rate – sulphur content <0.005 % – sulphur content >0.005 % **– Sulphur tax** (>0.005 %)	3.35	3.54	3.74 3.54 [2] 0.25	3.04 [6] 2.72 [2] 3.04 [2] 0.26 [5]	 2.77 3.10	
Lubricating oil NOK/litre	– tax – refund	1.05 1.50	1.11 1.80	1.46 1.65	1.50 1.70	1.53 1.73	
Continental shelf NOK/litre (/Sm^3)	**– CO_2 tax** on: - natural gas / petroleum – Sulphur tax	0.87	0.89 3.0	0.70 3.0 6.0 [2]	0.72 3.0	0.73	277 (oil), 308 (gas)
Coal/coke NOK/kg	**– CO2 tax** **– Sulphur tax**	0.435	0.46	0.47 3.0 6.0 [2]	0.48 3.0	0.49 3.0	201 (coal), 153 (coke)
Domestic air transport	– CO_2 tax on mineral oil (reduced rate) Per passenger: – noise charge aircraft landings (Bodø) – passenger (seat) tax:	 noise differentiated 70.5 141	 noise differentiated 114 [7] 228 [8]	 noise differentiated 116 232	0.27 128 [9] 128 [9]	0.28 0 [9] 0 [9]	108
Electricity tax NOK/kWh	– production – consumption	0.0139 0.0562	0.013 [10] 0.0594	0.013 [10] 0.0856	0.013 [10] 0.1130 0.1030 [2]	0.013 [10] 0.93	
Fertilizers	– phosphorus – nitrogen	2.30 NOK/kg 1.21 NOK/kg	2.30 NOK/kg 1.21 NOK/kg	0 0	0	0	
Tax on final waste treatment NOK/tonne	landfilling incineration [11] – basic tax – additional tax		300 75 225	306 77 229	314 79 235	320 80 240	
Cars NOK	– deposit for new cars – refund for scrapped cars	900 1000	1200 1500	1300 1500	1300 1500	1300 1500	

1 VAT (24 % in 2001) is not included.

2 From 1 July

3 Reduced rate NOK 0.24 per litre or NOK 0.27 per litre and exemptions for some other sectors: paper and pulp industry, production of herring meal, domestic goods transport by boat, the supply fleet for the continental shelf.

4 Reduced rate NOK 0.013 per litre

5 The rate of CO2 tax for mineral oil also applies to autodiesel for road use.

6 Until 1 July

7 Some domestic flights

8 International flights

9 From 1 April

10 The tax revenues now go to the local and regional levels of government, at the same overall rate.

11 Additional tax rate depends on energy utilization.

4.2 Cross-sectoral policies and measures

Norway has advocated cost-effectiveness across emission sources and sinks, sectors and greenhouse gases both domestically and internationally. This is 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.

4.2.1 The Norwegian CO_2 tax scheme

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. There has been some variation in tax rates (see figure 4.1), but in 2002, the rate for the offshore industry and petrol is NOK 315 per tonne CO_2 emitted. The CO_2 tax is levied on about 64 % of total CO_2 emissions, corresponding to about 47 % of total greenhouse gas emissions.

The CO_2 tax is only one element of the taxation system. 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 3.81 per litre, whereas the CO_2 tax is only NOK 0.73 per litre. Thus, the total tax on such goods must be taken into account in evaluating taxes as a means of limiting use and consequently emissions. The present coverage and tax rates are shown in Table 4.1.

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 careful design of the CO_2 tax system has meant that the competitive position of Norwegian industries has not been significantly affected so far. In the transport sector, some indirect leakage may be taking place at times when prices of petrol are higher in Norway than in neighbouring countries, thus shifting some of the consumption of petrol to neighbouring countries.

Using taxes to achieve a cost-effective policy domestically would have required a uniform tax rate for all emissions of greenhouse gases. For many emissions, particularly of non-CO_2 gases, this has not been technically feasible. Secondly, given that the introduction of a CO_2 tax is almost unilateral, it has not been politically feasible to introduce a uniform tax for all sources of CO_2 emissions, because this might affect the competitive position of Norwegian enterprises and result in carbon leakage. So far, very few other countries have introduced similar taxes, and even those countries that have done so have not taxed the activities that are exempted from Norway's CO_2 tax scheme. 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 relatively more emission-intensive industries.

Whereas the main features of the tax (the highest rates for the offshore sector and use of petrol, lower for other sectors) 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 minor sources of emissions were added in 1998.

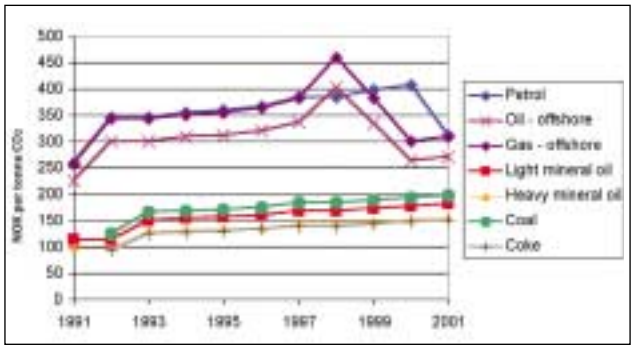


Figure 4.1: Norwegian CO2 taxes 1991-2001, prices not adjusted. Annual price rise in the period was about 2%.

Thus, the CO_2 tax has mainly been applied to uses of fossil fuels where the CO_2 tax only constitutes a limited fraction of the price or where its main effect has been to influence the choice of technological solutions at the time of investment. For this reason, in many sectors the tax could not be expected to have a major effect on emissions.

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. 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 anyway so small that it is not believed to significantly affect these markets.

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 development of a gas export pipeline network has also given natural gas an alternative value. The general focus on environmental issues is supported by the authorities. In the programme MILJØSOK, the industry and the authorities collaborated in an extensive effort to identify options and strategies for achieving cuts in emissions (see section 4.4.1 for a presentation of MILJØSOK).

The main effects of the tax are believed to be a result of improvements in the performance of installations planned and put in place after the tax was anticipated/adopted, as there has been relatively little opportunity to reduce emissions from installations that were already in place before the tax was introduced. By 1996, emissions per unit produced were 30 % 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 and characteristics of the petroleum fields are also important. Such factors have resulted in stable or slightly rising emissions per unit produced since 1996. In future, technology choices will be determined by expectations related to carbon costs, in particular the price of credits and quotas (AAUs, RMUs, ERUs and CERs), under the Kyoto Protocol from 2008. The importance of the CO_2 tax is thus limited to the costs it represents in the period during which it is levied.

The focus on fuel savings, energy efficiency and limiting gas flaring on offshore installations has reduced the emissions of CO_2 below the level expected in a "business-as-usual" scenario. However, it is difficult to quantify these reductions. Studies performed by the industry and consultancy firms indicate that emissions from upstream activities were approximately 15 % lower in 2000 than in a "business-as-usual" scenario. The consultancy firm ECON (ECON 1997) estimated that emissions from this sector in 1996 might have been 8% higher in the absence of certain measures taken after the tax was introduced. Measures responsible for 3 of these percentage points were considered to be directly attributable to the tax. However, ECON pointed out that the study would not be expected to cover all measures, and that some measures that would have been profitable without the tax might not have been identified and implemented without the attention drawn to this issue by the tax. The period 1996-2000 has been evaluated in other studies, and these indicate reduction by a further 8 %. If we accept that emissions in this sector are 15 % lower than they would otherwise have been as a result of the CO_2 tax, this is equivalent to a reduction of 1.6 million tonnes of CO_2, or 3 % of total Norwegian greenhouse gas emissions in 2000. In addition, 1 million tonnes of CO_2 per year (equivalent to 2 % of domestic emissions of greenhouse gases) from the Sleipner field has been reinjected into the Utsira formation (an aquifer) since 1996. Thus the tax (and the greater focus on environmental issues) may have reduced emissions by 2.6 million tonnes CO_2 in 2000, equivalent to 4.5 % of total greenhouse gas emissions in Norway.

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 % of the national total 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. The tax would also be expected to discourage the wider introduction of coal, which is currently hardly used in the Norwegian energy system.

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 % 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 315 per tonne CO_2 at present) have always been levied on gasoline. 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 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.

Another recent study has estimated the effects of the CO_2 tax in sectors other than the offshore petroleum industry (*Bruvoll and Larsen 2002 in press*). This study was based on estimation of macroelasticities and used a long-term dynamic equilibrium econometric model, MSG. This approach showed that the tax had only a limited impact, corresponding to about 0.8 million tonnes or 1.5 % of national emissions. It is possible that this relatively minor impact can partly be explained by rebound effects through income effects that were reflected in the counterfactual simulation. The authors cautioned against drawing very definite conclusions from the project, partly because it suffered from a lack of good quality price data for certain commodities such as heavy fuel oils. Larsen and Nesbakken (1995) used a partial analysis to study the effects of the CO_2 tax based on data for the years up to 1993. Given the limited changes that have been made since then in the structure of the tax and tax rates, the results from this study may still be relevant. In the period studied, the effect of the tax varied from 0 to 10-20 % reduction in emissions in the sectors studied, which covered about 25 % of Norwegian greenhouse gas emissions. On average, emissions in the sectors studied were reduced by 3-4 %.

Such econometric approaches reflect historical changes related to price signals. But if, for example, the tax has contributed significantly to keeping coal out of the Norwegian energy system, this would not be reflected in such simulations. To some extent such effects appear likely, as coal could be a possible energy source for some industries.

At the same time it is obvious that the design of the CO_2 tax scheme – exemptions and high degree of differentiation – has also limited its environmental impact. The exemptions from the tax are given in the interest of protecting regional employment and the competitive position of certain industries and avoiding carbon leakage.

4.2.2 Regulation by the Pollution Control Act

Greenhouse gas emissions are a form of pollution as defined by the Norwegian Pollution Control Act. As a general rule, such emissions must therefore be regulated, i.e. companies that generate greenhouse gas emissions must be licensed to do so, either by obtaining a discharge permit or through regulations pursuant to the Pollution Control Act. In addition, the EU directive concerning integrated pollution prevention and control (the IPPC Directive), which applies to most major sources of emissions, requires the use of the best available techniques (BAT) and efficient use of energy by industrial installations.

Until now, few requirements to reduce emissions of greenhouse gases have been included in discharge permits that have been issued pursuant to the Pollution Control Act. However, Norway will continue to follow up the directive's provisions by requiring Norwegian industry to make use of the best available techniques and use energy efficiently. To date, BAT standards only include individual requirements for energy efficiency measures at installations, but these may result in cuts in CO_2 emissions. Depending on technological advances, stricter requirements for cuts in greenhouse gas emissions may be laid down.

In the waste sector, regulations under the Pollution Control Act are used in combination with other policy instruments.

4.2.3 Emissions trading

In its inaugural address in October 2001, the present government announced its intention to establish a domestic emissions trading system for the period before the first commitment period under the Kyoto Protocol. In the supplementary white paper (Report No. 5 (2001-2002) to the Storting) the government outlined a domestic emissions trading system for 2005 –2007. The proposed system would where feasible apply to emissions not presently subject to the CO_2 tax, particularly emissions from the processing industry, which account for about 30 % of the national total. The Storting will consider the proposal in spring 2002. The question of whether an EU emissions trading system, which the EC Commission has proposed to implement from 2005, will be applicable to Norway under the EEA Agreement is under consideration, but this issue has not yet been settled.

There is a broad political consensus that emissions trading will be an important instrument of Norway's long-term climate policy. Last year's white paper (Report No. 54 (2000-2001) to the Storting) included a proposal for a domestic emissions trading system for the commitment period 2008-2012, in which emissions from the entities to which the system applied would be regulated by quotas. This proposal was endorsed by the present government and is also expected to be discussed by the Storting this spring. The proposed system will ensure that Norway can meet its quantitative emission commitment under the Kyoto Protocol for the period 2008-2012.

Last year's white paper recommended that the emissions trading system for the period 2008-2012 should be as broad-based as possible. This means that the system is intended to apply to all emission sources and gases where practical considerations make this possible. Thus, the system should from the outset include CO_2 emissions from combustion of fossil fuels for energy purposes, CO_2 emissions from the use of fossil fuels in industrial processes and transport, and emissions of nitrous oxide (N_2O), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) from industrial processes. These emissions make up about 80 % of Norway's total emissions. The trading system should be open to all types of entities. In a system based on quotas for greenhouse gas emissions, participation may be mandatory for 100-200 entities in Norway. Others may participate voluntarily. The number of Norwegian quotas available in the market must be evaluated in relation to the number the state will need to cover emissions from sectors that are not required to become part of the system.

Entities for which the emissions trading system is mandatory should also be able to take part in international emissions trading and joint implementation (JI) and to cooperate with developing countries in the clean development mechanism (CDM). This will give them the option of meeting their commitments by cutting their own emissions, reducing their level of activity or making use of opportunities to buy quotas or emission credits in Norway or abroad.

As a general rule, the white paper recommended the sale of emission quotas. However, it was recognized that to reduce the risk of Norwegian enterprises moving their activities to countries that are not applying climate policy instruments (carbon leakage), and to avoid excessively high adjustment costs, it might be necessary to provide quotas free of charge for a period of time. The intention was that this should be done for a limited period of time if the prospects for the competitive situation of enterprises that are exposed to international competition at the beginning of the first Kyoto commitment period indicated that this was necessary.

4.2.4 The Kyoto mechanisms

The present government has said that a "substantial proportion" of the reductions needed to meet Norway's Kyoto commitment should be achieved through domestic action, and the proposals in the supplementary white paper are meant to bring about domestic reductions. Nevertheless, it is expected that the Kyoto mechanisms will make an important contribution in enabling Norway to comply with the Kyoto Protocol. The government proposes that the domestic emissions trading system should be linked to the international trading scheme under the Kyoto Protocol and to the other Kyoto mechanisms.

Norway has gained experience of project-based cooperation during the AIJ (activities implemented jointly) pilot phase, and has a good basis for taking part in an operative phase under the Kyoto Protocol. As JI and the CDM become operative, more advanced forms of project-based cooperation may also be developed, through arrangements such as the World Bank's Prototype Carbon Fund. Norway has undertaken to provide USD 10 million towards the Prototype Carbon Fund, and the Norwegian private-sector companies Norsk Hydro and Statoil are participating.

In December 2001 Norway and Romania signed a bilateral climate change agreement on project cooperation for the reduction of greenhouse gases. This is the first bilateral Joint Implementation project under the Kyoto Protocol that Norway is taking part in and that allows for the transfer of credits.

In Romania the project will help to reduce local air pollution and improve district heating systems in the city of Fagaras, in addition to reducing greenhouse gas emissions. It is estimated that the project will reduce CO_2 emissions by about 500 000 tonnes during the 15-year project period, which starts in 2002. Under the agreement, Norway will receive credits corresponding to about 35 000 tonnes annually or a total of 175 000 tonnes for the commitment period 2008-2012. These ERUs can be used against the Norwegian quantitative commitment under the Kyoto Protocol. The cost of the credits arising from the emissions reductions is estimated to

about 30 NOK per tonne of CO_2, which is relatively inexpensive compared to most domestic measures in Norway.

Norway became a member of the Polish Ecofund through an agreement on a "debt-for-environment" swap between Norway and Poland in 2000. Poland's debt to Norway will be reduced by NOK 180 million in the period 2000-2010, and will instead be channelled to environmental investments in Poland through the Ecofund. Norwegian companies, along with other member countries, are allowed to compete through tender procedures for deliveries of technologies and goods to the Ecofund projects. These projects in Poland will help to reduce local air pollution and emissions of greenhouse gases, as well as protecting biodiversity and reducing waste.

In 2000, the Nordic energy and environment ministers decided to use the Baltic Sea region as a testing ground for the use of the flexible mechanisms. This initiative will comprise JI projects to meet the Kyoto commitments of the investor countries. Norway has declared its intention to play an active part in capacity building and other work along with other Nordic countries.

4.3 Energy and transformation industries

4.3.1 Electricity production on the mainland

Almost all electricity produced in Norway is hydropower. Thus, nearly all CO_2 emissions from electricity production are related to offshore petroleum production, where electricity is used mainly to compress and transport natural gas through pipelines to Europe (see section 4.4). However, the government has granted construction and operating licences for three gas-fired combined-cycle power plants in western Norway. These plants would have a total production capacity of approximately 12 TWh/year, and would generate total CO_2 emissions of about 4.4 million tonnes per year. Because of the low prices of electricity, it has so far not been economically viable to build gas-fired power plants in Norway, and it is still (April 2002) uncertain whether these plants will be built.

From 1999 to 2000, the tax on electricity consumption was raised from NOK 0.0594 to NOK 0.0856 per kWh, an increase of almost 70 % in one year. From 1 January 2001 the tax was raised again, and the current rate is NOK 0.093 per kWh. At the same time, a basic tax on fuel oil of NOK 0.389 per litre has been introduced to avoid a shift from electricity towards oil for heating purposes. Nonetheless, the electricity price to households in Norway is relatively low compared to prices in other OECD countries in Europe. In 2000, the price of electricity on the Nordic spot market (Nord Pool) averaged about NOK 0.12 per kWh, reflecting conditions that year (high precipitation and therefore abundant water supplies, and above-normal temperatures), while in 2001 it rose to NOK 0.186 per kWh. The consumer price also includes payment for grid services and 24 % VAT, and for households the price has typically varied between NOK 0.45 and NOK 0.65 per kWh. The relatively low price of electricity provides little incentive to further the introduction of new renewable energy sources and improve energy efficiency in Norway.

In its inaugural address, the present government announced its intention to establish a framework that makes it possible to develop "CO_2-free" gas-fired power plants, i.e. plants that use technology to separate and deposit CO_2. Further research, a cooperation programme with the industry, an economic "start-up package" containing tax exemptions and an investigation of environmental status including continuous evaluation of discharge permits will be important elements of the government's policy. In the budget for 2002, the government has allocated NOK 65 million to research and development related to CO_2-free technologies. This is an increase of about 140 % from the previous year. Several Norwegian companies are currently involved in research and development of technologies for gas-fired power plants with CO_2 separation and sequestration.

4.3.2 Use of new renewable energy sources

In 2002, petroleum and other fossil fuels accounted for 37 % of Norway's domestic energy use including transport, hydropower for 56 % and other renewable energy sources for about 7 %. One of Norway's objectives is to increase the use of new renewable energy sources, and the government will develop a strategy for the use of renewable energy sources instead of petroleum for heating.

A white paper on Norwegian energy policy (Report No. 29 (1998-1999) to the Storting) set out the goal of constructing wind power plants with a production capacity of 3 TWh/year by 2010. In 2001 licences were granted to two wind power parks on the north west of Norway. The plants that have been licensed

will produce about 1.6 TWh/year. There are also a number of planned wind parks that are currently being considered for licensing by the authorities. If all these applicants receive licences and the investments are put in place, total production capacity in 2010 could be about 4.4 TWh/year. However, both environmental and cultural heritage concerns need to be taken into consideration during the licensing process.

Even though the production costs for electricity from wind power at good sites will be lower than for other new renewable energy sources, some public funding is still needed for installations to be profitable. The most important policy instruments for promoting wind power in Norway are investment grants and exemptions from the 7 % investment tax. In addition, production support for wind power plants at a rate corresponding to half the electricity tax was introduced in 1999. Altogether, these measures to promote wind power correspond to about NOK 0.1 per kWh.

Corresponding tax exemptions and subsidies are provided for other renewable energy sources. Investments in biofuel reactors, heat pumps and district heating are also exempt from the investment tax and may be eligible for a 25 % direct state subsidy. Facilities that recover energy from waste are exempt from the tax on final waste treatment (section 4.9). In total, the national budget for promotion of non-hydro renewable energy sources has grown in recent years, and totalled nearly NOK 500 million in 2001.

4.3.3 Energy efficiency

In March 2001, the Storting approved the establishment of a new government agency to promote energy savings, new renewables and environmentally-friendly natural gas solutions. The enterprise, Enova, has been operative since 1 January 2002, and is owned by the Ministry of Petroleum and Energy.

The establishment of Enova is intended to ensure more cost-effective use of public funding by creating one central organization. This reorganization is a response to the fast growth of national energy use, and particularly electricity use, over the past few years, and the national and international environmental framework for new energy generation (see Figure 4.2).

A central task for Enova will be to achieve the energy objectives that were approved by the Storting in spring 2000. These are:

- to limit energy use considerably more than would be the case if developments were allowed to continue unchecked
- to increase annual use of central heating based on new renewable energy sources, heat pumps and waste heat by 4 TWh/year by the year 2010
- to construct wind generators with a production capacity of 3 TWh/year by the year 2010.

To achieve these objectives, the Storting has indicated that it is willing to provide grants up to a ceiling of NOK 5 billion over a ten-year period. The funding will come from a levy on the distribution tariffs and from ordinary grants over the state budget. Enova will use this funding to finance programmes and initiatives that are in line with these objectives. Enova will be given the freedom to establish different kinds of financial support schemes. Enova is expected to work pro-actively with market participants. A progress report will be submitted to the Ministry on a yearly basis. The various activities and results will be evaluated after a four-year period.

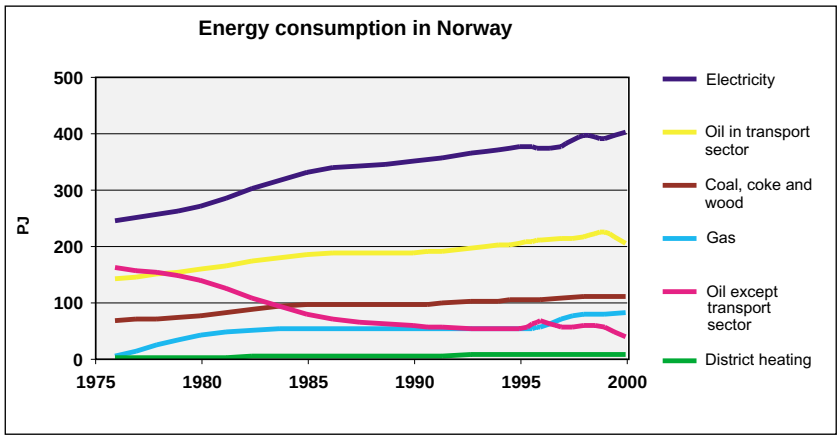


Figure 4.2 Energy use in Norway, 1975-2000. Sources: Norwegian Pollution Control Authority, Statistics Norway.

The above objectives 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. Reliable systems for measurement and verification of results will be given high priority.

Enova will also participate in international activities and act 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 will continue to be responsible for tasks related to legal and policy questions concerning the demand and supply of energy.

The supplementary white paper on climate policy also introduced a target of a 25 % reduction of the use of mineral oils for heating in 2008-2012, as compared to 1996-2000. A strategy for conversion from oil-fired heating to new renewable energy sources will be developed.

Residential and service sectors
New building codes entered into force in 1997, and introduced more stringent insulation requirements for walls, windows, floors and roofs. Emission standards for wood-burning stoves were also introduced. The Norwegian State Housing Bank administers various loan and grant schemes to finance residential energy efficiency measures. Energy efficiency networks for owners of commercial and public buildings have been established since 1996 to facilitate the exchange of information on energy efficiency efforts between them and lcoal authorities. Energy labelling of refrigerators, freezers, washing machines and tumble dryers was introduced in 1996 in accordance with EU directives.

4.4 The petroleum sector

4.4.1 CO_2 emissions

CO_2 emissions from the petroleum sector are mainly related to energy production in gas turbines. There are restrictions on flaring, but it is permitted for safety reasons and is still the second most important source of CO_2 emissions offshore. The CO_2 tax is the most important instrument for reducing emissions in the petroleum sector. Its effects have already been discussed in section 4.2.1. This section therefore focuses on other policies and measures in the petroleum sector.

Norway's 1995 Petroleum Act requires environmental impact assessments (EIAs) to be carried out as part of the input for decision-making at several stages in petroleum operations. The Ministry of Petroleum and Energy is responsible for ensuring that EIAs are performed, and the Storting must take their conclusions into account when making decisions on the development and operation of production and transport systems offshore.

The development of more efficient gas turbines is the single most important means of reducing emissions of CO_2 from oil and gas production. The Ekofisk field provides a good example of the progress that has been made in this respect. Ekofisk II came on stream in 1998, replacing older facilities that dated as far back as 1971. New gas turbines, infrastructure and a focus on energy efficiency reduced emissions from the field by approximately 60 % from 1997 to 2000. This effect was mainly achieved by replacing old machinery with new, but also partly by measures introduced in response to the CO_2 tax and to the environmental focus of the development project.

Another important development is the installation of equipment on the Sleipner West field to separate CO_2 from the well stream and re-inject it under the seabed. Since 1996 this solution has reduced CO_2 emissions from the field by 1 million tonnes each year. Other measures that have helped to reduce CO_2 emissions from the installations on the Norwegian continental shelf are:

- Flare gas recovery technologies
- Optimized power generation and drivers
- Process optimization
- Waste heat recovery from gas turbines
- Combined-cycle power generation.

In combined-cycle power plants, the hot exhaust gas from a gas turbine is utilized to produce steam and then generate electric power in a steam turbine. These are energy-efficient power plants, but are not commonly used offshore because of weight and space limitations. However, three such plants are currently in operation on the Norwegian shelf and produce some 43 MW of electric power.

The supplementary white paper on climate policy (Report No. 15 (2001-2002) to the Storting) states that the government wishes to pursue emissions reductions through the option of electricity supply

from onshore installations to installations on the continental shelf. Such measures could bring about substantial emissions reductions. The government will also consider further measures to reduce flaring.

In the same white paper, the government also stated that that it will ensure that the companies responsible for developing the Snøhvit petroleum field draw up a plan with a clear time-frame for testing CO_2 reduction technology. Otherwise, Snøhvit could add about 0.9 million tonnes CO_2 to Norwegian emissions. The government will report to the Storting on how the plan can be implemented.

Starting in 1995, the Norwegian petroleum industry and the government have run a joint programme – MILJØSOK – focusing on environmental improvements on the continental shelf. In the programme's final report, published in June 2000, it was estimated that greenhouse gas emissions could be cut by about 18 % in 2010 compared to a "business-as-usual-scenario". This estimate assumes that decisions on implementing new measures are based on the current CO_2 tax level. About half of the possible cuts are included in the existing projections of emissions. In order to achieve the total emission reductions estimated, all measures for which the costs are lower than the CO_2 tax would have to be implemented. The MILJØSOK programme was concluded in 2000, but has been replaced by a new arena for cooperation between leading actors from industry, authorities, research and environmental organizations, called MILJØFORUM.

4.4.2 Fugitive fuel emissions

Installing recovery systems can reduce emissions of non-methane volatile organic compounds (NMVOCs) from loading and storing of crude oil offshore and onshore. Fugitive NMVOC emissions from loading crude oil are counted as CO_2 emissions according to the IPCC Guidelines, since they contain fossil carbon and are not included under combustion in other sectors. As a result of a substantial increase in oil production from 1990 to 2000, emissions of VOCs increased by 22 % in this period. Total national emissions of NMVOCs from this source were about 223 000 tonnes in 1999, corresponding to 1.1 million tonnes of CO_2.

In the last few years, the government has intensified measures to reduce emissions during loading and storage of crude oil. In response to regulations laid down by the Norwegian Pollution Control Authority, a recovery system was installed at one oil terminal (the Sture terminal) in 1996. If maximum effect is achieved, this system makes it possible to recover up to 80% of the NMVOCs generated at the terminal. So far, however, the degree of recovery has been somewhat lower, about 60 %. The amount of NMVOCs recovered at the Sture terminal corresponded to about 24 000 tonnes of CO_2 in 1999.

After an attempt to conclude a voluntary agreement with the petroleum industry on the reduction of NMVOC emissions from offshore loading of crude oil failed in December 1999, these emissions are now subject to plant-by-plant regulation under the Pollution Control Act. Operators on the Norwegian continental shelf are required to install technology that will make it possible to recover about 70-80 % of NMVOCs released in connection with offshore loading and storage of crude oil. This technology is to be installed for 40 % of the offshore loading and storage of crude oil before the end of March 2003, 70 % before the end of 2004, and 95 % before the end of 2005. These measures are expected to reduce NMVOC emissions by about 52 000 tonnes in 2004 and 103 000 tonnes in 2006 compared with the business-as-usual level. In terms of CO_2 reductions this corresponds to about 156 000 tonnes in 2004 and 309 000 tonnes in 2006.

Norway has implemented EC Council Directive 94/63 on 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.

4.4.3 Methane emissions

Combustion and evaporation/leakage in the oil and gas industry accounted for 8 % of total methane emissions in 1999. These emissions are largely caused by landing and loading of crude oil offshore. From 1990 to 1999, methane emissions from the oil and gas industry rose by about 65 %. The substantial increase in emissions is a result of higher production in the oil and gas sector in the 1990s.

4.5 Transport

4.5.1 CO_2 emissions

CO_2 emissions from the transport sector have risen by more than 20 % from 1990 to 1999, 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 1999, road traffic accounted for about 18 % of total Norwegian greenhouse gas emissions, coastal shipping for about 5 % and air traffic for about 3 %. 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 are currently NOK 0.73 per litre petrol and NOK 0.49 per litre diesel. In addition, the general tax level on transport oils in Norway one of the highest in the world, currently NOK 3.81 per litre petrol (unleaded) and NOK 2.77 per litre diesel (low sulphur content). VAT is not included in these figures. The total taxes correspond to about 50 % of the consumer price on petrol.

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. The tax rate is currently NOK 0.28 per litre mineral oil, corresponding to NOK 108 per tonne CO_2 equivalent. International air traffic is still exempted from the CO_2 tax.

The Norwegian purchase tax on cars is one of the highest in world, and has since 1996 been differentiated according to car weight, engine output and engine volume. This tax structure is being evaluated and will be followed up as appropriate in the 2004 budget. The evaluation will include the question of whether to include CO_2 emissions as part of the basis for calculating the purchase tax. 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. Maximum speed limits in Norway are low by international standards, thus contributing to lower fuel consumption.

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. From 1 July 2001 the purchase tax on sales of electric cars was reduced to zero. It has also been decided to remove the investment tax from 1 February 2002. This will reduce the total price of electric cars by about 25 %. The government will increase its efforts to promote the use of biofuels for transport. To encourage research and development on alternative fuels, funds have in recent years been allocated to projects on the development and testing of electric and hybrid vehicles.

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 % lower than from diesel ferries. In the offshore sector the use of natural gas in vessels has moved a step further. From 2003, two supply vessels fuelled by natural gas will operate in the North Sea. These will be the world's first gas-fuelled offshore supply vessels. CO_2 emissions from these vessels will be about 20-30 % lower than from the existing supply vessels in the North Sea. The development of infrastructure for natural gas in the transport sector, including LPG, will be further discussed in a white paper scheduled to be submitted to the Storting in spring 2002.

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 focussed 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 Directorate for Public Roads is developing a strategy for encouraging cycling to be presented in the next national transport plan.

4.5.2 Nitrous oxide (N_2O)

Mobile sources accounted for about 1 900 tonnes of N_2O emissions in 1999, corresponding to 11 % 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

The CO_2 tax applies to energy-related emissions from the use of oil, but these only account for a small proportion of the industry's emissions. Emissions from the aluminium industry are addressed by an agreement between the companies and the authorities. However, most emissions from industry are not subject to climate change policy instruments. In the supplementary white paper on climate policy, the government has, however, proposed that all emissions from industry that are not subject to the CO_2 tax should be included in an emission trading scheme from 2005.

4.6.1 CO_2 emissions

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.

Emissions of CO_2 from Norwegian cement production are estimated to be about 1.7 million tonnes per year, corresponding to about 1 tonne CO_2 per tonne cement. Of this, about 60 % is generated by the decomposition of limestone during the production process. Decomposition is a necessary part of the manufacturing process, and emissions are therefore directly dependent on the production volume. The remaining 40 % of the emissions originate from the sources of energy, which are coal, waste oil and liquid organic hazardous waste. Beside 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 14 000 tonnes up to 1999 and that this will rise to 50 000 tonnes by 2010.
Emissions of CO_2 from metals manufacturing were about 5.9 million tonnes in 1999, corresponding to about 14 % of total emissions of CO_2 in Norway. The largest source category is the ferro-alloy industry, which alone accounts for over 6 percentage points. 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. CO_2 from aluminium production is addressed in the agreement between the government and the industry described in section 4.6.3.

4.6.2 Nitrous oxide (N_2O)

The main industrial source of emissions of nitrous oxide is the production of nitric acid. In 1999, emissions of nitrous oxide from this source amounted to about 6 100 tonnes, corresponding to about 35 % of total N_2O emissions. 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. The improvements in the production process have led to a reduction of 35 % per unit produced. In 1999 this corresponded to a reduction of about 0.8 million tonnes CO_2 equivalents, which again represented a reduction in Norway's overall greenhouse gas emissions of about 1.4 % from the 1999 level (see Table 5.5).

According to the Norwegian Pollution Control Authority, N_2O emissions from the production of nitric acid could be reduced by a further 0.4 million tonnes of CO_2 equivalents per year by improving production processes at all production units. This can be achieved at much lower cost than most other emission reductions in Norway – approximately NOK 7 per tonne CO_2 equivalent, according to the Pollution Control Authority.

Emissions of N_2O from stationary combustion in industry were estimated at about 400 tonnes in 1999, i.e. about 2.3 % of total emissions of N_2O in Norway. However, this figure is very uncertain. It is estimated that about 25 % 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.

4.6.3 Other greenhouse gases

PFC emissions 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 164 and 6 tonnes respectively in 1999, corresponding to a total of about 1.1 million tonnes of CO_2 equivalents.

From 1990 to 1999, emissions of PFC gases were reduced by 63 %. In 1997 the major aluminium producers signed an agreement with the Ministry of the Environment to reduce their emissions of greenhouse gases per tonne aluminium produced by 50 % in 2000 and 55 % in 2005, compared to 1990 levels. The industry's own reports shows that the agreement has been respected so far - emissions were 51 % lower per unit produced in 2000 than in 1990. According to the Norwegian Pollution Control Authority, the emission reductions achieved by the measures taken since 1990 could be equivalent to as much as 3 million tonnes CO_2 equivalents in 2000, compared to the "business-as-usual" scenario. This estimate also includes the reduction achieved through voluntary action, in anticipation of an agreement, before 1997. If only the direct effect of the agreement is included, in other words only the reductions achieved in the agreement period, the estimated reductions are substantially lower, about 0.7 million tonnes CO_2 equivalents in 2000 compared to the "business-as-usual" scenario (see Table 5.5).

4.6.4 SF_6 emissions

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 in the magnesium industry in Norway has been reduced from about 90 tonnes in 1990 to about 35 tonnes in 1999, or 0.83 Mtonnes in CO_2 equivalents. The reduction is 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 reduction in the magnesium industry gave emission reductions corresponding to about 1 million tonne CO_2 equivalents in 1995 and about 1.4 million tonne CO_2 equivalents in 2000.

In October 2001, Norsk Hydro decided to close down the main magnesium foundry in Norway, thus reducing SF_6 emissions. However, a secondary foundry will continue to operate and emit SF_6, but emissions are expected to drop to only about 25 % of the current level.

In 1999, emissions of SF_6 from gas-insulated switchgear and transformers in Norway totalled about 2.4 tonnes. Emissions occur as a result of leakage or accidents, or if installations are destroyed without recovering the gas. In June 2001, a non-profit trust, RENAS, which under an agreement with the government is in charge of the collection, recycling and destruction of discarded electric and electronic equipment, established an SF_6 recovery facility. This facility, combined with a detailed plan for maintenance of equipment in use containing SF_6, is expected to bring about significant reductions in SF_6 emissions.

In March 2002, the government concluded an agreement with the relevant branches of industry on non-industrial emissions of SF_6. Producers, importers and users of electrical equipment have agreed to reduce emissions of SF_6 by 13 % in 2005 and 30 % in 2010.

4.6.5 Use of HFCs

Various HFC compounds are of interest as substitutes for CFCs and HCFCs, which are to be phased out in accordance with the obligations of the Montreal Protocol. In 1999, emissions of HFCs totalled were 91.7 tonnes or 0.18 Mtonnes expressed in CO_2 equivalents. Emissions have increased substantially over the last 5–6 years, and are expected to increase further unless new measures are implemented. In the supplementary white paper on climate policy, the government proposed the introduction of a tax on HFCs imported in bulk or products, to take effect on 1 January 2003. The tax rate should be in line with the CO_2 tax on mineral oils, which at present is equivalent to NOK 186 per tonne.

In February 2001, the Norwegian Pollution Control Authority published a report analysing the effects of a tax of NOK 250 per tonne CO_2 equivalent on the import of HFCs, PFCs and SF_6. According to the report, this would be expected to reduce emissions

of these gases by about 47 % in 2010 and about 40 % in 2020 compared with a "business-as-usual" scenario where no regulation was introduced.

4.7 Agriculture

4.7.1 N_2O emissions

Emissions of N_2O from agriculture were estimated at 8 300 tonnes in 1999, and have probably remained more or less unchanged since 1980. In 1999, almost 50 % of Norway's total N_2O emissions came from the agricultural sector. Emissions can be reduced by careful spreading of nitrogenous fertilizer, and by spreading it at specific times during the growing season when the crops make best use of the nitrogen. This may reduce the amount of fertilizer needed as well as the generation of N_2O. These and other routines for irrigating and preparing the soil have been published by the Norwegian fertilizer manufacturer and distributed to farmers. The manufacturer is continuing research on how to reduce emissions of N_2O. The aim is to identify options for reductions and evaluate costs and reduction potentials related to these.

4.7.2 Methane emissions

Methane emissions from the agricultural sector were estimated at about 110 000 tonnes in 1999, and constitute about 33 % of total Norwegian methane emissions. Most of this is 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 general agricultural policies and measures, and the livestock numbers in Norwegian agriculture has been fairly stable throughout the 1990s. The storage and disposal of manure accounts for about 14.5 % 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 current forest policy has resulted in a steady increase in forest biomass and thus increased the yearly fixation of CO_2. In the last few years, the annual net uptake of CO_2 (annual increment minus roundwood removals and calculated natural losses) by Norwegian forests has varied between 14 and 18 million tonnes. As a result of historical forest management practices, the annual net CO_2 removals are expected to increase slowly over the next 10–15 years, reaching a level of 18–20 million tonnes of CO_2 by the end of the first commitment period.

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.
One national research study indicates that the carbon reservoir in buildings, furniture, landfills and other wood products in Norway is in the order of 60 million tonnes CO_2, and that it is increasing by approximately 0.7 million tonnes per year. The CO_2 sink in wood products is additional to carbon sequestration in the living forest stock.

4.9 Waste management

4.9.1 Methane emissions

In 1998, the method of calculating emissions from landfills was improved, and published emission figures were substantially reduced. However, this did not significantly affect the trend in methane emissions from 1990 to 1999.

It is estimated that emissions of methane from landfills in 1999 totalled about 188 000 tonnes, corresponding to about 7 % of the total greenhouse gas emissions in Norway. Methane emissions were reduced by about 3 400 tonnes from 1996 to 1999. Looking at the 1990s as a whole, emissions from the waste management sector have been relatively stable, because higher waste volumes have been offset by increasing recycling and extraction and combustion of landfill gas.

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 final waste treatment. Licences

include requirements for collection and combustion of methane from landfills. The licensing requirements are being steadily tightened up, and a recent EU directive on landfills will in the near future be implemented in Norwegian legislation. The directive requires substantial reductions in the proportion of biodegradable municipal waste landfilled and measures to collect methane generated in landfills. With very few exceptions, it is currently prohibited to landfill easily degradable organic waste in Norway. In the supplementary white paper on climate policy, the government indicated that it would consider a ban on landfilling of organic waste.

Norway introduced a tax on final treatment 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 final waste treatment, and thereby act as an incentive to increase recycling and to reduce the quantities of waste landfilled. For waste that is incinerated, the tax is levied at a basic rate and an additional rate. The basic tax rate is NOK 80 per tonne waste. The maximum additional tax rate is NOK 240 per tonne waste, but this is reduced according to the degree of energy utilization by the plant. For incineration with no energy recovery, the tax rate is NOK 320 per tonne in 2002. The supplementary white paper on climate policy indicated that the government will propose a revision of the structure of the tax to adjust it to climate policy in the budget for 2003.

During the last 5–6 years, emissions of methane have been reduced at several landfills by extracting the landfill gas for energy purposes or by flaring it. Today more than 40 landfills have installed landfill gas extraction systems, and approximately 22 000 tonnes of methane were recovered in 1999, 5 % more than in 1998. Estimates from the Norwegian Pollution Control Authority indicate that emission reductions achieved by extracting or flaring landfill gas corresponded to about 0.25 Mtonnes CO_2 equivalents in 1995 and about 0.5 Mtonnes in 2000 (see Table 5.5).

In addition, the amounts of waste recycled have increased significantly since 1990. It is more difficult to quantify the effects of waste recycling, but estimates presented in last year's white paper on climate policy indicated that the increase in recycling between 1992 and 1998 has given emission reductions corresponding to about 0.6 Mtonnes of CO_2 equivalents in 1998 (see Table 5.5).

Methane emissions from landfills were not included in the emissions trading system that was proposed in last year's white paper on climate policy. The white paper concluded that an evaluation of whether methane emissions from landfills can be included in the emissions trading system from 2008, and if so, how this should be done, should be carried out at a later date.

An alternative to mandatory inclusion in the emissions trading system for some or all landfills would be a form of joint implementation at national level, in which other entities invest in measures at landfills and thereby obtain quotas. This would ensure that as many low-cost measures as possible are carried out. The supplementary white paper on climate policy opens for this form of joint implementation as part of the emissions trading system for 2005–2007 in the case of landfills that have been closed, where it is difficult or costly to assign responsibility to a specific person or entity.

5. Projections and the effect of policies and measures

5.1 Introduction

The Long-Term Programme for 2002-2005 and the white paper (Report No. 54 (2000-2001) to the Storting) on Norwegian climate policy published projections of greenhouse gas emissions for the period up to 2010. For energy-related emissions, the projections are based on macroeconomic model simulations supplemented by sectoral studies (e.g. transport and petroleum production). For some source categories, mainly non-CO_2 emissions, sector- and plant-specific information has been collected from the industries concerned.

The reference scenario in the Long-Term Programme is based on the assumption that the Kyoto Protocol is implemented. In this scenario the Norwegian commitment is assumed to be met by a cost-effective combination of domestic measures and use of the flexible mechanisms in the Protocol. Some of the main results of the reference scenario are presented below in section 5.3, as an illustration of the effects of new measures.

The main focus in this chapter will, however, be on the modified version of the reference scenario presented in the white paper, in which no new measures to control greenhouse gas emissions are introduced. These projections are presented below in section 5.2.

5.2 Projections of greenhouse gas emissions with adopted and implemented measures

5.2.1 Methodology and key assumptions

The emission projections for Norway presented in this report are based on macroeconomic model simulations. The model underlying the projections is described in Annex B.

Table 5.1 shows projected trends for key macroeconomic variables. For the period 1999–2010, the gross domestic product grows at an average annual rate of 1.7 %. GDP in mainland Norway grows at 2 %, while petroleum activities and sea transport exhibit slower growth due to the development in offshore petroleum activities. Petroleum extraction is assumed to reach a peak at about 275 million Sm^3 oil equivalents (Sm^3 o.e.) in 2005–2006, and then gradually drop to about 240 million Sm^3 o.e. in 2010 and 190 million Sm^3 o.e. in 2020.

Table 5.1 Projections for key macroeconomic variables and energy use based on the reference scenario with adopted and implemented measures

	Billion 1999 NOK	Annual average growth rate 1999–2010
Gross domestic product	1192.8	1.7
Mainland Norway	994.2	2.0
Manufacturing	126.9	2.9
Petroleum activities and ocean transport	198.6	-0.7
Private consumption	578.3	2.2
Government consumption	252.2	1.7
Gross fixed capital formation	265.2	-1.0
Mainland Norway	186.2	0.5
Petroleum activities and ocean transport	79.0	-6.1
Number of persons employed (1000)	2280.6	0.4
Net domestic energy use: [1]		
Petroleum products (Mtonnes)	4.0	0.5
Electricity (TWh)	110.8	1.0

1 Except use in energy sectors and sea transport

Consumption of petroleum products is expected to grow at about 0.5 % per year from 1999 to 2010. Consumption of electricity is assumed to grow at about 1 % per year during this period. The rate of energy efficiency improvement varies between sectors but is assumed to average about 1 % per year. Production of electricity is assumed to increase from 123 TWh in 1999 to 133 TWh in 2010. Until now, nearly all production of electricity in Norway has been based on hydropower, but the projections for 2010 include 3 TWh wind power and 6 TWh from natural gas.

The government has so far approved plans for the construction of three gas-fired power plants. Two of these were approved in 2000, and have a total capacity of approximately 6 TWh. The corresponding increase in CO_2 emissions would be about 2.1 million tonnes yearly. The third power plant, which was approved in autumn 2001, has a production capacity of 6.2 TWh and would increase annual CO_2 emissions by up to 2.36 million tonnes if it were built.

Projections of emissions of other gases than CO_2 are mainly based on sector- and plant-specific information, collected by the Norwegian Pollution Control Authority from the industries concerned. However, projections of emissions of CF_4 and N_2O from stationary and mobile combustion are based on the macroeconomic model simulations in the white paper on climate policy.

The Norwegian Pollution Control Authority (1999) has developed a new model for calculating methane emissions from landfills. This model, which is based on the IPCC theoretical first order kinetics methodologies (IPCC emission inventory guidelines), takes into account the fact that methane emissions from waste continue for several years after disposal. The projections take into account measures that have been implemented, such as licensing requirements for collection and combustion of methane from landfills and reduction of wet organic waste disposal.

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 emissions supplied by the Norwegian producers. Projections of emissions of perfluorocarbons (CF_4 and C_2F_6) from aluminium production are also based on reports from the producers and take into account the mitigation effects of the voluntary agreement between the Ministry of the Environment and the aluminium industry.
The Norwegian Pollution Control Authority has drawn up projections of HFCs on the basis of Haukås (2000) and SINTEF (2000). The projections are mainly based on data and knowledge of the structure of CFCs, HCFC and halon consumption and an assessment of the possibility of substituting HFCs for these ozone-depleting substances.

5.2.2 Projections of emissions

Tables 5.2, 5.3 and 5.4 show projected greenhouse gas emissions for the period 1990–2010 based on current policies, i.e. including the present CO_2 taxes. The projections include emissions from the two gas-fired power stations approved in 2000. If current policies are continued, total greenhouse gas emissions are projected to rise by about 22 % from 1990 to 2010. The increase in GHG emissions from 1990 to 2010 is mostly driven by an increase in CO_2 emissions, which alone are expected to rise by 36 %. The 65 % increase in emissions from oil and gas production accounts for a large proportion of this rise. Emissions of PFCs and SF_6 will probably drop by 65 and 88 % respectively in the same period as emission-reducing measures are introduced in aluminium and magnesium production. Emissions of HFCs are expected to increase as CFCs and other ozone-depleting substances are phased out. Emissions of N_2O are projected to increase slowly up to 2010 and then stabilize. CH_4 emissions will probably decrease after 2010 as a result of the measures implemented.

Table 5.2 Projections of greenhouse gas emissions in 2010 by sector and gas, based on the reference scenario with implemented and adopted measures.

2010	CO_2 eq.	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
Energy	41.5	39.5	0.8	1.2			
Oil and gas production [1]	12.7	12.1	0.5	0.0			
Electricity generation [7]	2.1	2.1					
Manufacturing [2]	6.7	6.6	0.0	0.0			
Transport [3]	16.8	15.7	0.0	1.1			
Other sectors [4]	3.2	3.0	0.2	0.0			
Industrial processes [5]	12.5	7.9	0.0	2.1	1.1	1.1	0.2
Agriculture	5.1	0.2	2.3	2.6			
Waste [6]	4.1	0.0	4.0	0.1			
TOTAL	63.2	47.6	7.1	6.0	1.1	1.1	0.3

[1] *Including fugitive fuel emissions, oil test drilling, and emissions from natural gas terminals*
[2] *Own transport in the sector included under "transport"*
[3] *Including transport in all sectors*
[4] *Including energy consumption in residential, commercial, agricultural sectors, etc.*
[5] *Including "Solvent use"*
[6] *Including N_2O from waste water*
[7] *Including two gas-fired power stations approved for construction in 2000.*

Table 5.3 Greenhouse gas emissions for 1990, 1999 and 2010 (projections) by sector. Reference scenario with implemented and adopted measures

	1990	1999	2010
		Million tonnes CO_2 equivalents	
Energy	29.1	35.6	41.5
Oil and gas production [1]	7.7	10.2	12.7
Electricity generation	0.0	0.0	2.1[7]
Manufacturing [2]	4.8	6.1	6.7
Transport [3]	13.7	16.8	16.5
Other sectors [4]	2.9	2.5	3.2
Industrial processes [5]	14.0	11.5	12.8
Agriculture	5.0	5.0	5.1
Waste [6]	4.0	4.1	4.1
TOTAL	52.0	56.2	63.2
		Change relative to 1990 (%)	
Energy		22	43
Oil and gas production [1]		33	65
Electricity generation [7]		..	..
Manufacturing [2]		26	38
Transport [3]		23	22
Other sectors [4]		-14	12
Industrial processes [5]		-18	-11
Agriculture		0	2
Waste [6]		4	4
TOTAL		8	22

[1] *Including fugitive fuel emissions, oil test drilling, and emissions from natural gas terminals*
[2] *Own transport in the sector included under "transport"*
[3] *Including transport in all sectors*
[4] *Including energy consumption in residential, commercial, agricultural sectors,. etc.*
[5] *Including "Solvent use"*
[6] *Including N_2O from waste water*
[7] *Including two gas-fired power stations approved for construction in 2000*

Table 5.4 Greenhouse gas emissions for 1990, 1999 and 2010 (projections) by gas. Reference scenario with implemented and adopted measures

	1990	1999	2010
		Million tonnes CO_2 equivalents	
CO_2	35.1	41.7	47.6
CH_4	6.5	7.1	7.1
N_2O	5.2	5.3	6.0
HFCs	0.0	0.2	1.1
PFCs	3.0	1.1	1.1
SF_6	2.2	0.8	0.3
TOTAL	52.0	56.2	63.2
		Change relative to 1990 (%)	
CO_2	0	19	36
CH_4	0	9	10
N_2O	0	2	16
HFCs			
PFCs	0	-63	-64
SF_6	0	-64	-88
TOTAL	0	8	22

5.3 Assessment of aggregate effects of policies and measures

5.3.1 Effects of new policies – the reference scenario

As described in section 5.1, the reference scenario is based on the assumption that the Kyoto Protocol is implemented. In this scenario the Norwegian commitment is assumed to be met by a cost-effective combination of domestic measures and use of the Kyoto mechanisms. The current Norwegian CO_2 tax is replaced by a system of tradable quotas. The quota price, measured in 2001 prices, is assumed to be NOK 125 per tonne CO_2 in Norway and in the international quota market. Other fuel taxes are adjusted in the projection, so that for all fuels the sum of the quota price and fuel tax is at least as high as the current tax level. For example, the real value of the sum of all taxes on gasoline (quota price included) is kept constant at the current level. Hence, only emissions currently exempted from the CO_2 tax, including other gases than CO_2, are affected by the introduction of a quota system in the projection.

In the reference scenario including new measures, GHG emissions are projected to total 57.9 million tonnes CO_2 equivalents in 2010, compared to 63.6 million tonnes if no new measures are implemented.

5.3.2 Effect of implemented measures

In Norway, there has only been a limited amount of quantitative analysis of the effects of 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, para 39-41), can therefore only be partial and to some extent qualitative, building on information on the main policies and measures.

There are considerable methodological difficulties in ex-post estimation of the effects of policies and measures. These are related to the establishment of a hypothetical baseline in a situation where it is generally unknown which emissions path would have materialized in the absence of the policy instruments. The selection of appropriate analytical tools and the provision of relevant data have also proved to be difficult.

Effects of policies and measures that have been implemented or adopted

The estimates of effects of selected measures that have been implemented or adopted are based on information derived from studies by the Norwegian Pollution Control Authority, Statistics Norway, the Norwegian Petroleum Directorate and consultancy

firms and are shown in the table below. 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 to enhance energy efficiency and encourage the use of new renewable energy sources and of measures related to transport and agriculture are not included.

Table 5.5 Effects of selected measures that have been implemented or adopted. Million tonnes CO_2 equivalents.

	1995	1999-2000	2005
Directly related to climate change:			
- CO_2 tax in:			
the petroleum sector	0.6	2.6	2.6
energy use onshore, including transport	>0	0.8	>0.8
- Waste – requirement to collect landfill gas	0.25	0.5	>0.5
- Waste – reduced landfilling of paper	..	0.6	>0.6
Agreement with aluminium industry	0 – 1.6 [1]	0.7 - 3 [1]	0.7 – 3 [1]
Other regulation:			
- VOC regulation offshore	-	-	0.25
- VOC regulation at the Sture terminal	-	0.02	<0.02
Voluntary reductions of emissions:			
- SF_6 reduction, magnesium production	1	1.5	>1.5
- N_2O reduction, production of nitric acid	..	0.8	>0.8
- Use of biocarbon in cement production	..	<0.05	>0.8
Total emission reductions	1.85–3.45	7.57-9.87	

[1] The lower figure reflects the direct effect of the agreement between the aluminium industry and the government, while the higher figure includes the reduction achieved through voluntary action before the agreement was signed in 1997.

The table indicates that in the absence of the policies and measures that are in effect, the growth in emissions would have been 15-20 % higher.

5.4 Projections of CO_2 sequestration in forests

In the last few years, annual net carbon sequestration in Norwegian forests has been 14-18 million tonnes of CO_2, see chapter 4. As a result of historical forest management practices, the annual net CO_2 removals are expected to increase slowly over the next 10–15 years, reaching a level of 18–20 million tonnes of CO_2 by the end of the first commitment period. This projection 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 (CO, NO_X, NMVOCs and SO_2)

Table 5.6 shows projections of emissions of NO_x, NMVOCs and SO_2 for the scenario including adopted and implemented measures. These are based on the same assumptions as for the other gases, as described in section 5.2. Norway expects to implement further policies and measures to comply with its commitments for 2010 under the UN-ECE Gothenburg Protocol, and is currently undertaking an evaluation of appropriate policies and measures.

Table 5.6 Anthropogenic emissions of NO_x, NMVOCs and SO_2 (thousand tonnes) in 1990–2010 (projections for 2010), based on the reference scenario with adopted and implemented measures. Figures for 2010 in square brackets represent the commitments in the Gothenburg Protocol.

	1990	**1995**	**2000**	**2010**
NO_X	219.2	214.2	216.7 [1]	225 [<156]
NMVOCs	302	378	337 [1]	172 [2] [<195]
SO_2	52.7	33.8	26.0 [1]	30 [<22]

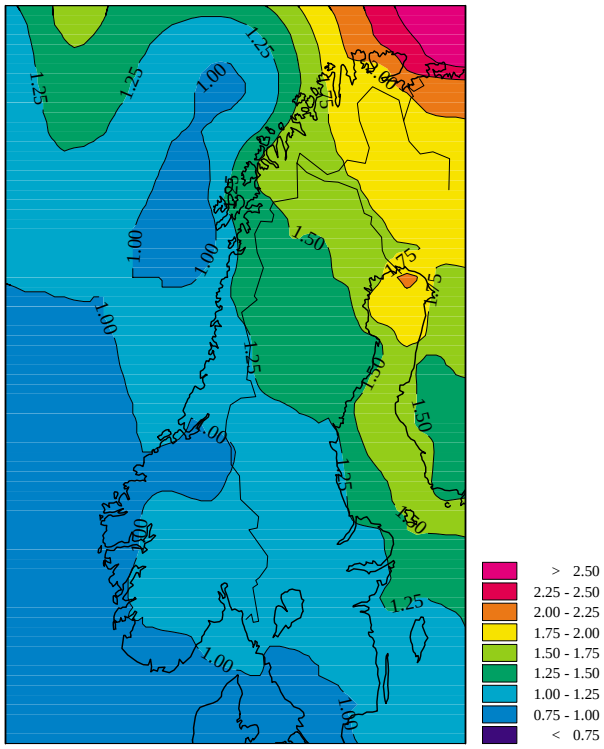
1 Preliminary figures.

2 It is assumed that the oil companies comply with the licensing requirements imposed on the petroleum sector by the Norwegian Pollution Control Authority. This will give emission reductions of about 65 000 tonnes in 2010. The oil companies have appealed against the requirements laid down by the Pollution Control Authority, cf. Section 4.4.2.

6. Impacts and adaptation

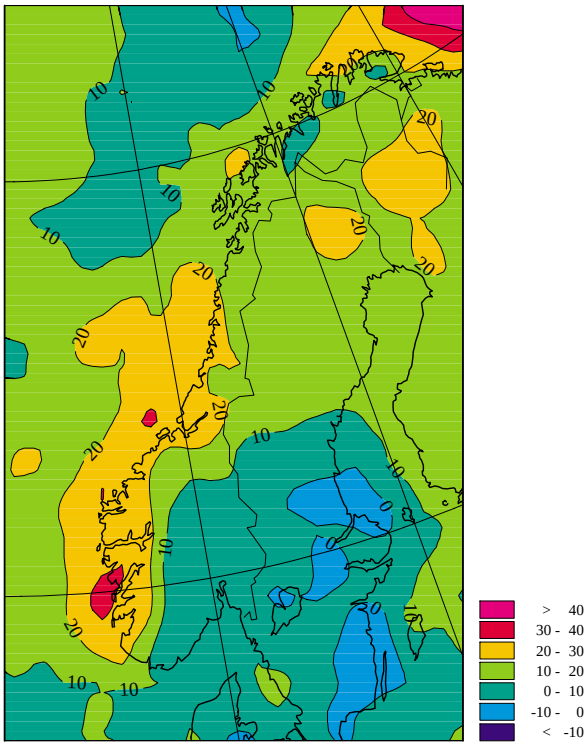
In 1997, the Research Council of Norway set up a research programme to study regional climate development in northern Europe in a scenario with global warming (RegClim). Several research institutes have been cooperating in RegClim, and about 35 scientists have been involved in the programme. According to the scenarios from RegClim, climate change in Norway over the next 50 years is expected to give a mean temperature increase of 0.9°C in the summer and 1.6°C in the winter (see figure 6.1). The increase is expected to be most noticeable in the northern parts of the country. Precipitation is expected to increase by about 10 % in the same period. Most of the increase is expected to occur in the western and northern parts of the country, particularly during summer and autumn (see figure 6.2). Stronger winds and more frequent storms are also expected along some parts of the coastline.

Although the RegClim scenarios still at a preliminary stage involving substantial uncertainty, the results clearly indicate that there will be marked climate change in Norway in the next 50 years. 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.nilu.no/regclim/.



Change in Temperature Jan-Dec (C)

Figure 6.1 Projected changes in mean annual temperature (°C). Source: RegClim.



Change in Precipitation Sep-Nov (%)

Figure 6.2 Projected changes in precipitation, September-November (%). Source: RegClim.

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 in large parts of Southern Norway in the autumn of 2000 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 been increased substantially. The government has also started a process of building adaptation strategies into the most vulnerable sectors of society, see section 6.3

6.1 Impacts of climate change on biodiversity and natural ecosystems

6.1.1 Terrestrial ecosystems

A temperature rise may lead to a shift of climate zones in both altitude and latitude.
Many species of plants and animals migrate more slowly than the rate at which the climate is predicted to change. As a consequence, species may be exposed to a climate to which they are not adapted. Over time it is therefore expected that climate change may cause changes in the species composition, abundance and distribution of plants, invertebrates and vertebrates. Extreme climatic events such as storms, drought and frost in late spring might be as significant as the rate of temperature change as regards alterations in species composition and ecosystem processes.

The varied topography of Norway makes it possible for some species of plants and animals to migrate short distances in altitude and thus follow the climatic conditions to which they are adapted. 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 montane forests and other alpine habitats may decrease, or shift upwards.

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. A warmer 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 suitable habitats are available.

6.1.2 Fresh water ecosystems

The predicted temperature rise will probably not lead to a great loss of species diversity in Norwegian fresh water ecosystems, but some species may disappear from certain localities. 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. 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.

6.1.3 Marine ecosystems

There is no indication that the expected rise in temperature is critical for marine ecosystems. Most marine species are capable of moving quickly to favourable growing and spawning areas. Climate change may, however, result in changes in the distribution and stock size of most fish species. A general northward shift in the distribution of fish stocks may be expected. Higher sea temperatures may lead to immigration of new marine species, but the overall effects of this on marine ecosystems are not easily predicted. 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.

An increase in storm activity is expected to result in increased damage to fish farming installations, and thus in escapes of farmed fish. Escaped farmed salmon in Norwegian rivers already constitute a significant problem, and the negative consequences include genetic interactions between farmed fish and wild fish, and the possible transmission of harmful organisms to wild fish populations. An increase in storm activity will also increase the risk of shipping accidents and oil spills along the Norwegian coast.

6.2 Impacts of climate change on vulnerable sectors

6.2.1 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. A research project looking at the growing season in an area in mid-Norway concludes that the season has increased by 10 days since 1963. 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.

6.2.2 Forests and 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.

6.2.3 Fisheries

The expected rise in sea temperature will probably lead to an overall increase in fish catches in Norwegian waters. Whether this will have positive impacts for the fisheries sector is more uncertain. Changes in species composition will probably be negative because the most valuable species such as cod, North Atlantic herring, haddock and saithe will to some extent be replaced by other less valuable species such as brisling, mackerel and sardine.

More frequent incidents involving pests and algal blooms might create substantial problems for the fish farming industry, which is becoming increasingly important in Norway.

6.2.4 Transport

Incidents such as flooding, landslides and storms will probably result in an increase in the costs of maintaining infrastructure. Avalanche protection

measures may also be necessary to make roads safer in some areas. More snow and wind in the mountain areas will probably make it more difficult to keep mountain passes open in winter. In other parts of the country, driving conditions are likely to be more variable, and thus more difficult, in the winter. More precipitation, fog and wind are also expected to result in more cancelled and delayed planes, trains and ferries.

6.2.5 Hydropower

Higher precipitation will result in higher electricity production at hydropower installations. In several parts of the country, however, precipitation is expected to vary more between seasons. This, combined with the risk of more frequent flooding, will make it necessary to expand and strengthen the dams to avoid damage to technical installations and ensure adequate levels of dam safety. The larger variations in inflow during the year will also reduce the predictability of electricity production.

6.3 Adaptation measures

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.

The initial work on adaptation strategies has identified a number of priorities for Norway in the next few decades. This includes areas such as management of wildlife, forestry and agriculture, fisheries, water resource management, coastal and river flood defence and a better coordinated approach to infrastructure planning. To improve understanding of climate change and its regional impacts it will be necessary to continue to support research programmes such as RegClim and ACIA (Arctic Climate Impact Assessment).

Norway is currently in the process of developing adequate response strategies to the impacts of climate change. The government recognizes that a number of organizations in both the public and the private sectors should take part in this process. 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 so far alerted and informed the sectoral authorities to ensure that climate change considerations are taken into account in planning processes wherever relevant.

The next stage in the process will be to have all relevant sectoral agencies develop adequate response strategies for their sectors, and to ensure an overall strategy based on the analyses in the respective sectors. This process is currently taking place, and it will be intensified in the years to come.

7. Research and systematic observation

7.1 Funding of research and systematic observation – general policy

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 include 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. In addition, Norway has taken an active part in a newly initiated programme under the Arctic Council that is intended to evaluate and synthesize knowledge of climate change and its consequences in the Arctic (ACIA – the Arctic Climate Impact Assessment).

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 1998, its the contribution to research related to climate change was NOK 113 million. It was estimated that this was equivalent to about 25 % of total national funding for to climate change research that year. Funding from the Research Council was about NOK 40–50 million higher in 2001 than in 1998. This is an increase of about 40 %.

7.2 Research programmes related to climate change

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

7.2.1 Climate processes and climate system studies: modelling and prediction

The framework for the main thrust of Norwegian research in these areas has been provided by the climate and ozone research programmes of the Research Council, the first of which was established in 1989. Recently the Research Council launched a new 10-year programme called *KlimaProg – Research Programme on Climate and Climate Change*. The programme will run until 2011, and its goal is to increase our understanding of the climate system and of both natural and human-induced climate variability. The overall objective is to ensure that Norwegian scientific research on climate maintains the highest international standards and to enable Norwegian researchers to conduct research in priority areas. Although *KlimaProg* is defined as a basic research programme, it is also intended to deliver results that lend themselves to further application, e.g. for research into the impacts of and adaptation to climate change.

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 priority research tasks are as follows:

- Detection of ongoing climate changes, understanding of their causes and how they can be related to natural and anthropogenic forcings.
- How will the climate develop in our region, and to what degree do effects from remote regions influence climate changes in our region?
- How large is the probability of abrupt changes in the climate system, particularly those associated with the ocean circulation? Which processes may cause abrupt changes and how large are the forcings needed to offset such changes?
- Why do large-scale climate changes of regional or global character arise on time scales from 10 to 1000 years? How do such changes affect the present-day climate developments? What is the climate system's sensitivity to various natural and anthropogenic forcings that operate on longer and shorter time scales?
- What is the origin of the interannual to decadal variability in the North Atlantic/Arctic system, and is it possible to predict this?
- Improved understanding of key processes, particularly those associated with feedback processes and non-linear phenomena, in the climate system.
- Improved understanding of exchanges of greenhouse gases (particularly carbon dioxide, methane and nitrous oxide) between terrestrial systems, the atmosphere and the ocean.
- How will greenhouse gases and aerosols be affected by physical and chemical processes in the atmosphere?
- What role does ozone have as a greenhouse gas today, and what role will it have in the future?

The total annual budget available to *KlimaProg* is about NOK 30 million. A large fraction of the funding is currently being channelled through four large coordinated projects with participants from several institutions. These projects are:

- *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 the uncertainties in these estimates as far as possible. Processes determining sea-surface temperature and sea ice cover in the Nordic Seas, and processes related to the radiative forcing of atmospheric contaminants with a regional distribution (direct and indirect aerosol effects, and tropospheric ozone) are included in the project. The project involves six universities and independent research institutes, and is being coordinated by the Norwegian Meteorological Institute.
- *Past Climates of the Norwegian Region* (*NORPAST*), which investigates natural climate archives (including marine sediments, lake sediments, speleothems, glaciers etc.) from terrestrial and marine sites in the Norwegian region. One of its main objectives is to identify patterns and frequencies of natural climate variability in the region and contribute to our understanding of the mechanisms behind this variability. The project involves five universities and independent research institutes, and is being coordinated by the Geological Survey of Norway.
- *Norwegian Ocean Climate Project (NOClim),* which focuses on the stability and variability of the Nordic seas and adjacent regions and on maintaining series of observations. Proxy climate parameters

and instrumental observations are used to study circulation and thermodynamics in the region. The project involves seven universities and independent research institutes, and 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.
- *Coordinated Ozone and UV Project (COZUV)*, which deals with changes in the stratospheric ozone layer and in UV radiation at ground level. Its aims include improving understanding of the processes leading to ozone depletion in the Arctic and at mid-latitudes during winter and spring, improving predictions of changes in the ozone layer related to climate change and changes in ozone depleting substances, and increasing knowledge of the distribution of UV radiation under different atmospheric conditions. The project involves four universities and independent research institutes, and is being coordinated by the Norwegian Institute for Air Research.

KlimaProg also supports a number of independent projects covering a wide range of the priority areas outlined above. In addition two advanced research groups have been established:
- *The Bjerknes Center for Climate Research (Bjerknes)* 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.
- *The Tropospheric Chemistry and Climate (ChemClim*) project in Oslo is coordinated by the University of Oslo, and also includes participants from CICERO (Center for International Climate and Environmental Research), the Norwegian Meteorological Institute and the Norwegian Institute for Air Research. The group studies a range of relationships between tropospheric chemistry and climate, such as processes governing the distribution of greenhouse gases and aerosols and chemical precursors, e.g. emissions, gas phase oxidation processes and cloud-chemistry interactions. The work includes GCM studies as well as radiative forcing estimates.
- *KlimaProg* also 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.

7.2.2 Impacts of climate change

The most important research efforts as regards the effects of climate change on the natural environment are currently being carried out as part of the research programme on biodiversity (*Biological Diversity - Dynamics, Threats and Management)*. This programme focuses on studies at population and ecosystem level, but also includes studies of the effects of climate change on individual species. In addition to several smaller studies, the project portfolio includes a new multi-disciplinary project at the University of Oslo focusing on the biological effects of climate fluctuations in three systems: a multi-species marine system, a plant-herbivore terrestrial system, and a seabird system linking the terrestrial and the marine system through the food chain. These studies are linked in a comparative manner to several other studies (e.g. from Africa, Japan, Chile and Scotland). The total annual budget for research on effects of climate change through the biodiversity programme is approximately NOK 5 million. The Research Council also funds some projects of relevance to possible impacts of climate change on sectors such as forestry and fisheries.

In the spring of 2001, the Research Council commissioned a review of the overall research needs related to the impacts of climate change and to adaptation to climate change across all sectors of society. In its report, the cross-disciplinary review group concluded that research funding through the Research Council needs to be increased more than fivefold over the next few years to meet the need for new knowledge in this area. Both more targeted basic research in the natural and social sciences, and impact studies on specific sectors such as fisheries, agriculture, forestry, energy, transport, infrastructure and tourism, are called for. In addition the group highlighted the need for regional studies to assess vulnerability to climate change across all sectors,

taking into account structural differences and variations in the degree to which adaptation is possible in different regions of Norway. The Research Council will use the conclusions of the review group in its efforts to strengthen Norwegian research in this field.

7.2.3 Socio-economic analysis

The most recent white paper on research in Norway (Report No. 39 (1998–1999) to the Storting on research at the beginning of a new era) emphasizes that the relationships between technology, energy and environment should be given special attention. The new 10-year research programme *Social Science Research in Energy, Environment, and Technology (SAMSTEMT, 2001-2010)* provides a framework for social scientific research on energy and environmental issues, including climate issues. SAMSTEMT follows up the programme *Norwegian Energy and Environmental Policy: Constraints, Opportunities and Instruments (SAMRAM)* that came to an end in 2000, and will thus ensure the continuity of research in this area.

The aim of *SAMSTEMT* is to improve the social science knowledge base as regards energy and environment issues. The results of the research should be of great interest to the government, business and industry, non-governmental organizations, the media, and the general public. The total budget is approximately NOK 12 million per year. At the moment 10 research institutions, including three universities, are participating and are cooperating closely. The main focus of the programme is on economics and political science, but the research also involves several other disciplines.

SAMSTEMT covers three relatively broad main topics:
- Energy markets and energy consumption
- Technological options, energy planning, and infrastructure
- International environmental agreements and climate policy

Research needs related to the third main topic include the following:
- Design of international energy-related environmental agreements and mechanisms for following up agreements, including Norway's role in the negotiations.
- Organization of the international decision-making apparatus in the area of climate, including legal aspects and compliance with international commitments.
- Institutional framework conditions and behaviour in negotiations on international energy-related environmental agreements, including implications for formation of preferences and negotiation behaviour of key actors.
- Relationships between democratic influence and the strengthening of international agencies in energy policy and climate policy.
- Design of effective policy tools for implementing international agreements, and distribution impacts of the measures. Issues in this regard include how various instruments affect behaviour, attitudes, and compliance with regulations and commitments, etc.
- The impacts of other countries' climate policy and measures for energy production and consumption in Norway, and possible consequences for the design of Norwegian policy instruments.
- Economic and social impacts in Norway of climate change and regional air pollution.

The Research Council is also financing two other major social science research projects on climate change issues.
- The project *Climate change impacts and vulnerability in Norway: A regional assessment*, run by CICERO in collaboration with the Foundation for Research in Economics and Business Administration and the Western Norway Research Institute, is to develop the methodological foundations for an analysis of the regional impacts of climate change in Norway. The project will focus on new approaches to research and will be the first "country study" for Norway that focuses on the vulnerability of different regions and economic sectors to changes in climate and climate variability. The total budget is approximately NOK 8 million for the period 2000-2004.
- The project *Environmental measures and efficiency,* at the Institute for Research in Economics and Business Administration, focuses on three problems. Firstly, it is undertaking an evaluation of the economic costs related to reductions in CO_2 emissions. The evaluation focuses especially on the effects of joint implementation of various environmental measures at the same time. The second problem relates to the functioning of emissions and energy markets, particularly in relation to the question of issuing emission quotas free of charge. Thirdly, it is considered essential to learn from previously implemented environmental measures by evaluating their results. Such evaluations improve our understanding of the consequences of already implemented actions and provide a better foundation for developing environmental measures in the future. The total

budget is approximately NOK 2.75 million for the period 2000-2004.

7.2.4 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. *KLIMATEK* covers all greenhouse gases, but projects so far are focusing on CO_2 and methane. Initially, priority was given to projects in the offshore petroleum sector and in the process industry. At present, Norwegian efforts to develop technologies to capture and sequester CO_2 from power generation based on natural gas are a major part of the programme. CO_2 storage is also covered, with the emphasis on ocean storage and storage in geological reservoirs.

One of the main goals of *KLIMATEK* is to encourage the demonstration of new technologies that can reduce emissions of greenhouse gases. Most contracts are therefore with emission "owners" or equipment vendors in close cooperation with an emission "owner", and government funding constitutes on average 25 % of total project costs. In particular a long-term research effort primarily funded by the government has been initiated to look at the capture of CO_2 generated by power production based on natural gas.

At present the accumulated *KLIMATEK* project portfolio includes 45 projects with a total budget of NOK 575 million, of which government funding accounts for NOK 200 million. Most of the projects are in the following four categories: offshore petroleum production, process industry (ferroalloy and aluminium production), gas-fired power production with CO_2 capture, and CO_2 storage.

CO_2 capture in connection with power generation from natural gas and CO_2 storage is an important topic within *KLIMATEK*. Approximately 60 % of the *KLIMATEK* budget is currently allocated to this. The focus on CO_2 capture is expected to increase further in the years ahead in accordance with a substantial budget increase for development of cost-effective and CO_2-friendly technologies for power generation from natural gas.

Projects supported by *KLIMATEK* include the following:

- Development of a novel membrane gas/liquid contactor for exhaust gas cleaning using amine absorption. The technology is being demonstrated at a pilot plant at Statoil's gas processing plant at Kårstø, Norway. Norwegian contractor: Kvaerner.
- 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 Gas R&D Programme. Norwegian contractor: Statoil.
- Participation in the international large-scale experiment to release liquefied CO_2 into the deep ocean offshore of Hawaii. The Norwegian focus is on consequences for the marine environment. US participation is from MIT and University of Hawaii. Norwegian partner: Norwegian Institute for Water Research.
- Participation in 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.
- Long-term research on novel power cycles, membrane technologies, combustion and absorption/adsorption processes, radical chemistry, novel reforming processes, fuel cells etc. Norwegian participants: Norwegian independent research organizations and universities.

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 proposed 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 Meteorological Institute sends data from the Norwegian meteorological stations to the WMO international data exchange and 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. A wide range of greenhouse gases is monitored at the Zeppelin Station in Ny-Ålesund, Spitsbergen. They include several halogenated species (including CFC gases and replacements), methane, and tropospheric and stratospheric ozone. This is part of the WMO Global Atmosphere Watch (GAW) system and the Network for Detection of Stratospheric Change (NDSC). 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.

Data on the halogenated greenhouse gases are now receiving particular attention, as the Norwegian Institute for Air Research is coordinating an 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 Dataset (ECD), 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).

The Archaeological Museum in Stavanger has developed a historical (pre-1990) meteorological database. This is a part of a European Science Foundation project and provides data for the international marine historical database Comprehensive Ocean-Atmosphere Data Set (COADS), hosted by the US.

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	135
How many of those are operating now?	10	1	1	135
How many of those are operating to GCOS standards now?	9	1	1	105
How many are expected to be operating in 2005?	10	1	1	125
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 now 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. We have been asked to report on our participation in oceanographic observations within GCOS, but since the Commission has only been in operation for a few months, we think it is too early to report on this. 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. The programme will be revised in spring 2002. Temperature and salinity observations are made at nine fixed coastal stations with vertical profiles and several standard sections acrosscrossing the Norwegian Coastal Current, the Atlantic Current and the Arctic Current. Along the sections, samples are taken for nutrients, phytoplankton and zooplankton. In addition, the Geophysical Institute at the University of Bergen operates the weather ship M in the Norwegian Sea.

Sea surface temperature observations are made along the course of the coastal steamer between Bergen and Kirkenes (24 positions) and between Stavanger and Aberdeen (9 positions). The institute is responsible for five moorings with ten current meters at the western entrance of the Barents Sea.

The hydrographic observations from the stations described above are regularly submitted to the International Council for Exploration of the Sea (ICES).

7.3.3 Terrestrial observations

Norway participates in the Global Terrestrial Observing System (GTOS) by reporting data from 8 study areas of birch forest. Apart from this, Norway does not participate in the GCOS or in GTOS programmes for terrestrial observations. For terrestrial observations there is no national monitoring programme dealing with climate change. Climate 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)
- Vegetation monitoring in protected coniferous forests
- Forest monitoring programme (state/vitality of forest ecosystems)
- National Forest Inventory (inventory on permanent plots all over the country at 5-year intervals)
- Monitoring of cultural landscapes
- Environmental monitoring on Svalbard and Jan Mayen.

Norway will also contribute to ACIA (Arctic Climate Impact Assessment) under the Arctic Council. ACIA includes both marine and terrestrial systems. The ACIA programme will continue at least until 2004.

Existing national plans

A national plan for biodiversity monitoring was adopted in 1998. This plan includes different threats against biodiversity, including climate. Implementation of the plan is foreseen in 2003. In response to a white paper on biodiversity from 2001 (Report No. 42 (2000-2001) to the Storting), an interministerial group dealing with surveying and monitoring including reporting biodiversity data has been established.

There is general agreement in Norway that climate monitoring and climate research need to be closely linked. The Research Council has published a report presenting the need for more research on the effects of climate change in the future. A newly started research programme, "Ecological effects of climate change in arctic ecosystems" (ARKTØK), should give valuable results and data with respect to monitoring of climate effects in marine and terrestrial ecosystems when the projects have been conducted (the first projects will be finished in 3 to 5 years' time). The Research Council has recently launched a new broader research programme on the effects of and adaptation to climate change. The total budget available to the *KlimaEffekter*-program for 2003 is about NOK 10 million.

Climate parameters monitored in Norway

The programmes described above are not, with the exception of ACIA, 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 subalpine birch forests, coniferous forests and on Svalbard, changes in populations of passerine birds and small mammals in subalpine 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 (forests).

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 changes in forests at 8 sites 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. Reporting to FAO + Eurostat

All of the sites listed above are operating now and are expected to be operating in 2005.

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) by providing satellite data from Norwegian stations. Since ESA and EUMETSAT are responsible for deriving climate-related information from the data they receive, we assume that ESA and EUMETSAT will provide the required information.

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 resources and transfer of technology

8.1 Financial support (non-ODA)

8.1.1 Cooperation through multilateral channels

Norway makes a substantial contribution to the aid programmes of the UN development agencies and international financial institutions. These contributions include funding for projects in developing countries related to the implementation of the United Nations Framework Convention on Climate Change.

Norway recognizes that it is very important for developing countries to participate in the Convention and the Intergovernmental Panel on Climate Change (IPCC), and therefore makes regular contributions to the Convention and IPCC Trust Funds to enable developing country participants to attend meetings.

Global Environment Facility

The Norwegian government's contribution to the Global Environment Facility (GEF) for the period 1997-2000 has been in the order of USD 30 million (see table 8.1). This includes the appropriate shares of the Norwegian contribution to GEF-I (USD 8.5 million) and the funding pledged for GEF-II for the period 1998–2001 (USD 31.3 million).[1] Norway reports 65 % of the contributions to GEF as Official Development Assistance (ODA). Norway's total commitment to GEF I and II is thus more than USD 39 million. Negotiations on replenishment of the GEF Trust Fund (GEF III) are currently taking place. According to GEF estimates, 40 % of total GEF commitments are allocated to projects in the climate change focal area.

At the resumed Sixth Conference of the Parties in Bonn, many donor countries made a political declaration reaffirming their commitment to climate change funding for developing countries. Norway intends to meet its fair share of the USD 410 million per year contribution by 2005.

United Nations Framework Convention on Climate Change

Each year, the Norwegian government has contributed the equivalent of USD 35 000-65 000 to finance participation from developing countries at COPs and other convention-related meetings. In 2000, Norway contributed an additional amount equivalent to USD 115 000 in support of the convention workshop on policies and measures in Copenhagen. Norway has also seconded one person to work in the secretariat for a three-year period.

Prototype Carbon Fund

Norway is committed to investing USD 10 million in the World Bank's Prototype Carbon Fund (PCF). The PCF funds projects that produce high quality greenhouse gas emission reductions for the purposes of the Kyoto Protocol. In 2000, Norway paid USD 0.8 million to the PCF. These are not ODA funds.

Nordic Environment Finance Corporation

In 1999 and 2000, Norway contributed USD 0.73 million (non-ODA) 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. NEFCO now plans to set up a financing facility for projects based on joint implementation, and the Baltic Sea Region will become a Testing Ground for JI.

1 Norway usually gives its contributions in NOK. However, to comply with UNFCCC regulations/guidelines, we need to convert to USD.

Table 8.1 Financial contributions to the Global Environment Facility (GEF) and other climate change funds, projects and activities. Source: Ministry of Foreign Affairs

	Financial contributions (million USD)			
	1997	1998	1999	2000
Global Environment Facility (GEF)[1]	6.58	7.825	7.825	7.825
Financing of climate change and other environmental related projects (non-ODA)	1.26	5.91	9.49	5.37
Nordic Environment Finance Corporation (NEFCO)			0.39	0.34
Prototype Carbon Fund (PCF)				0.80

1 Contributions to GEF in total, 65% are reported as ODA.

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

Activities Implemented Jointly (AIJ)

Public financing for AIJ projects is additional to development assistance allocations. In the period 1997–2000, the Norwegian government contributed a total of NOK 187 million/USD 22 million in addition to the development assistance allocations for climate change and other environment-related projects (see table 8.1). Norway's allocations to AIJ projects have been channelled through our joint AIJ programme with the World Bank and bilaterally.

The pilot phase for Activities Implemented Jointly (AIJ) was established under the Convention on Climate Change in 1995. The aim was to raise awareness of project-based international cooperation as a means of reducing global emissions of greenhouse gases (GHGs). The co-financing arrangements involved in AIJ projects make 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, but energy projects have dominated. In total, Norway has allocated approximately USD 17.5 million to AIJ projects, which are described below.

Norway-World Bank AIJ Programme

Integrated agricultural demand-side management, India. The Norwegian government has allocated USD 4.6 million to a World Bank energy efficiency project in the agricultural sector in India (including conversion from low voltage to high voltage feeders, automated load control and direct metering and replacement of pumps). An agreement between Norway and India was finalized and signed in June 1998.

Energy efficiency in charcoal production, Burkina Faso. Norway is also co-financing a World Bank project in Burkina Faso, which seeks to increase the efficiency of charcoal production, develop more sustainable forest management and introduce solar energy for household lighting and the operation of waterpumps. The project in Burkina Faso is the first AIJ project to take place in Africa. Norway has allocated USD 2.4 million.

Introduction of energy efficient light bulbs, Mexico. The GEF and Norway co-financed a World Bank energy efficiency project in Mexico, providing USD 10 million and USD 3 million respectively. CO_2 emissions were reduced by 20 000 tonnes in the period 1995–1997, and emissions of SO_2, NO_x and particulate matter were also reduced. The project reduced the costs of electricity and decreased the pressure for investments in new electricity capacity, and also contributed to transfer of know-how and capacity-building.

Fuel switch from coal to gas-fired boilers, Poland. Financial support of USD 1 million was provided for a project involving a fuel switch from coal to gas-fired boilers, CHP units and improvement of energy efficiency. The agreement with Poland was signed in 1994, and implementation started in 1996. The project is to be completed in September 2002.

Other bilateral AIJ projects

Fuel switch in boilers in the Slovak Republic. By converting fuel from coal to biomass in several small heaters, the aim is to reduce the emissions and waste from the forest industry at the same time. Norway contributed USD 0.15 million to the projects, which will reduce CO_2 emissions by 50 000 tonnes over the 15-year project period.

Energy efficiency in Shanxi, China. In October 1998, Norway became one of the first countries to sign a deal with China on an AIJ project. This project is designed to improve the energy efficiency of a coal-fired thermal power plant in Shanxi, Henan province. Norway has contributed USD 4.65 million over a three-year period.

Forest conservation and replanting in Costa Rica. The aims of the project are to improve the water quality of the river basin through forest management and to increase the energy efficiency of the hydropower plant below the dam/basin. Norway has contributed USD 1.7 million to the project, which started in 1997.

8.1.3 Other bilateral funding of projects related to climate change

Norway has funded a number of climate change and other environment-related projects. Including the AIJ projects, the total funding that not has been registered as Official Development Assistance (ODA) is USD 22 million for the years 1997-2000.

General technical assistance to Annex I parties with economies in transition has been provided with an emphasis on capacity-building and transfer of know-how and technology. Assistance to countries with economies in transition is provided in addition to Norwegian ODA. Norway has also supported a UNDP-GEF project called the National Communications Support Programme, which helps non-Annex I parties to prepare and submit national communications to the Convention. Norway has also provided USD 0.8 million in support of a UNITAR project to contribute towards a country-driven assessment of capacity-building needs of developing countries within the UNFCCC process. A number of capacity-building projects have been funded, for instance Tata Energy Research Institute's project to raise awareness of climate change and the Clean Development Mechanism in India. Norway has also contributed USD 90 000 to the *Climate Change Capacity Project – Africa*, run by the International Institute for Sustainable Development. The Institute, in cooperation with the Climate Change Knowledge Network, published "*On Behalf of My Delegation,…* A Survival Guide for Developing Country Climate Negotiators."

Norway has supported activities intended to assist Small Island Developing States (SIDS) in environmental negotiations through capacity-building activities, such as building up SIDSnet as a tool for joint action and giving it a stronger coordination function on behalf of the group. SIDSnet has received total funding of USD 160 000 for the years 1999 and 2000. Norway has also financed a SIDS coordinator through UNDESA by providing a total of USD 363 000 for the years 1999 and 2000.

8.2 Financial support (ODA) - Norwegian development cooperation

Norway's development assistance programme is expanding. From 1997 to 2000, annual contributions classified as Official Development Assistance (ODA) have increased from NOK 9 241 million (USD 1 306.7 million) to NOK 11 115 million (USD 1 263.6 million). Norwegian ODA is higher than the agreed United Nations target for official development assistance, which is 0.7 % of GNP. Norway's average ODA for the period 1997–2000 thus corresponds to about 0.87 % of GNP. Norway's development assistance budget is set to rise further over the next two years to a total of NOK 12 764 million and NOK 13 947 million for the financial years 2001 and 2002 respectively. The Norwegian government aims to raise ODA to 1 % of GNP during the present parliamentary period (2001–2005).

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

	1997	1998	1999	2000	Total/ Average
ODA (USD)[1]	1 306.66	1 321.86	1 369.79	1 263.56	5 261.87
ODA (NOK)	9 241.10	9 973.70	10 680.09	11 115.15	41 010.04
ODA %	0.86 %	0.91 %	0.91 %	0.80 %	0.87 %

1 Exchange rates:
1997: USD 1 = NOK 7.0723
1998: USD 1 = NOK 7.5452
1999: USD 1 = NOK 7.7969
2000: USD 1 = NOK 8.7967

Transfer of technology and know-how in order to promote development and energy availability/ efficiency constitutes a significant element of Norwegian ODA, and has significant environmental side effects that are consistent with promoting the Convention. Work is now under way to address recording of specific climate change-related activities. Currently, all statistical information is organized according to DAC sector codes, but in response to new directions from OECD/DAC, collection of data on ODA that is intended to fulfil the objectives of the UNFCCC has started. Tentative figures indicate that in 1998, 1999 and 2000, Norway contributed USD 175 million to activities where the principal or significant objectives were considered to be related to climate change (see table 8.3). However, funding is registered at the time an agreement enters into force, and the statistics do not reflect the actual payments, which may take place later.

Table 8.3 Bilateral ODA funding of new climate change-related activities (USD million). Source: NORAD

	1997	1998	1999	2000	Total
Significant objective	N/A.	12.42	3.72	1.11	17.25
Principal objective	N/A.	49.57	67.46	40.82	157.86
Total	N/A.	61.99	71.18	41.93	175.11

8.2.1 Strategy for Norwegian development cooperation

The Norwegian Agency for Development Cooperation (NORAD) channels most of the registered financial resources used in environmental assistance. The Norwegian strategy for environmental assistance in development cooperation is based on a white paper entitled "A Changing World" (Report No. 19 (1995-96) to the Storting) and the guidelines set out there and on following up the international commitments in Agenda 21. One of the objectives of Norwegian development assistance is to contribute to international cooperation in order to address the global challenges we are facing.

The main objective of NORAD's environmental assistance is to contribute to sound management of the global environment and biological diversity. Four areas have been given priority:

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

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

The environmental assistance aims to integrate environmental concerns into all Norwegian-supported development assistance as well as to establish environment-specific programmes. The environment-specific programmes focus primarily on enhancing the recipient country's capacity and willingness to integrate environmental concerns into its own development efforts.

8.3 Capacity-building, adaptation and technology transfer

8.3.1 Capacity-building

The main objective of the Norwegian Strategy for Environment in Development Cooperation for 1997-2005 is to contribute to sound management of the global environment and to biological diversity. Two of the areas to which the strategy gives high priority are the development of sustainable production systems and reduced air pollution.

Besides supporting recipient countries' efforts to implement international environmental commitments, one of the main principles of NORAD's development strategy is to improve the recipient countries' ability to themselves identify the measures necessary to promote sustainable development. This includes strengthening the countries' 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, and the development of legislation and standards.

In this context, NORAD supports the following activities relating to protection of the atmosphere:

- Capacity-building projects aiming at institutional and human resource development and improved decision-making in national environmental and energy authorities. Most of the capacity-building projects dealing with environmental/pollution authorities have a primarily local or regional focus, and do not deal directly with greenhouse gas emissions or depletion of the ozone layer. However, standards and technologies necessary to deal with local and regional pollution problems can often help reduce global and transboundary air pollution. Institutional strengthening of national energy authorities may contribute to the more efficient use of available energy resources.
- Identification/assessment of appropriate technologies and the introduction of cleaner production methods and industrial environmental standards. Provision of know-how and incentives for the transfer of technologies that are benign to the atmosphere.

8.3.2 Adaptation

Sustainable development that takes into account the environment, poverty abatement and economic development 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 channelled through its general contributions to multilateral development institutions, including the UNDP, see table 8.5.

NORAD supports the Global Change System for Analysis, Research and Training (START), a Pan-African regional network of universities and research institutions on environmental change research. The objectives of the programme are to:

- Support global change research at regional level
- Strengthen START fellowship/visiting scientist and guest lecturer programmes in the pan-African region
- Provide support for policy formulation
- Support the pan-African START operation.
- NORAD is providing USD 1 million in funding for a three-year programme that started in 2000.

Through the Norwegian Trust Fund for Environmentally and Socially Sustainable Development in the World Bank (NTFESSD), Norway has contributed USD 0.75 million to the Africa Environmental Risk Management Programme. This programme includes elements like capacity-building in strategic environmental assessments, reducing climate change impact and vulnerability, and environmental knowledge management and capacity-building in Africa. Norway has also provided co-funding (USD 73 000 in 2000) for the South Pacific Applied Geoscience Commission (SOPAC) work on an environmental vulnerability index (EVI). Norway is also funding projects such as the joint CICERO, IISD and TERI research project concerning vulnerability and climate change in India.

8.3.3 Technology transfer

NORAD contributes to the international transfer of energy-related technology by supporting investment in infrastructure and production capacity in the energy sector of recipient countries. Such investment support, which is normally done on a BOOT basis, is frequently supplemented by institutional and human resource development measures that improve the technological expertise of the recipient. NORAD supports investments in energy technology that are given political priority by the recipient country and that are economically viable and competitive. 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 developments in particular, but also to solar energy and other renewable energy technologies, and this helps to reduce emissions of greenhouse gases. In the period 1997 – 2000, between 3.5 % and 7 % of total ODA has been earmarked for energy projects (Ministry of Foreign Affairs 2001). Table 8.4 illustrates Norwegian bilateral funding of energy projects for the years 1999 and 2000 for each relevant DAC sub-sector.

The Norwegian government considers the financial mechanism of GEF and the transfer of climate-friendly technology to be essential to the implementation of the Convention. In addition, Norway voluntarily supports a number of International Energy Agency (IEA) projects that aim to transfer environmentally sound and climate friendly energy technologies.

Norway has supported the development of the IEA's Energy and Environmental Technologies Information

Table 8.4 Bilateral ODA funding of energy projects (USD million). Source: NORAD

Selected relevant DAC sub-sectors from DAC Main sector 410 General Environmental Protection	1999	2000
10 Energy policy and management	9.71	6.87
20 Power generation/non-renewable sources	0.08	0.07
30 Power generation/renewable sources	4.81	4.27
40 Transmission/distribution of electricity	36.70	32.53
65 Hydroelectric power plants	11.85	10.50
67 Solar energy		0.04
81 Education and training	0.33	0.29
82 Research	0.24	0.22
Total General Environmental Protection	**63.72**	**54.78**

Centres (EETIC). EETIC is an umbrella Implementing Agreement that came into being in 1996 with the merger of the Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET) and the Greenhouse Gas Technology Information Exchange (GREENTIE). CADDET disseminates high quality, up-to-date information that assists decision-makers in evaluating energy efficiency and renewable energy technologies. GREENTIE's objective is to improve awareness of and facilitate access to suppliers and experts of "clean technologies", particularly technologies that help mitigate greenhouse gas emissions. The database and all of CADDET's and GREENTIE's publications are freely accessible from their website. The databases are intended to help developing countries to locate information on new technologies and identify equipment suppliers and centres of excellence.

Norway has actively participated in and provided financial supported for the Climate Technology Initiative (CTI) that was launched by the OECD and the IEA countries at the First Conference of Parties to the UNFCCC in Berlin in 1995. The mission of the CTI is to foster international cooperation to accelerate the development and diffusion of climate-friendly technologies and practices for all activities and sectors and for all greenhouse gases. The Initiative also works closely with the Secretariat to the UNFCCC with the aim of accelerating technology transfer.

Norway has participated in the IEA's Greenhouse Gases R&D Programme. The Greenhouse Gases R&D Programme has an important role to play in responding to the challenge posed by climate change through developing and demonstrating opportunities to reduce emissions from the use of fossil fuels. The aims of the Greenhouse Gases R&D Programme are to evaluate technologies for reducing emissions of greenhouse gases from fossil fuel use, to disseminate information, to prepare research, development and demonstration proposals and, where appropriate, to conduct R&D projects. Activity under the programme initially focused on the capture and disposal of carbon dioxide from power stations and has since broadened to explore a range of opportunities for reducing emissions of greenhouse gases (for example, additional sources of carbon dioxide, other greenhouse gases and comparison with alternative mitigation options).

Norway has supported the IEA India Energy Data and Indicators project. This project creates and exploits energy indicators to better understand how technology and structural change are affecting energy use and carbon emissions in India.

Norway has been involved in work to improve the quality of IEA Energy Statistics for non-OECD members and improve transparency as regards information on oil, gas, coal, electricity and renewables.

Norway has been involved in the Energy Technology Perspectives programme of the IEA. This focuses on assessing how new technologies on the supply and demand side can affect the long-term development of the global energy system. On the supply side, particular attention is being paid to the evolution of costs for oil and gas production technologies. The project is designed to give policy makers better insight into which technology options may be most

cost-effective in reducing greenhouse gases and achieving other energy policy goals, including greater energy security. The work is closely coordinated with the development of IEA World Energy Outlook.

Table 8.5 Financial support to multilateral institutions and programmes (USD million). Sources: Ministry of foreign Affairs, NORAD

Institution or programme	**Contributions**			
	1997	**1998**	**1999**	**2000**
Multilateral institutions				
World Bank	81.74	59.84	54.51	33.44
International Finance Corporation	1.60			
African Development Bank			0.88	0.93
Asian Development Bank	0.36	0.37	0.37	
European Bank for Reconstruction and Development (non-ODA)	0	3.71	3.72	3.41
Inter-American Development Bank (IDB)	0.70	0.76	0.73	0.65
United Nations Development Programme	79.75	80.25	76.44	90.84
– specific programmes – of which:				
– UNCDF	4.24	3.98	3.85	1.65
– UNIFEM	1.41	2.05	2.05	2.00
United Nations Environment Programme		2.04	1.03	0.66
– Montreal Protocol				
UNFCCC			0.034	0.06
– Supplementary Fund				0.053
Other multilateral scientific, technological and training programmes:				
Asian Development Bank Special Fund	5.51	5.16	5.00	4.43
IDB Special Fund	0.93	0.87	0.70	0.62
IDB	0.70	0.76	0.73	0.65
African Development fund	29.29	34.12	24.14	34.52
Nordic Development fund	12.69	6.37	9.82	8.12
Total multilateral assistance	**390.25**	**371.30**	**363.16**	**329.82**

9. Education, training and public awareness

The Climate Convention refers directly to education, training and public awareness, and these issues have been important elements of 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 cooperation with government agencies, professional and educational bodies and the private sector.

9.1 Education

In both primary and secondary school, issues related to energy, energy use and climate change are integrated into the curricula to promote an early awareness of the adverse effects of climate change. Some examples from the curricula are:

- 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 through 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 also 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.

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

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 organized as a cooperation 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 network's website. The network functions as a meeting ground for students, teachers, the environmental authorities, research institutions and voluntary organizations. The institutions offer professional support and ideas for teachers on how to organize environmental education. Since 1990 many schools have implemented energy efficiency programmes, and the results have been good.

Several general university and technical college courses at various levels in both the natural and the social sciences are relevant to climate change. This applies particularly to courses in geophysics, oceanography and chemistry. The University of Oslo holds an interdisciplinary course at first-degree level, called Weather and Climate, which is attended by 50-100 students annually. Every year, a number of students take doctorates on atmospheric chemistry and other themes related to climate and climate change. In 1998, the Norwegian University of Science and Technology in Trondheim established a programme focusing on energy, energy efficiency and the development of energy-efficient technologies.

The Research Council of Norway supports several programmes that focus on climate change. The Research Council has also emphasized recruitment to the area and has funded 10 doctoral students and seven post-doctoral students through the research programme "Changes in the climate and ozone layer" in 2000.

9.2 Information

The Ministry of the Environment uses all available channels and many types of information activities to provide different target groups with relevant information. In recent years, it has built up extensive information resources on the Internet. News articles, white papers, reports, press releases and other relevant information are published on its website (www.miljo.no) on a daily basis.

Another website that focuses on climate change is State of the Environment Norway (www.mistin.no). The content of the website is produced by the environmental authorities, and the Norwegian Pollution Control Authority has the overall editorial responsibility. State of the Environment Norway aims to provide the public with the latest information about the state of the environment and environmental trends. The service covers nine main topics, further divided into subtopics. Each topic is presented in a simple and easy-to-follow way and provides access to more detailed scientific presentations. Further information is given on legislation and international agreements, environmental targets, references and relevant links.

The biannual white paper on the government's environmental policy and the state of the environment presents the Norwegian government's main aims and strategies in all key areas of environmental policy. In addition, the white paper gives an updated review of emissions of pollutants, the state of the environment and existing and planned measures. The publication of the white paper is followed by a broad debate about the government's environmental policy in the Storting.

Every efforts is made to ensure that the white paper is readily accessible to the general public and politicians. An English summary is made available on the Internet immediately after publication. The publication is free of charge. Since it was first published in 1999, the white paper has thus become a key tool that gives central decision-makers, business and industry, NGOs and the general public relevant information on the state of the environment and the government's environmental policy.

Statistics Norway compiles an annual overview of statistics on important natural resources and the state of the environment. The agency has developed methods and models for analysing trends in the extraction and use of natural resources and changes in the natural environment, focusing particularly on relationships between these factors and other economic developments. The annual publication *Natural Resources and the Environment* is widely used, and presents the environmental situation in an easily understandable way, at the same time as it includes considerable detail on a wide range of topics. *Natural Resources and the Environment* can be found at: www.ssb.no/english/subjects/01/sa_nrm/.

As an institution with a specific focus on climate change, CICERO (the Center for International Climate and Environmental Research 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. It publishes a regular newsletter, CICERONE, circulated among ministries, directorates, the business sector, research institutions and schools. The newsletter includes reports on the development of international climate policy as well as research findings. CICERO has also produced many publications related to the IPCC reports. CICERONE also provides information to the public during major events in the international climate negotiations.

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 organized to provide information on development trends in international climate research and policies, and to improve the dialogue between the various parties involved. The Ministry of the Environment contributes a large proportion of the funding for CICERO's information activities.

9.3 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 have the lowest environmental impact throughout their life cycles. Product categories are carefully defined so that all products that have direct "equivalence of use", as seen through the eyes of the consumer, are included in the same category. 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 Swan Label is also a member of the Global Ecolabelling Network (GEN), which is a non-profit association of ecolabelling organizations from around the world.

The Swan is a widely recognized eco-label in the Norwegian market. As many as 82 % of those asked in 1998 knew that the Swan was Norway's official eco-label, and almost equally many said that they preferred Swan-labelled products to those without the label.

Together with the other countries in the European Economic Area, Norway has introduced a system of energy labelling of household appliances. In 1996, regulations relating to energy labelling of refrigerators, freezers and their combinations, tumble dryers and washing machines were introduced in Norway. Further types of household appliances will be energy labelled in the future, and combined washer-dryers 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.

9.4 Networks and information centres

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.

Energy efficiency centres have now been established in every county in Norway. The centres provide customers with basic analyses and information on state-funded energy efficiency programmes, energy use and prices. The centres are also involved in activities such as teaching school pupils and arranging courses for industry on how to reduce energy use in industry. An energy-efficiency magazine ("Switch") is published twice a year and distributed free of charge to every household in Oslo and some other regions of Norway.

References

Alfsen, Knut (2001): *Klimaet er i endring!*, CICERO Policy note 2001:02: www.cicero.uio.no/publications/searchpub.asp?lang=no&viewyear=2001

Bruvoll, Annegrete and Bodil M. Larsen (2002): *Norwegian Emissions of Greenhouse Gases 1990–1999: Effects of Carbon Taxes,* Report Statistics Norway.

ECON (1997): *CO_2-avgiftens betydning for CO_2-utslipp på norsk sokkel,* ECON Report 50/97.

Haukås, Hans T. (2000): "Oppdatering av tiltaks-analyse for HFK." Report from Hans T. Haukås AS commissioned by the Norwegian Pollution Control Authority.

IPCC (1996): *Climate Change 1995 – The Science of Climate Change: summary for Policymakers and Technical Summary of the Working Group I Report*, Intergovernmental Panel on Climate Change, Cambridge University Press.

IPCC (2001): *Third Assessment Report. Summary for Policymakers.* http://www.grida.no/climate/ipcc_tar/syr/index.htm Intergovernmental Panel on Climate Change.

Larsen, Bodil M. and Runa Nesbakken (1995): *Norwegian CO_2 emissions 1987-1993. A study of the effects of the CO_2 tax.* Report 95/14, Statistics Norway.

Ministry of the Environment (1997): *Norway's second national communication under the Framework Convention on Climate Change, April 1997.* www.dep.no/md/engelsk/publ/rapporter/index-b-n-a.html

Ministry of Foreign Affairs (2001): "Energi og utvikling" (Energy and development), Report from a working group submitted to the Minister of International Development on 26 November 2001.

Ministry of Petroleum and Energy (2000): *The energy sector and water resources in Norway.* www.dep.no/oed/engelsk/p10002017/index-b-n-a.html

Ministry of Petroleum and Energy (2001): *Environment 2001 The Norwegian Petroleum Sector.* www.dep.no/oed/engelsk/p10002017/index-b-n-a.html

Ministry of Petroleum and Energy (2001): *Fact Sheet 2001 Norwegian Petroleum Activity.* www.dep.no/oed/engelsk/p10002017/index-b-n-a.html

Official Norwegian Report 1998:11, *Energi- og kraftbalansen mot 2020:* www.dep.no/oed/norsk/publ/utredninger/index-b-n-a.html

Official Norwegian Report 2000:1, *A Quota System for Greenhouse Gases. A policy instrument for fulfilling Norway's emission reduction commitments under the Kyoto protocol,* Report from the Quota Commission: www.dep.no/md/norsk/publ/utredninger/nou/022005-024001/index-dok000-b-n-a.html

Norwegian Pollution Control Authority (2000): *Reduksjon av klimagassutslipp i Norge. En tiltaksanalyse.* www.sft.no/publikasjoner/get.cfm?1=1&kat=106

Norwegian Pollution Control Authority (2001): *State of the Environment.* www.miljostatus.no/

Norwegian Pollution Control Authority (2001): *Greenhouse Gas Emissions in Norway 1990-1999: Reporting According to the UNFCCC Guidelines.* www.sft.no/english/publications/get.cfm?1=1&kat=106&sprak=en

Norwegian Pollution Control Authority (2001): *Reduksjon i utslippene av HFK, PFK og SF_6. Utredning av avgift som virkemiddel.* SFT-report 1754/2001. www.sft.no/publikasjoner/luft/1754/ta1754.htm

Norwegian Pollution Control Authority (2001): *Estimating the net emission of CO_2 from harvested wood products. A comparison between different approaches*. SFT-report 1831/2001.

Report No. 24 (2000–2001) to the Storting: *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's Environmental Policy and the State of the Environment in Norway), Ministry of the Environment. www.dep.no/md/engelsk/publ/stmeld/index-b-n-a.html

Report No. 54 (2000–2001) to the Storting: *Norsk klimapolitikk.* (Norwegian Climate Policy), Ministry of the Environment. www.dep.no/md/engelsk/publ/stmeld/index-b-n-a.html

Report No. 15 (2001–2002) to the Storting: *Tilleggsmelding til St.meld. nr. 54 (2000–2001) Norsk klimapolitikk* (Amendment to Report No. 54 (2000–2001) to the Storting on Norwegian Climate Policy), Ministry of the Environment. http://www.dep.no/md/engelsk/publ/stmeld/index-b-n-a.html

SINTEF (2000): "Utredning av tiltak for å redusere utslippet av SF_6, og konsekvenser av regulering", Report nr. TR F5193.

SSB/Statistics Norway (2001): *Natural Resources and the Environment 2001.* www.ssb.no/english/subjects/01/sa_nrm/

Unander, F. with H. Birkeland and L.Schipper (2000): *Trends in Norwegian stationary energy use: an international perspective.* International Energy Agency.

Annexes

Annex A. Key assumptions for projections of emissions

This annex gives a description of the model used and the assumptions made in connection with the projection of future emissions of greenhouse gases presented in chapter 5.2 and 5.3.

Emission coefficients by source and sector are calibrated to a base year, and are projected by taking into account environmental instruments or policies that have already been implemented or decided. The projections presented therefore represent future developments based on current economic and environmental policies and future economic developments. The projections depend on many uncertain assumptions concerning key variables and parameters.

The projections are based on measures implemented in 2001, i.e. a CO_2 tax of NOK 0.72 per litre for petrol, NOK 0.48 per litre for mineral oil, NOK 0.48 per kg for coal and coke for energy purposes, NOK 0.72 per litre for use of oil in the North Sea and NOK 0.72 per Sm^3 for use of natural gas in the North Sea.

Trends in the petroleum market are highly uncertain. The projections are based on a technical assumption about the future price of crude oil. It assumed that this will drift down from the high level in 2001, but stabilize at NOK 135 per barrel from 2010, measured in 2001 prices. Changes in the prices of oil and natural gas are expected to influence Norwegian CO_2 emissions in several ways. In addition to their impact on the domestic use of oil products, they will affect the level of activity in the petroleum industry in the long run and thus emissions from this industry. It is assumed that Norwegian petroleum production will from 226 million Sm^3 oil equivalents (Sm^3 o.e.) in 1999 to about 279 million Sm^3 o.e. in 2002. After 2002, petroleum production is expected to fall as a result of reduced oil extraction.

Some additional assumptions are listed below:

- The average annual rate of GDP growth in trading partner countries is assumed to be 2 % in the period 2000–2010. However, assumptions about international economic growth are not assumed to be decisive for long-term projections. Research based on historical data from industrialized countries indicates that it is a country's ability to utilize the resources at its disposal that determines growth in the long term.
- The annual increase in consumer prices in trading partner countries is assumed to be 1.75 %.
- Growth in international tradables is expected to be 1.25 % per annum.
- The international interest rate is assumed to be 4 % in real terms.
- The rate of autonomous energy efficiency improvement varies between sectors, but is on average assumed to be about 1 % per year.
- The level of direct and indirect taxes will remain broadly unchanged.
- The household savings rate will be roughly unchanged.

Table A.1 Real GDP and population in Norway. Percentage annual growth

	1999 level [1]	**1999–2010**
GDP (volume)	1193	1,7
Population	4.5	0.5

1 GDP in billion 1999 NOK. Population in millions.

Table A.2 Supply and use of electricity [1]. TWh

	1999	2010
Net domestic use		
Of which:	111	124
Excluding energy-intensive industry	80	92
+Net export	2	-1
+Power losses	10	10
= Production	123	133
Hydropower	122	124
Other types of power [2]	1	9

1 Figures may not add up because of rounding errors.

2 The projections are based on the assumption that 6 TWh power from gas-fired plants and 3 TWh wind power will be supplied in 2010.

Table A.3 Net domestic use of transport and heating oil [1]. 1000 tonnes

	1995	2010
Transport oil	4747	5861
Heating oil	2186	2794

2 Figures include use in energy sectors and ocean transport.

Table A.4 Supply and use of petrol and autodiesel. 1000 tonnes

	1995	2010
Total supply	12387	16086
Production	11049	14689
Import	1338	1397
Export	7161	10098
Statistical differences,		
changes in inventories	127	127
Net domestic use	5099	5861
Energy-intensive industry	17	30
Rest of the economy	5082	5831

Table A.5 Electricity per unit of production [1]. GWh/million 1995 NOK

	1995	2010
Total	0.113	0.098
Energy-intensive industry	4.307	2.872
Rest of the economy	0.081	0.075

1 Value added

Table A.6 Heating oil per unit of production [1]. 1000 tonnes/million 1995 NOK

	1995	2010
Total	2.35	2.21
Energy-intensive industry	6.37	6.74
Rest of the economy	2.28	2.09

1 Value added

Table A.7 Petrol and autodiesel per unit of production [1]. 1000 tonnes/million 1992 NOK

	1995	2010
Total	5.49	4.64
Energy-intensive industry	0.99	0.93
Rest of the economy	5.57	4.74

1 Value added

Annex B. Methodology – projections

B.1 CO_2 emissions

The projections of CO_2 emissions are based on a macroeconomic model of the Norwegian economy called MSG (Multi-Sectoral Growth). Various versions of the model, which is being continuously developed by Statistics Norway, have been used in the Ministry of Finance since the 1960s.

The MSG is a general equilibrium model. The main determinants of growth are capital accumulation, labour supply, the availability of natural resources and the rate of technological progress. As all resources are fully utilized, the model is unsuitable for analysing short-term adjustment problems like unemployment or extensive downscaling of specific industries due to changes in policy or international prices.

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 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.

The MSG is a model of heterogeneous industries. Producers enjoy some market power at home, 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.

It should be emphasized that adjustment lags are not taken into account in MSG. A substantial change in policy might require considerable time for adjustment and large costs could be incurred. Simulation results should therefore be considered realistic only after allowing for a certain period of adjustment.

Estimates of the following main assumptions are provided by the model operator:

- Labour supply
- Rate of technological progress in the various production sectors
- Production, real investments and prices in the petroleum sector
- World market prices
- The rate of return on capital
- The current account and financial balances of the government sector and households
- Demographic estimates including the number of pensioners
- Tax rates

B.2 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, where harvested wood is counted as emissions in the year the harvest takes place. The national forest inventory is the underlying basis 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, combined with annual figures for felling. The figures cover biomass above and below ground, including tops and branches, bark, stumps and coarse roots. The carbon content of forest soils is not included in these estimates.

The projections of CO_2 uptake in Norwegian forests are also based 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 standing stock is growing and there are more trees in older age-classes. But for the period up to 2010, there are few indications that the depletion rate will change considerably. Up to 2010 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 5.4 are based on the assumption that the current level of harvesting will continue.

Annex C. Summary of policies and measures and their effects

Policies and measures – supplementary table

Table C.1 Cross-sectoral measures.

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						1995	2000	2005
CO_2 tax	Oil and gas production. Consumption of mineral oil, petrol, coal and coke.	CO_2	Economic, fiscal	Implemented in 1991.	Government	0.6 >0	2.6 0.8	2.6 >0.8
Petroleum Act	Oil and gas production. Permit required for flaring.	CO_2	Regulatory		Government	n.e.	n.e.	n.e.
Pollution Control Act/IPCC Directive	Industrial activities, oil, gas, energy production. BAT and energy efficiency requirements in industrial installations.	Several/ all	Regulatory	IPPC Directive applies to new entities. For existing entities the Directive will apply from 2007.	Government	n.e.	n.e.	n.e.
Emissions trading	Most major emission sources from 2008. The proposed system would then cover 80-90% of total GHG emissions. A narrower system from 2005.	All	Economic, market	Implementation from 2008 proposed in Report No. 54 (2000-2001) to the Storting. Implementation with narrower coverage from 2005 proposed in Report No. 15 (2001-2002) to the Storting .	Government	n.a.	n.a.	1.6

Table C.2 Energy and transformation industries.

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						1995	2000	2005
Electricity tax	Electricity consumption. Tax rate in January 2001 NOK 0.113 per kWh	CO_2	Economic, fiscal	Implemented	Government	n.e.	n.e.	n.e.
Support for renewable energy	Investment grants and tax exemptions for renewable energy production	CO_2	Economic, subsidies	Implemented	Government	n.e.		
CO_2-free gas-fired power production	Government wishes to establish pilot plant for CO_2-free gas-fired power production around 2005.	CO_2	Research, development .	Proposed in white paper.	Government, industry.			
Energy efficiency	Private and public energy use. State funding for energy efficiency to be coordinated through Enova.	CO_2	Research, information.	Enova has been operative from 1 January 2002.	Enova and regional energy efficiency centres.			

Table C.3 The petroleum sector.

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						1995	2000	2005
CO_2 tax	Flaring and burning of natural gas and diesel in the petroleum sector.	CO_2	Economic	Implemented	Government		1.6	1.6
Pollution Control Act	NMVOC regulation offshore	CO_2	Regulatory	Implemented	Government			0.25
Pollution Control Act	NMVOC regulation onshore – the Sture terminal	CO_2	Regulatory	Implemented	Government		0.02	<0.2
Carbon reinjection	Deposition of carbon at Sleipner	CO_2		Implemented			1.0	1.0

Table C.4 Transport.

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						1995	2000	2005
CO_2 tax, petrol and diesel taxes	Domestic transport.	CO_2	Economic	Implemented	Government	n.e.	n.e.	n.e.
Exemption from purchase and investment tax for alternative fuels.	Purchase tax differentiated according to car weight and engine output. Electric cars exempted from purchase and investment tax.	CO_2	Economic, research and development	Exemption from the purchase tax implemented. Investment tax will be removed from February 2002.	Government			
Exemption of natural gas from CO_2 tax.	Use of natural gas in buses, ferries and supply ships.	CO_2	Research and development	Natural gas used in buses in certain towns. Pilot project on natural gas in ferries started in February 2000. Supply ships will be in operation from 2003.	Government			

Table C.5 Industry.

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						1995	2000	2005
Agreement	Aluminium industry		Voluntary/ negotiated agreements	Agreement reached in 1997.	Government and aluminium industry	0 – 1.6[1]	0.7 – 3[1]	0.7 - 3[1]
Agreements	Industrial activity exempted from the CO_2 tax.	PFC, HFC and SF_6	Voluntary/ negotiated agreements	Implemented March 2002	Government and branches of industry or individual companies			13%
Production improvements	Improved routines and plant maintenance in magnesium production	SF_6	Voluntary	Implemented	Industry	1.0	1.5	..
SF_6 recovery facility	Collection, recycling and destruction of electric equipment.	SF_6	Administrative	Implemented.	Facility (RENAS) established in June 2001.			
Energy use	Greater use of bioenegy and alternative fuels in cement production	CO_2	Voluntary	Implemented	Industry	..	<0.5	..
Production improvements	Technical changes in the production of nitric acid	N_2O	Voluntary	Implemented	Industry	..	0.8	..

Table C.6 Waste management.

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 equivalent)		
						1995	2000	2005
Pollution Control Act (licensing requirements)	Licences include requirements for collection and combustion of methane.	Methane	Regulatory	Implemented	Government	0.25	0.5	>0.5
Tax on final waste treatment	The tax puts a price on emissions from final waste treatment.	Methane	Economic, fiscal.	Implemented in January 1999.	Government			
Agreement with industry	Waste minimization	Methane	Voluntary agreement	Implemented	Government and industry		0.6	>0.6
EU Directive on landfills	Requirements to reduce biodegradable municipal waste and collect methane.	Methane	Regulatory	Under implementation.	Government, EU Commission			

Annex D. Bilateral and regional financial contributions

Table D.1 Norwegian ODA for general environmental protection registered according to OECD/DAC specific main sectors in 2000 (in 1000 NOK). Source: NORAD.

	GENERAL ENVIROMENTAL PROTECTION DAC Main sector 410							Total 410
Country	**10 Environmental policy and administrative management**	**20 Biosphere protection**	**30 Biodiversity**	**40 Site preservation**	**50 Flood prevention/ control**	**81 Environmental education and training**	**82 Environmental research**	
Africa unspecified	3 618		66				2 733	6 417
Angola	640							640
Azerbaijan				690				690
Asia unspecified	8 774		25 835	3 500		801	1 000	39 910
Bangladesh			2 681			170		2 851
Botswana	4 036					1 044		5 080
Brazil	483		1 806			560		2 849
Central America unspec.	27		6 000					6 027
China	19 838	220		1 754		1 250	8 740	31 802
Costa Rica	- 168						563	395
El Salvador	1 000							1 000
Eritrea			5					5
Ethiopia	1 532						527	2 059
Europe unspecified	1 000							1 000
Global unspecified	102 604	850	45			1 761	1 536	106 797
Guatemala						484		484
India	1 125	152		1 247	553	6 166		9 242
Indonesia	3 438					4 086	392	7 916
Jamaica				1 500				1 500
Jordan	660							660
Laos				1 050				1 050
Madagascar			1 099			1 200		2 299
Maldives	90							90
Mali	1 710							1 710
Mozambique	588		120				388	1 096
Namibia	2 160							2 160
Nepal	129						1 156	1 285
Nicaragua	76							76
Pakistan	3 035	3 200	325	887		171	84	7 702
Papua New Guinea	191		1 315					1 506
Paraguay						85		85
Philippines	2 000							2 000
S. of Sahara unspec.			2 000	237				2 237
South Africa	5 246	29	562	940			653	7 430
Sri Lanka	2 656	751	2 167			106	- 1	5 680
Tanzania	4 304	733	9 159			13 241		27 437
Thailand							367	367
Uganda	356							356
Venezuela					860			860
Vietnam	2 640				2 701	3 311	3 804	12 456
Zambia	9 506		12 610			1 130		23 246
Zimbabwe	1 415		443			615	540	3 014
Total	184 712	5 935	66 240	11 805	4 113	36 181	22 481	331 466

410 GENERAL ENVIRONMENTAL PROTECTION
Non-sector specific.

10 Environmental policy and administrative management
Environmental policy, laws, regulations and economic instruments; administrative institutions and practices; environmental and land use planning and decision-making procedures; seminars, meetings; miscellaneous conservation and protection measures not specified below.

20 Biosphere protection
Air pollution control, ozone layer preservation; marine pollution control.

30 Bio-diversity
Including natural reserves and actions in the surrounding areas; other measures to protect endangered or vulnerable species and their habitats (e.g. wetlands preservation).

40 Site preservation
Applies to unique cultural landscape; including sites/objects of historical archaeological, aesthetic, scientific or educational value.

50 Flood prevention/control
Floods from rivers or the sea; including seawater intrusion control and sea level rise related activities.

81 Environmental education and training

82 Environmental research

Table D.2 Norwegian ODA for general environmental protection registered according to OECD/DAC specific main sectors in 1999 (in 1000 NOK).

	GENERAL ENVIROMENTAL PROTECTION DAC Main sector 410							Total 410
Country	**10 Environmental policy and administrative management**	**20 Biosphere protection**	**30 Biodiversity**	**40 Site preservation**	**50 Flood prevention/ control**	**81 Environmental education and training**	**82 Environmental research**	
Africa unspecified	7 020					50	2 483	9 553
America unspecified	300					2 000		2 300
Angola	60							60
Asia unspecified	2 676		21 279				1 000	24 955
Azerbaijan				250				250
Bangladesh	104		1 606			27		1 738
Botswana	2 139					586		2 725
Brazil	467		1 940			591		2 998
Burkina Faso	6 000							6 000
Central America unspec.	3 363		4 267					7 630
China	17 497			453		1 095	4 261	23 306
Costa Rica	336		66				432	833
Croatia	1 000							1 000
El Salvador	1 000							1 000
Ethiopia	10 118						811	10 929
Global unspecified	63 129	4 075				5 954	5 600	78 758
Guatemala						504		504
India	8 878	1 538	625	2 155	2 000	4 224		19 419
Indonesia	10 241		520			1 968		12 729
Laos	1 947			750				2 697
Madagascar	1		1 398			1 000		2 399
Mali	1 600					70		1 670
Mozambique	15 289						400	15 689
Namibia							2 430	2 430
Nepal							324	324
Nicaragua	240					146		386
Niger	6 000					110		6 110
Pakistan	1 600	3 770		1 078				6 448
Papua New Guinea			1 091					1 091
Paraguay						85		85
S. of Sahara unspec.			200				3 105	3 305
Sri Lanka	1 027	500	2 656	24		194	8	4 409
South Africa	2 098	1 188	2 880	1 160			3 602	10 928
Tanzania	7 160	546	6 250			7 863		21 819
Uganda	1 336							1 336
Vietnam	373				13 738	3 344	4 666	22 121
Zambia	4 789		22 009			1 098		27 896
Zimbabwe	13 355		490			798	500	15 143
Total	191 143	11 617	67 277	5 870	15 738	31 706	29 621	352 972

410 GENERAL ENVIRONMENTAL PROTECTION
Non-sector specific.

10 Environmental policy and administrative management
Environmental policy, laws, regulations and economic instruments; administrative institutions and practices; environmental and land use planning and decision-making procedures; seminars, meetings; miscellaneous conservation and protection measures.

20 Biosphere protection
Air pollution control, ozone layer preservation; marine pollution control.

30 Bio-diversity
Including natural reserves and actions in the surrounding areas; other measures to protect endangered or vulnerable species and their habitats (e.g. wetlands preservation).

40 Site preservation
Applies to unique cultural landscape; including sites/objects of historical archaeological, aesthetic, scientific or educational value.

50 Flood prevention/control
Floods from rivers or the sea; including seawater intrusion control and sea level rise related activities.

81 Environmental education and training

82 Environmental research
Including establishment of databases, inventories/accounts of physical and natural resources; environmental profiles and impact studies if not sector specific.

Annex E. Acronyms and abbreviations

ACIA	Arctic Climate Impact Assessment
AIJ	Activities Implemented Jointly
ARKTØK	Ecological Effects of Climate Change in Arctic Ecosystems
BAT	Best Available Techniques
C_2F_6	Hexafluoroethane
CCP	Carbon Capture Project
CDM	Clean Development Mechanism
CF_4	Tetrafluoromethane
CFC	Chlorofluorcarbon
CH_4	Methane
CICERO	Center for International Climate and Environmental Research
CO_2	Carbon Dioxide
EEA	European Economic Area
EIA	Environmental Impact Assessment
EU	European Union
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
IEA	International Energy Agency
IGRP	International Geosphere-Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
kWh	kilowatt-hour
N_2O	Nitrous Oxide
NDSC	Network for Detection of Stratospheric Change
NEFCO	Nordic Environment Finance Corporation
NILU	Norwegian Institute for Air Research
NIR	National Inventory Report
NMVOC	Non-Methane Volatile Organic Compound
NOClim	Norwegian Ocean Climate Project
NOK	Norwegian Kroner
NORAD	Norwegian Agency for Development Cooperation
NO_x	Nitrogen Oxides
NTFESSD	Norwegian Trust Fund for Environmentally and Socially Sustainable Development in the World Bank
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
OECD/DAC	OECD Development Assistance Committee
PCF	Prototype Carbon Fund
PFC	Perfluorcarbon
RegClim	Regional Climate Development under Global Warming
SF_6	Sulphur Hexafluoride
SO_2	Sulphur Dioxide
SOGE	System for Observation of Halogenated Greenhouse Gases in Europe
TWh	Terawatt-hour
UNDP	United Nation Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
USD	US Dollar
VAT	Value-Added Tax
VOC	Volatile Organic Compound
WCRP	World Climate Research Programme
WMO	World Meteorological Organization

Published by:
Royal Ministry of the Environment
2002

Additional copies may be ordered from:
Norwegian Pollution Control Authority (SFT)
P O Box 8100 Dep
N-0032 Oslo
Norway

Telephone: + 47 22 57 34 00
Fax: + 47 22 67 67 06
e-mail: postmottak@sft.no
http://www.sft.no/skjema.html

Publication number: T-1386 E
ISBN 82-457-0341-9

Cover design:
Skomsøy Grønli as

Printed by:
www.kursiv.no
06/2002 – 1000

Printed on paper with the
Nordic Environment Label