Report

Norway`s Fifth National Communication under the Framework Convention on Climate Change

Status report as of December 2009

NORWEGIAN MINISTRY OF
THE ENVIRONMENT

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1. EXECUTIVE SUMMARY

This report is Norway's fifth national communication on national circumstances, policies and measures related to climate change under the Framework Convention on Climate Change (UNFCCC). The first, second, third and fourth national communications were submitted in 1994, 1997, 2002 and 2006 respectively. The latest national greenhouse gas inventory report was submitted in April 2009. Norway ratified the UNFCCC on 9 July 1993. Norway ratified the Kyoto Protocol on 30 May 2002 and became a Party when the Protocol entered into force on 16 February 2005.

1.1 National circumstances

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

Most of Norway has a maritime climate with mild winters and cool summers. Because of the influence of the North Atlantic Ocean, Norway has a much warmer climate than its latitudinal position would indicate. Over the period 1900-2008, the annual mean temperature in Norway has increased by about 0.9° C.

Agricultural areas account for only 3 per cent of the mainland, while about 37 per cent is covered by forest. With a total area of almost 324 000 km^2 and only 4.8 million inhabitants, Norway has the lowest population density in Europe after Iceland. In 2009, almost 79 per cent of Norway's population lives in urban settlements.

Norway's energy and industrial profile is quite different from that of other developed countries. Half of all energy use is from renewables, and nearly all electricity is hydropower, which generates virtually no greenhouse gas emissions. However, there is only limited potential for further development of hydropower production. There is an energy-intensive industrial cluster based on the availability of hydropower, which generates substantial process-related emissions. Over the past thirty to forty years, Norway has developed an oil and gas sector which today is the country's largest industry, and is responsible for about one fourth of the country's greenhouse gas emissions. Norway's decentralized settlement pattern gives rise to a relatively high demand for transport. In addition, the Norwegian economy is largely based on the extraction of raw materials and export of goods, which means that there is a large volume of goods transport. Nevertheless, because of the amount of renewable energy used in Norway, per capita emissions of CO^2 are lower than the OECD average.

From 2003 to 2007, annual growth in mainland gross domestic product (GDP) (excluding offshore activities) averaged 5 per cent. After the business cycle peak at the turn of the year 2007/2008, growth in the Norwegian economy slowed sharply in 2008, falling to 2.6 per cent. The financial crisis that developed into a full-blown global economic crisis in autumn 2008 also affected Norway, amplifying the downturn that was already underway. However, the impact of the financial crisis has so far been less severe in Norway than in many other countries.

Emission intensity[1] in Norway has on average fallen by about 2.5 per cent per year from 1990 to 2008. A strong downward trend in the emission intensity for the mainland economy has to some extent been counteracted by increased emission intensity in the petroleum sector.

1.2 Greenhouse gas inventory information

Norway's national greenhouse gas inventory covers emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorcarbons (PFCs), sulphur hexafluoride (SF_6) and hydrofluorcarbons (HFCs). Emission figures for the period 1990-2007 are shown in table 1.1.

1 *Emissions per unit of GDP*

Table 1.1 Emissions of greenhouse gases in Norway during the period 1990-2007. Units: CO2 and CO2 eqvivalents in Mtonnes (Mt), CH4 and N2O in ktonnes (kt) and other gases in tonnes (t).

Year	CO_2 Mt	CH_4 kt	N_2O kt	PFC t	SF_6 t	HFC[1] t	Total CO2-eq Mt
1990	34.8	219.7	15.2	503.6	92	0.1	49.7
1991	33.4	222	14.8	447.5	87	0.4	47.7
1992	34.2	225	12.9	343	29.5	0.9	45.9
1993	35.9	228.3	13.7	344.9	30.9	2.6	48
1994	37.9	231.8	14	305.2	36.7	6.9	50
1995	37.8	230.8	14.2	301.4	25.4	15.1	49.7
1996	40.9	231.8	14.4	274.7	24	27.6	52.7
1997	41	232.8	14.4	245	24.3	43.8	52.6
1998	41.1	226.9	14.7	223.1	30.4	67.1	52.8
1999	42	220.1	15.3	208.5	36.6	94.7	53.8
2000	41.6	226.6	14.6	198	39.1	124.8	53.4
2001	43	227.2	14.3	199.4	33.1	157.6	54.6
2002	42	219.2	14.9	215.3	10	188.9	53.3
2003	43.4	220.4	14.4	135.7	9.8	215.2	54
2004	43.9	218.8	14.9	131.5	11.5	240.7	54.7
2005	42.9	211.1	15.3	124.3	13.1	274.4	53.7
2006	43.3	202.8	14.2	110.7	8.9	303	53.5
2007	45	210.1	13.7	119	3.2	328.7	55.1
Changes 1990-2007	**29 %**	**-4 %**	**-10 %**	**-76 %**	**-97 %**	**-**	**11 %**

[1] HFCs are given as actual emissions (Tier 2).
Source: Statistics Norway/The Norwegian Pollution Control Authority

Norway prepares its National Inventory Reports (NIR) in accordance with the UNFCCC Reporting Guidelines on Annual Inventories, and generally the estimation methods follow the Guidelines for National Greenhouse Gas Inventories published by the Intergovernmental Panel on Climate Change (IPCC). The UNFCCC reviews all parties' NIRs and emission inventories every year. The last in-country review of Norway was in April 2007. Norway submitted its latest NIR to the UNFCCC Secretariat on 15 April 2009.

Norway's total emissions of greenhouse gases, measured as CO_2 equivalents, were about 55.1 million tonnes in 2007. Over the period 1990-2007, these emissions rose by about 11 per cent. Norway has been experiencing economic growth since 1990, which is the main explanation for the general growth in emissions.

In the period 1990-2007, total emissions of CO_2 increased by 29 per cent, or 10.2 million tonnes. The sectors that contributed most to the increase in emissions were the oil and gas industry and transport (road traffic, other mobile sources and to a lesser extent coastal traffic and fishing). Emissions of methane (CH_4) totalled 210 100 tonnes (4.4 Mtonnes CO_2 equivalents) in 2007; about 81 per cent of this originated from landfills and agriculture. Agriculture and two plants producing nitric acid (fertilizer) are the main sources of nitrous oxide (N_2O). During the period 1990–2007, total N_2O emissions decreased by 10 per cent.

Emissions of PFCs (CF_4 and C_2F_6) from Norwegian aluminium plants in 2007 were calculated to be approximately 0.8 Mtonnes CO_2 equivalents. These plants account for virtually all Norwegian PFC emissions. Emissions of SF6 in 2007 were 3.3 tonnes (0.08 Mtonnes CO_2 equivalents), which is 97 per cent lower than in 1990. The emissions[2] of HFCs were 0.57 Mtonnes CO2 equivalents in 2007, amounting to about 1 per cent of total emissions of greenhouse gases in Norway. Emissions of HFCs in 1990 were insignificant.

2 HFCs are measured in actual emissions. Actual emissions take into account the time lag between consumption of substitutes for ozone-depleting substances and emissions.

1.3 Policies and measures

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

Norway is working towards an ambitious global climate agreement that will ensure a maximum global mean temperature rise of 2° C compared to the pre-industrial level. This is necessary to avoid dangerous climate change that threaten life on earth, and will require political leadership by all nations. Global emissions will have to be reduced by 50-85 per cent by 2050, most likely closer to 85 per cent.

The Ministry of the Environment has cross-sectoral responsibility for coordination and implementation of Norwegian climate policy. The other ministries are responsible for implementation in their respective sectors. Effectiveness and cost effectiveness are two key criteria in environmental policy development, as in other policy areas. The polluter-pays principle is an important element of environmental policy. To follow up the ambitious goals on sustainable development, Norway has integrated sustainability into the most important political and economic steering documents – the annual national budgets.

The most recent white paper on climate policy, Norwegian climate policy, was published in 2007 (Report No. 34 (2006-2007) to the Storting). The white paper and the subsequent Storting debate and recommendations are the foundation for Norwegian climate policy. In these documents the general targets and policy instruments to reach these targets are outlined.

Norway's target is to reduce global greenhouse gas emissions by the equivalent of 30 per cent of its own 1990 emissions by 2020. The Government considers that a realistic target is to reduce Norwegian emissions by 15-17 million tonnes CO2 equivalents relative to the reference scenario presented in the National Budget for 2007, when CO2 uptake by forests is included. To ensure that Norway achieves this target, the Government established a group called "Klimakur" in 2008, which is to propose tools and measures for achieving the 2020 emission target. The Government intends to make five-yearly reviews of progress and how the use of policy instruments at national level should be further developed. The Ministry of the Environment plans to submit its first review of climate policy to the Storting in 2010. The "Klimakur" group will provide important input to this.

Cross-sectoral policies and measures

On 1 January 2005 Norway adopted the Greenhouse Gas Emissions Trading Act, thereby establishing an emissions trading scheme (ETS) that was to operate from 2005-2007.

The Norwegian emissions trading scheme for 2005-2007 closely resembled the EU ETS, and applied to 10-15 per cent of total Norwegian greenhouse gas emissions. Emissions subject to a CO_2 tax were not included. Allowances for the period 2005-2007 were allocated to operators free of charge. The Act was amended in June 2007 and February 2009. The amended Act provided the basis for the emissions trading scheme in the Kyoto Protocol commitment period (2008-2012). In the current trading period, the Norwegian system is linked to the EU ETS. The total Norwegian cap is set about 20 per cent below the 2005 emissions from the installations concerned. The offshore petroleum sector does not receive any allocations free of charge, and has to buy all the allowances it needs need in the market. About half of the total quantity of allowances will be auctioned by the Government.

A tax on CO_2 was introduced in 1991 as the first measure designed only to curb emissions of greenhouse gases. The tax covers about 55 per cent of total Norwegian greenhouse gas emissions, and rates range up to NOK 363 per tonne (approximately EUR 42). High rates apply to petrol and petroleum activities, and lower rates to the use of mineral oils. Exemptions apply mainly to emissions from energy-intensive and emissionsintensive industries that are exposed to international competition. These industries are covered by an arrangement with the Government.

The Pollution Control Act applies to greenhouse gas emissions. Greenhouse gas emissions are therefore included in the discharge permits that industrial installations are obliged to obtain under the Pollution Control Act. As a general rule, an emitter is granted a discharge permit for CO_2 corresponding to the amount in the application. Greenhouse gas emissions are to a large extent covered by other specific policy instruments such as the CO_2 tax, the emission trading system and specific agreements with the industry to cap emissions. These instruments have been regarded as more efficient tools for reducing greenhouse gas emissions than quantitative limits set in individual discharge permits.

The growth trend in HFC and PFC emissions changed from exponential to linear after a tax on import and production of HFCs and PFCs was introduced in 2003. In 2004, this tax was supplemented with a refund scheme,

which prescribes a refund corresponding to the tax when HFCs and PFCs are delivered for destruction.

Norway was found eligible to participate in the Kyoto mechanisms on 22 April 2008. Acquisitions and transfer of Kyoto units to and from the Norwegian registry will take place under all three mechanisms. According to projections it will be necessary to realize about a further 7.2 Mt annually through national measures and/or net acquisitions of Kyoto units to achieve the commitment in the Kyoto Protocol's article 3. Net acquisition of Kyoto units will also be crucial in achieving Norway's target of reducing emissions by 10 percentage points more than its Kyoto commitment.

Sector-specific policies and measures

Almost all electricity produced on the Norwegian mainland is hydropower. Norway has two gas-fired power plants in operation. The Government has granted construction and operating licences for three other gas-fired combined cycle power plants in Norway. Statoil has received a licence for a power plant at Mongstad, which is now under construction. A carbon capture and storage (CCS) project at Mongstad is based on an implementation agreement between the Norwegian State and Statoil, and a discharge permit issued by the Ministry of the Environment. All new licences for gas-fired power plants are based on carbon capture and storage.

Norway has an integrated strategy for increased production of renewable energy and energy efficiency. The national energy agency Enova SF, a state-owned enterprise owned by the Ministry of Petroleum and Energy, is responsible for promoting this strategy. Enova SF`s main tasks are to contribute to environmentally sound and rational use and production of energy, relying on financial instruments and incentives to stimulate market actors and mechanisms to achieve national energy policy goals.

The CO_2 tax has so far been the most important instrument for reducing emissions in the petroleum sector, and has had a significant effect. The low level of CO_2 emissions per produced oil equivalent is to a great extent due to general improvements in technology and emission-reducing measures implemented after the introduction of the CO2 tax in 1991. Another important consequence is the two CO_2 storage projects at Sleipner and Snøhvit. The Sleipner CO_2 storage project was initiated in 1996, and since then, one million tonnes of CO_2 per year have been separated from the natural gas produced on the Sleipner West field in the North Sea and stored in the Utsira formation.

The Norwegian Government has ambitious plans for carbon capture and storage. It intends to build on experience gained from the Sleipner and Snøhvit CO_2 storage projects so that Norway can continue to play a leading role in the development and deployment of CCS.

In the last few decades, there has been a substantial increase in emissions from the transport sector, and the Government's goal is for existing and new measures in the sector to result in a reduction in emissions of between 2.5 and 4.0 million tons CO_2 equivalents (12 to 19 per cent) relative to expected emissions in 2020 according to the projections. The CO_2 tax is the main instrument for limiting CO_2 emissions from the transport sector. Changes in the vehicle purchase tax system to reward vehicles with low CO_2 emissions and penalize vehicles with high emissions have reduced emissions from new cars.

Norway has for a number of years been working actively through the International Maritime Organization (IMO) towards the limitation of greenhouse gas emissions from international shipping.

Forests contribute significantly to reducing net emissions of greenhouse gases in Norway. A huge amount of carbon is stored in biomass and soil. In recent years, net CO_2 uptake in Norwegian forests has been in the order of 25–31 million tonnes per year. This corresponds to approximately half of the total Norwegian greenhouse gas emissions.

1.4 Projections and the effect of policies and measures

In the baseline scenario, total greenhouse gas emissions in Norway are projected to increase by 15 per cent from 1990 to 2010, and then to fall by 1 per cent from 2010 to 2020. Projected emissions in 2010 and 2020 are 57.3 and 56.5 CO_2 equivalent, respectively.

There are considerable methodological difficulties in calculating the effect of policies and measures ex post, including establishing a hypothetical baseline and obtaining relevant data. So far there has only been a limited amount of quantitative analysis of the impact of various policies and measures in Norway after they have been implemented. Effects are monitored more systematically in some sectors than in others. The list of measures in chapter 4 in the present report 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 the effects of measures related to transport and agriculture, have not been analysed.

Projections indicate that in the absence of the policies and measures described in chapter 5.3, CO_2 emissions would be 8.6-11.7 million tonnes higher in 2010 and 11.5-14.6 million tonnes higher in 2020 compared to the baseline scenario.

1.5 Impacts and adaptation

The most recent projections of climate change for Norway indicate warming in all regions and during all seasons. It is estimated that the annual mean temperature will increase by 3.4°C. Precipitation changes are probably the more dramatic of the signals. Annual precipitation averaged over the mainland is estimated to increase by 18 per cent up to 2100. The largest seasonal precipitation increase is 23 per cent for the autumn. On average, there are expected to be more days with heavy rainfall and higher precipitation values during extreme weather events in all regions and in all seasons.

Climate change in the Arctic has already led to major impacts on the environment and on economic activities. If the present warming trend continues as projected, these impacts are likely to increase, greatly affecting ecosystems, cultures, lifestyles and economies across the Arctic. For Svalbard, the increase in annual temperature up to the end of the 21st century varies from ca. 3°C in the southwest to ca. 8°C in the northeast.

Climate change will affect ecosystems, with severe consequences for vulnerable Arctic species adapted to a colder climate. As warming continues, northbound migration and vegetation shifts to higher altitudes and latitudes will change ecosystems. Marine ecosystems will be affected both by the rise in temperature and by acidification as CO_2 from the atmosphere is absorbed by seawater. From a global perspective, the Arctic Ocean is the region most sensitive to changes in its water chemistry due to anthropogenic increases in carbon dioxide.

Climate change will lead to an increase in the risk of flooding and landslides or avalanches affecting roads, railways and airports. This poses a major challenge to the transport and communications sector, and will entail a greater need for maintenance and investments. More precipitation could increase energy production, whereas more frequent extreme weather will increase the risk of damage to important infrastructure such as electricity grids, dam constructions and power plants. Climate change will be an important aspect of regional and local land use planning.

In May 2008, the Ministry of the Environment presented a framework for enhancing society's resilience to climate change, reducing vulnerability and strengthening our ability to adapt. In this initial phase the framework sets out the following objectives:

- To identify vulnerabilities and incorporate climate change considerations into relevant policy areas;
- To obtain more knowledge about climate change and adaptation to climate change;
- To promote coordination, information and competence building.

In December 2008, the Norwegian Government appointed the Norwegian Commission on Vulnerability and Adaptation to Climate Change. The Commission includes experts from government agencies, research institutes and civil society and has been tasked with drawing up a review of the risks and opportunities associated with a changing climate, and to provide advice on priorities and specific measures to reduce the vulnerability of society. The Commission is to report to the Ministry of the Environment by 1 November 2010.

1.6 Financial resources and transfer of technology

There is no internationally agreed definition of what constitutes "new and additional" resources under Article 4.3 of the Convention. Norwegian official development assistance (ODA) has been increasing steadily over the period under review and is now approximately 1 per cent of gross national income (GNI). Funding for climate change actions has been increased considerably over the last few years; by any definition these resources can therefore be classified as "new and additional".

Measures to reduce emissions from deforestation and forest degradation in developing countries (REDD) is currently being negotiated as a part of a post-2012 climate regime. In order to promote early action on REDD, the Government of Norway has launched a comprehensive Climate and Forest Initiative. The initiative was launched by Prime Minister Stoltenberg at the Bali summit in 2007, and will have an annual budget of up to about NOK 3 billion (USD 500 million). In 2008, NOK 280 million was allocated to the initiative, increasing to NOK 1.5 billion in 2009. For 2010, the allocation has been increased to NOK 2.1 billion.

Through this initiative, Norway is providing support to a number of developing countries and thus encouraging them to take early action to achieve cost-effective and verifiable reductions in greenhouse gas emissions.

1.7 Research and systematic observation

Climate change is a long-term, complex problem that affects all sectors of society. Climate research is therefore extremely important both as a basis for developing policy and as a climate policy instrument. The most recent white paper on research in Norway, Climate for Research, (Report No. 30 (2008 - 2009) to the Storting), puts global challenges high on the agenda. The white paper lists five thematic priority areas; climate, energy, the environment, aquaculture and food security. It states that Norwegian research must address social challenges, not limited to Norway, but globally.

Norwegian public funding for research is mainly channelled through the Research Council of Norway, which had a budget of approximately NOK 6.2 billion in 2009. The Research Council supports research in several areas and covers all disciplines. Unlike most other countries, Norway has only a single research council.

The Research Council's strategy for the period 2009-2012, In the Vanguard of Research, identifies several priority areas, including climate change and the processes of globalization. Within these areas, the Research Council funds research programmes and schemes for Centres of Excellence and Centres for Environment-friendly Energy Research. The objective of the latter is to establish time-limited research centres which conduct concentrated, focused and long-term research of high international calibre in order to solve specific challenges in the field.

Norwegian climate researchers are active in international research cooperation, for example under the EU Framework Programmes and the global change programmes (IGBP, WCRP, and others). Norwegian scientists are involved in the EU 7th Framework Programme projects, including one third of all projects in the thematic area Environment and Climate. International collaboration outside these established frameworks is also important.

As a follow-up of the agreement on Norway's climate policy reached between the main political parties in Norway the Norwegian Government appointed a strategic forum for climate research, Klima21, in addition to the Energi21 initiative on energy research. The agreement on climate policy emphasizes the need for research in three main areas: renewable energy, CCS and climate change. Allocations for research on renewable energy and CCS have already been increased in line with the agreement. It is expected that allocations to research on climate change will also be increased. In 2008, funding through the Research Council for research related to climate change, including CCS but excluding renewable energy technology, totalled NOK 330 million, compared to NOK 270 million in 2005. The private sector also funds a considerable amount of research, particularly related to carbon capture and storage: for example, several petroleum companies fund research in this field.

The ten-year NORKLIMA programme (Climate change and impacts in Norway) was launched in 2004 and runs until 2013. The primary objective of the NORKLIMA programme is to generate vital new knowledge about the climate system, about climate trends in the past, present and future, and about the direct and indirect impacts of climate change on the natural environment and society, as a basis for adaptive responses by society. The NORKLIMA programme seeks to foster climate research of top international calibre. The total annual budget for NORKLIMA is about NOK 90 million, and in 2009 the program has been funding around 90 projects.

1.8 Education, training and public awareness

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

Awareness of issues related to sustainable development and climate change has long been an important topic in the Norwegian system of education. Norway is participating in the UN Decade for Education for Sustainable Development (2005–2014) in cooperation with the other Nordic countries. In 2006, a new curriculum was introduced for primary and secondary schools.

The Ministry of the Environment works through many channels to enhance public awareness of issues related to climate change, and has built up extensive information resources on the Internet. News, publications, press releases and other relevant information are published on the Ministry's website (www.miljo.no), which is updated on a daily basis. The website covers all environmental fields, including extensive information on climate change. Another important website is State of the Environment Norway (www.environment.no).

In March 2007 the Ministry launched "Klimaløftet", a public awareness campaign on climate change. It was initiated as a measure to help ensure the necessary longterm reductions in Norwegian emissions. The purpose of the campaign is to spread information on the climate issues, based on scientific research, with the objective of educating the general public about these issues.

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

CICERO (Center for International Climate and Environmental Research – Oslo) is an independent research institute with a specific focus on climate change, and 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. CICERO's mission is to provide reliable and comprehensive knowledge about all aspects of the climate change problem.

2. NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1 Government structure

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

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

2.2 Geographic profile and land use

The mainland of Norway extends for 1 752 km from north to south, spanning about 13 degrees of latitude. The total area of the mainland is 323 802 km^2. In addition the Norwegian sea area is 2 201 599 km^2. The mainland coastline is 2 650 km long, excluding fjords and bays. In the east, Norway shares a border with Sweden, Finland and Russia. In addition, the Arctic archipelago of Svalbard is under Norwegian jurisdiction. Emissions from Norwegian activities on Svalbard are included in the Norwegian emission inventories.

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

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

Because of prevailing westerly winds, moist air masses flow regularly in from the ocean giving abundant precipitation over most of Norway. Areas just inside the coast of western Norway get most precipitation (see Figure 2.12). This zone of maximum precipitation is one of the wettest in Europe, and several sites in this region have normal annual precipitation of more than 3500 mm. On the leeward side of the mountain ranges the annual precipitation is much lower, and a few sheltered stations in south-eastern Norway and Finnmarksvidda have normal annual precipitation less than 300 mm.

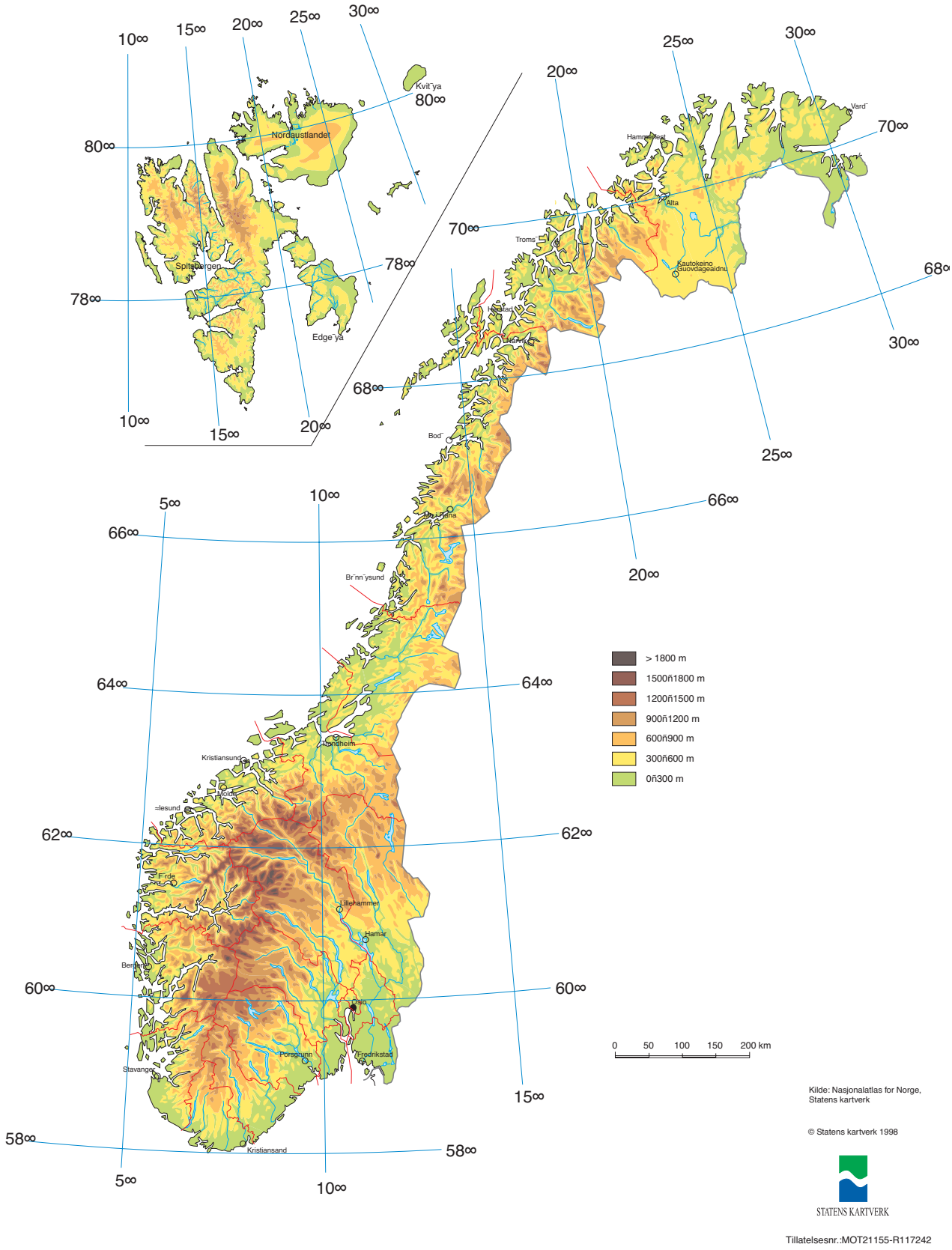
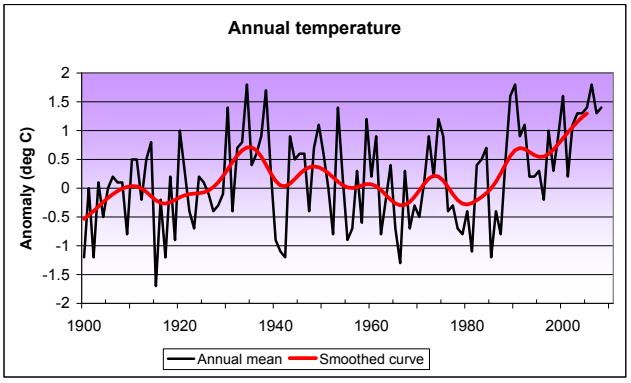


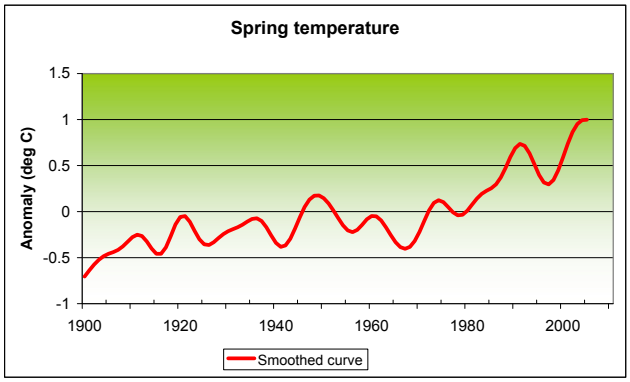
Figure 2.1: Map of Norway, including Svalbard, showing altitudes.
Source: National Atlas of Norway. The Norwegian Mapping Authority.

Figure 2.2 Annual temperatures for the Norwegian mainland 1900-2008



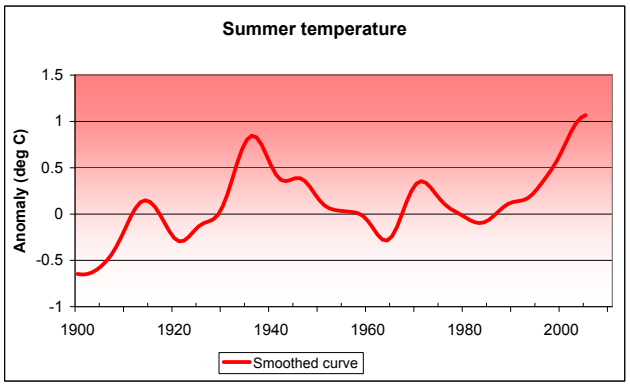
Source: Norwegian Meteorological Institute

Figure 2.3 Spring temperatures for the Norwegian mainland 1900-2008



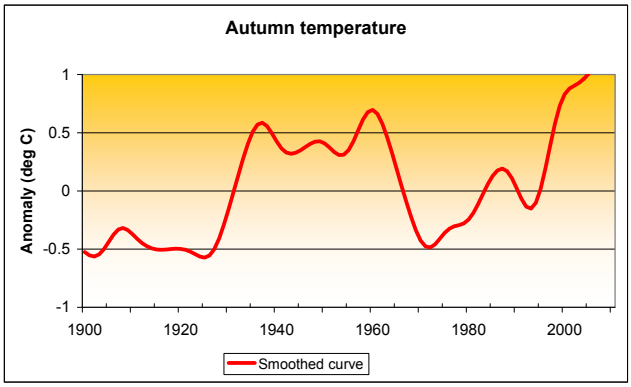
Source: Norwegian Meteorological Institute

Figure 2.4 Summer temperatures for the Norwegian mainland 1900-2008



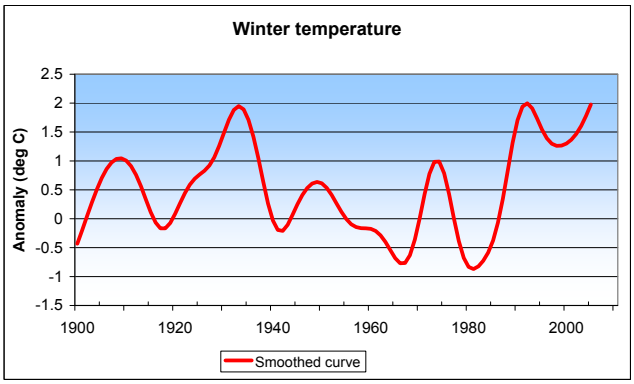
Source: Norwegian Meteorological Institute

Figure 2.5 Autumn temperatures for the Norwegian mainland 1900-2008



Source: Norwegian Meteorological Institute

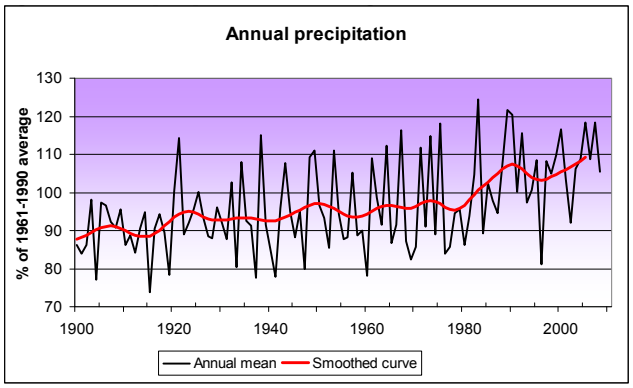
Figure 2.6 Winter temperatures for the Norwegian mainland 1900-2008



Source: Norwegian Meteorological Institute

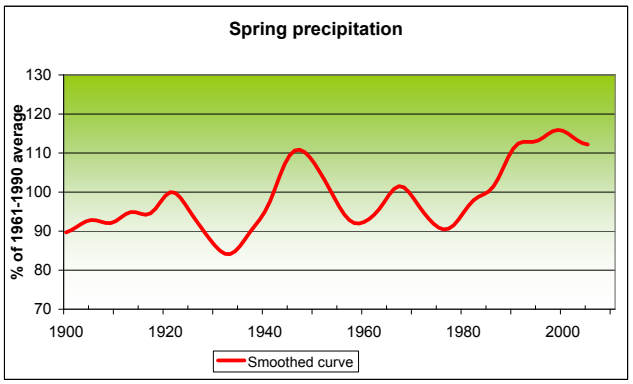
The above figures on annual and seasonal temperature anomalies show deviations (°C) relative to the 1961-1990 average. The smoothed red curves of fig 2.2 to 2.6 show decadal scale variability, while the black line (given only for annual temperatures) indicate values for individual years. The last 3 values of the smoothed curves have been skipped as they may change when data for coming years are added. Data from the entire period 1900-2008 have nevertheless been used to calculate the smoothed curves.

Figure 2.7 Annual precipitation for the Norwegian mainland 1900-2008



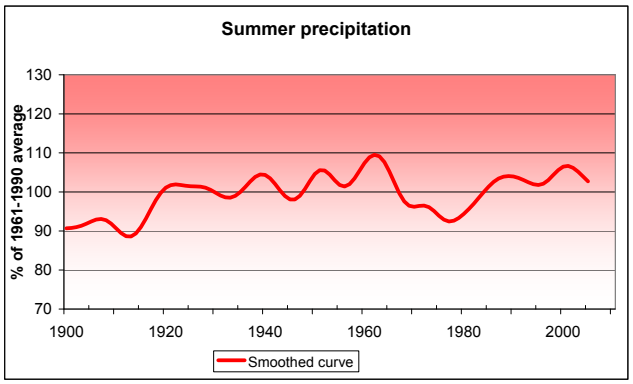
Source: Norwegian Meteorological Institute

Figure 2.8 Spring precipitation for the Norwegian mainland 1900-2008



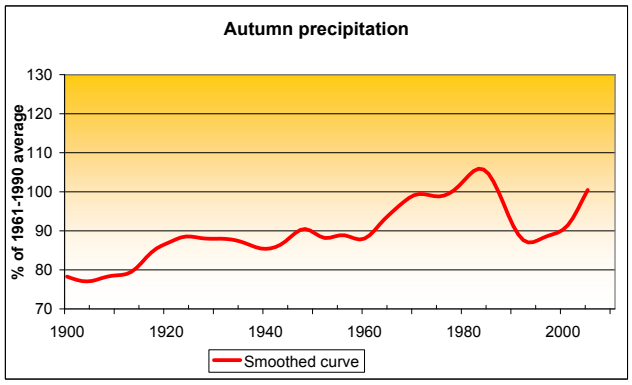
Source: Norwegian Meteorological Institute

Figure 2.9 Summer precipitation for the Norwegian mainland 1900-2008



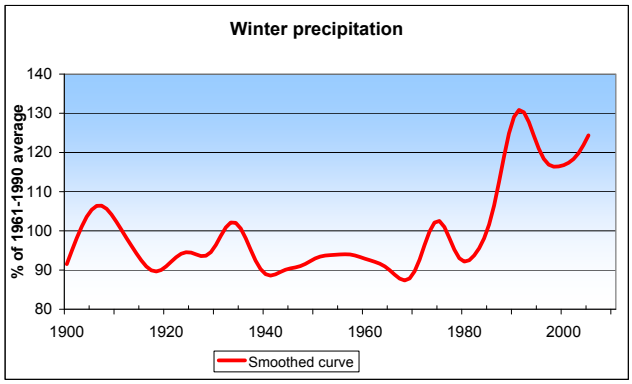
Source: Norwegian Meteorological Institute

Figure 2.10 Autumn precipitation for the Norwegian mainland 1900-2008



Source: Norwegian Meteorological Institute

Figure 2.11 Winter precipitation for the Norwegian mainland 1900-2008



Source: Norwegian Meteorological Institute

The above figures on annual and seasonal precipitation show the values in per cent of the 1961-1990 average. The smoothed red curves of fig 2.7 to 2.11 show decadal scale variability, while the black line (given only for annual precipitation) indicate values for individual years. The last 3 values of the smoothed curves have been skipped as they may change when data for coming years are added. Data from the entire period 1900 to 2008 have nevertheless been used to calculate the smoothed curves.

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

For the period 1900-2008 as a whole, the annual mean temperature in Norway has increased by about 0.9°C. Dependent on geographical region, the increase in annual temperature vary from 0.5 to 1.1°C. The largest

increase is found during spring, where the mean temperature has increased by 0.7-1.4°C. Also the annual precipitation has increased in Norway during 1900-2008. The largest increase (19-22 per cent) is found in western and north-western Norway. In southern regions the precipitation increase is largest during autumn, while in northern regions it tends to be larger during winter.

Also in Svalbard, observations from the last hundred years tend to show positive trends in temperature and precipitation. Composite series of temperature and precipitation from 1912 to 2008 show linear trends of 2.3°C per century and 24 per cent per century, respectively.

The size and elongated form of the country result in wide variations in climate, geology and topography and therefore in great variations in conditions for land use. About 30 per cent of its area lies 0–299 meters above sea level, and this is where most people live and where agricultural production is most intensive. As much as 20 per cent of the land area lies at least 900 meters above sea level. Agricultural areas account for only 3 per cent of the mainland, while about 37 per cent is covered by forest. The remaining area consists of other cultivated land, scrub and heath along the coast, mountain forest and marginal forest, and sparsely vegetated mountains and mountain plateaus. Some 47 per cent of the land is above the tree line. Currently, almost 8 per cent of the land area is protected under the Nature Conservation Act. Nevertheless, the proportion of wilderness-like areas, defined as areas more than 5 km from major infrastructure development, has been reduced dramatically from about 48 per cent of the land area in 1900 to about 12 per cent today. Only about 5 per cent of the area of southern Norway is characterized as wilderness-like.

2.3 Population and urban profile

With a total area of almost 324 000 km2 and only 4.8 million inhabitants, Norway has the lowest population density in Europe after Iceland. The large majority of the Norwegian population is settled along the coast and the fjords, and an increasing percentage of the population lives in urban settlements. Around 1900, 35 per cent of the population lived in densely populated areas. In 2009, almost 79 per cent of Norway's population lived in urban settlements. The number of large urban settlements is small – only 20 have more than 20 000 residents. Only five city areas – Oslo, Bergen, Trondheim, Stavanger/Sandnes and Fredrikstad/Sarpsborg – have more than 100 000 residents. Currently, 32 per cent of Norway's population lives in the five largest city areas.

2.4 Economic profile and industry

From 2003 to 2007, annual growth in gross domestic product (GDP) for Mainland Norway (excluding offshore activities) averaged 5 per cent. The exceptionally strong growth in the Norwegian economy those years can, among other things, be attributed to large gains from a new round of integration of the global economy that gathered headway after China's entry into the WTO in 2001. Strong global growth in demand led to higher prices on oil and other important commodities that Norway exports such as metals. This development in export prices in the years 2003-2007 contributed to high profitability in large parts of the mainland industries. Combined with increasing capacity utilisation, the high profitability contributed to strong growth in real investments (annually by 14.2 per cent on average) in the mainland businesses. Due to soaring oil prices, investments in the petroleum sector also grew briskly, at 9.7 per cent annually on average.

Norway also lowered its interest rates from 2002 to 2004 as inflation fell and international interest rates were subdued. Together with strong growth in real wages, the low interest rates, contributed to strong growth in household demand in this period (5.2 per cent annually in 2003-2007). The last cyclical upturn had a long duration. The typical pattern of high productivity growth at the beginning of the upturn also occurred in this cycle. At the more mature stage of the cycle the productivity growth abated, while a significant increase in man-hours worked facilitated an even stronger growth in Mainland GDP in 2006 and 2007. The high growth was brought about by an increase in labour force participation by Norwegians and by a substantial increase in labour immigration from the new EU member states. The unemployment rate (measured by the Labour force survey) fell to 2.5 per cent in 2007.

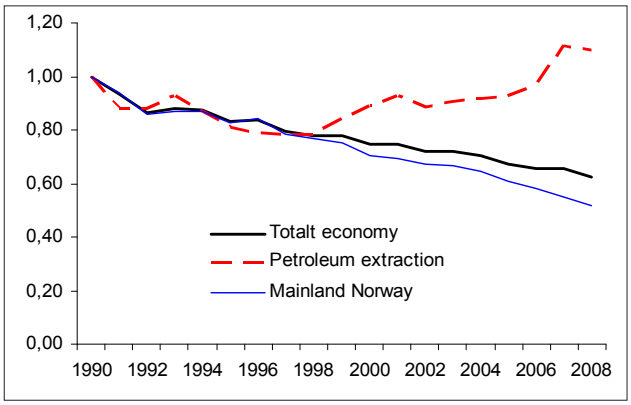
After the business cycle peak at the turn of the year 2007/2008, growth in the Norwegian economy slowed sharply in 2008, falling to 2.6 per cent. Higher interest rates contributed to a slowdown in the housing market and to a lower growth in private consumption. Moreover, the growth in manufacturing production and investments in mainland businesses started to decline. The financial crisis that developed into a full-blown global economic crisis in autumn 2008 also affected Norway, amplifying the downturn that was already underway. However, the impact of the financial crisis has so far been less severe in Norway than in many other countries. The implementation of extensive liquidity and credit policy actions, as well as expansionary fiscal and monetary policy measures, stabilised the economy and provided stimulus to domestic demand. Investments in the petroleum sector have kept up and are predicted to be strong also in 2009 and 2010. Exports of traditional goods are projected to fall by 11 per cent in 2009 and are not expected to add to growth in the near future, due to below trend growth internationally and a high

Norwegian cost level. Business investments in the mainland economy are not expected to pick up again until later in the recovery. Overall, a decline in GDP for Mainland Norway of 1.1 per cent is expected in 2009, whereas the growth forecast for 2010 is 2.1 per cent.

Even though economic growth has been strong, emissions have stayed more or less at the same level throughout the upswing. This reflects a reduction in emission intensity. Emission intensity in Norway has on average fallen by about 2.5 per cent per year from 1990 to 2008, see figure 2.12. In most Mainland Norway sectors the emission intensity has been decreasing substantially. The CO_2 tax that was introduced in Norway in 1991 has later been supplemented by an emission trading system. In 2008 more than 70 per cent of total emissions of Kyoto gases were covered by economic instruments. The use of economic instruments, and other policy measures, is an important reason for the strong decline in emission intensity.

The emission intensity in road transport is, however, relatively high and strong growth in this sector has lead to increasing emissions. The largest emitting sector in Norway, oil and gas extraction, has experienced good economic conditions over the past years with high oil and gas prices. This has lead to increased efforts to extract marginal resources which requires substantial amounts of energy. Moreover, an increase in the share of production from mature fields contributes to higher energy requirements. The emission intensity in the petroleum sector has been increasing for some years. As Norway is a small open economy, with large exports of petroleum, international measures to mitigate global emissions of greenhouse gases might affect terms of trade.

Figure 2.12 Emission intensity. 1990=1

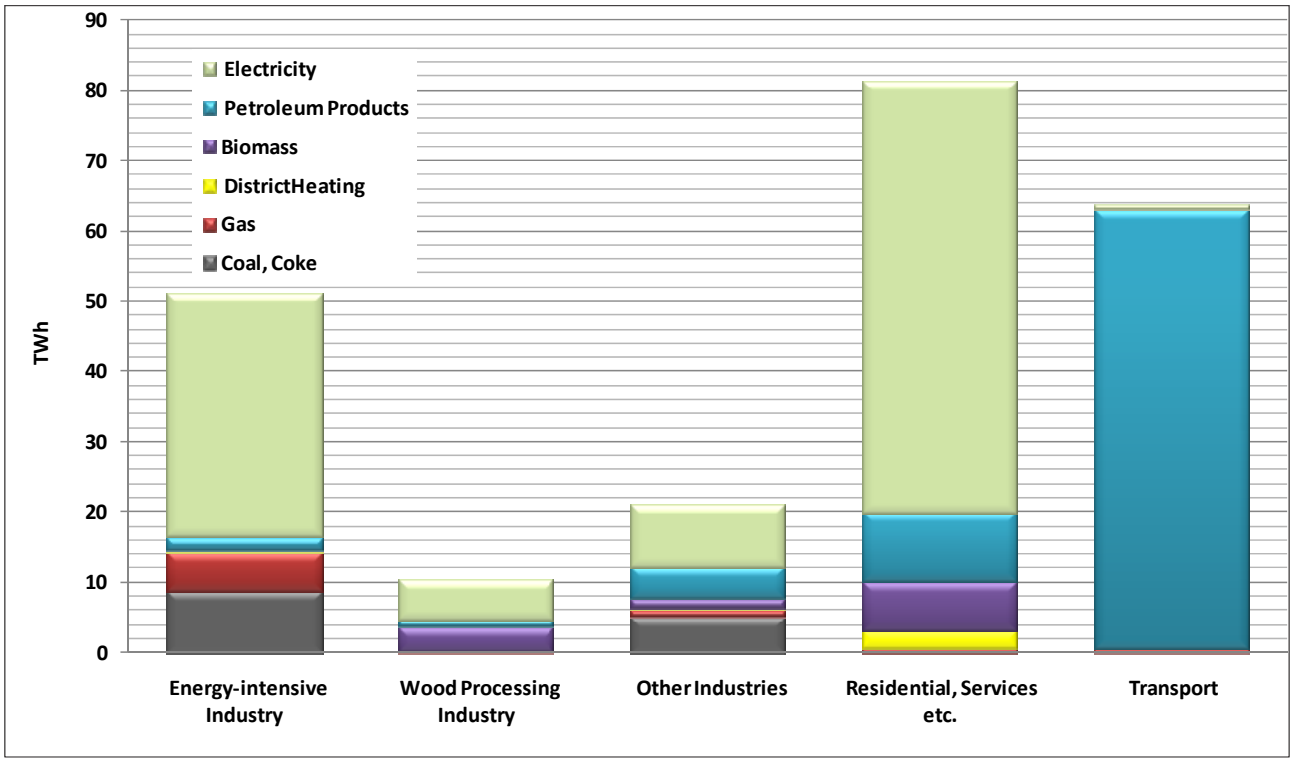


Source: Ministry of finance

2.5 Energy

Figure 2.13 shows energy use by consumer and category in 2008. The proportion of energy use accounted for by electricity is considerable higher than in most other countries.

Figure 2.13 Norwegian energy use by consumer group and sector. 2008. TWh

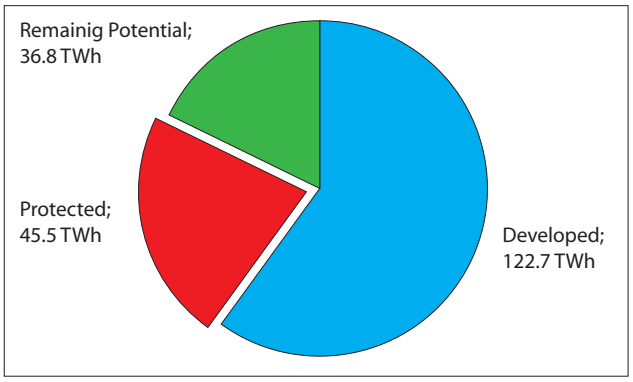


Source: Statistics Norway.

Electricity production in Mainland Norway is based almost entirely on hydropower, which has virtually no direct emissions of greenhouse gases, but has other environmental impacts. There is a limited potential for further development of hydropower production, see figure 2.14.

Because of variation in the availability of water supplies and consequently in hydropower production, emissions from electricity production in the Nordic countries vary considerably from year to year.

Figure 2.14. Norway's hydropower potentials of January 2009, TWh/year.



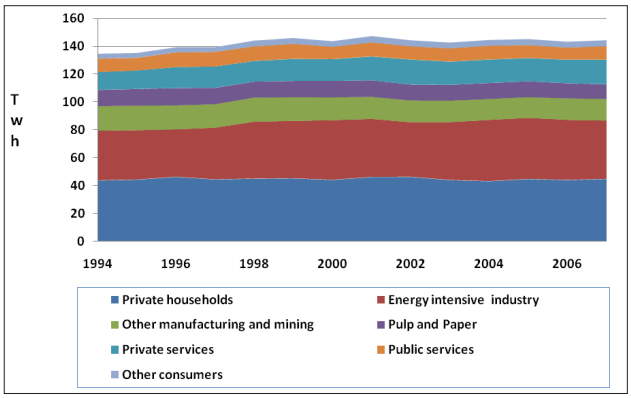
Source: NORDEL

Given the production capacity in 2008, production in a year with normal precipitation is calculated to be 124.8 TWh (including 1.2 TWh thermal power and 0.9 TWh wind power). In the 10 years 1999-2008, Norway was a net exporter of electricity in 6 of the years and a net importer in 4 years. In 2008, electricity production in Norway was 142.7 TWh and total electricity consumption was 128.9 TWh. The net electricity export was 13.9 TWh.

Energy use in the manufacturing, residential and service sectors (i.e. stationary energy use) in Norway has been around 145 TWh since the late 1990's despite high economic growth, see figure 2.15. Energy efficiency and energy savings are an integrated part of the Norwegian energy policy, see Chapter 4.3.2.

Because of the amount of renewable energy (hydropower and some wind and biofuel) used in Norway, per capita CO_2 emissions are lower than the OECD average. Energy-related CO_2 emissions have not risen at the same rate as economic growth in Norway.

Figure 2.15 Stationary energy use by sector 1994-2007. TWh



Source: Statistics Norway

The petroleum sector is Norway's largest industry measured in value. In 2008 the petroleum sector accounted for 26 per cent of GDP, 35 per cent of state revenues, 50 per cent of the value of Norway's exports and 23 per cent of the country's total investments.

In 2008, total petroleum production on the Norwegian Continental Shelf amounted to 2.5 million barrels of oil (including Natural Gas Liquids and condensate) per day and 99 billion standard cubic meters (scm) of gas, making a total of saleable petroleum of 242 million scm of oil equivalents. While oil production has been in a decline since 2001, the gas production is increasing. Sales of gas are expected to reach a level of 115 -140 billion scm during this decade.

The petroleum sector accounted for about 31 per cent of total CO_2 emissions in Norway or about 15 million tonnes CO_2 in 2007. Both total emissions of CO_2 and CO_2 emissions per produced unit have increased in the sector the last years. This is explained by the development on the Norwegian Continental Shelf towards more mature fields, movement of activities towards the north and longer distances for gas transport. In the next few years, CO_2 emissions will be about 14 million tonnes of CO_2 per year, most likely peaking in 2019.
Further details of the energy situation in Norway may be found in the Ministry of Petroleum and Energy's fact sheets of energy and water resources and on the petroleum sector and its environmental impact (please view www.regjeringen.no/oed).

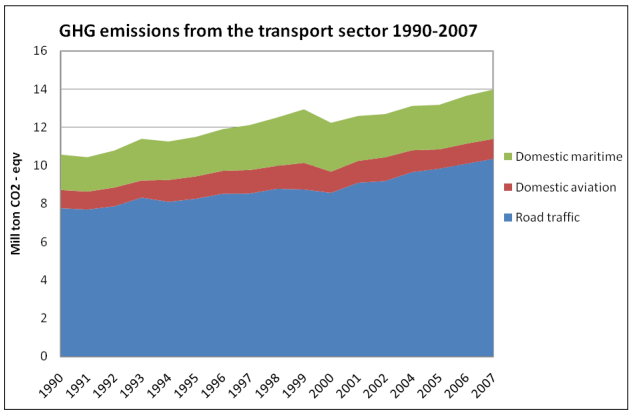
2.6 Transport

Norway's decentralized settlement pattern gives rise to a relatively high demand for transport, and makes public transport systems relatively costly. 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 increasing. As a result, the proportion of passenger transport by cars and the proportion of goods transport by road and air are rising, and this generates higher CO_2 emissions.

About 32 per cent of the total Norwegian greenhouse gas emissions originated from transport[3] in 2007. Road traffic was responsible for most of these emissions (19 per cent of total emissions in Norway in 2007), while domestic aviation, domestic maritime transport and off road machinery were responsible for the rest. The last decades have shown a substantial increase in emissions from the sector. In the period 1990 to 2007, greenhouse gas emissions from road transport increased by 33 per cent, domestic aviation by 10 per cent and domestic maritime transport by 40 per cent, see figure 2.16.

Figure 2.16 Development of GHG emissions in the transport sector 1990-2007.



Source: Statistics Norway

2.7 Manufacturing industries and construction

Emissions from the sector of manufacturing industries and construction include industrial emissions originating to a large extent from the production of raw materials and semi-manufactured goods. The sector includes several sub-sectors e.g. iron and steel, non-ferrous metals, chemicals, fertilizers, pulp and paper, mineral industries, food processing industries and the building and construction industry. The major emissions from the sector are related to fuel combustion, that is, emissions from use of oil, gas and coal for heating purposes.

Emissions from fuel combustion from this sector contributed 6.5 per cent to the total greenhouse gas emissions in 2007. Emissions from the sector have decreased by 2.2 per cent from 1990 to 2007.

3 The transport sector includes road transport, civil aviation, navigation, railway and off road vehicles and other machinery.

2.8 Agriculture and forestry

Stretched along the western side of the Scandinavian Peninsula, approximately one fourth of the surface area of Norway lies north of the Arctic Circle. The long coastline has an Atlantic, humid climate, while the inland climate is continental. Approximately 3 per cent of Norway's land area is cultivated soil, and approximately 37 per cent of the land area is forested. The area under agricultural cultivation has declined by approximately 2 per cent the last decade. There has also been a shift from harvested land to more grassing land.

Agriculture

Agriculture is estimated to account for about 9 per cent of Norway's emissions of greenhouse gases. This includes agricultural related emissions of CO_2 from the use of fossil fuels. Emissions are particularly associated with methane and nitrogen oxide from animal husbandry, fertilisation and soil management. Agriculture has its share of the responsibility for reducing greenhouse gas emissions. The agricultural emissions have been reasonable stable the last decade.

Forestry

Forest and wooded land cover 12 million hectares and constitute 37 per cent of the land area in Norway. The most important species are Norway spruce (47 per cent), Scots pine (33 per cent) and birch (18 percent).

Norway has long traditions in forestry and forest management, and for using wood in construction and as a source of energy. Sawn wood and round wood have been important exports for more than 500 years.

Roughly 88 per cent of the forest area is privately owned. The majority of the forest holdings are farm and family forests. Due to the ownership structure and specific terrain conditions, Norwegian forestry is diversified and characterised by small-scale activity. The average size of clear-cuttings is estimated to be 1.4 hectares. During the last 80 years the annual harvest has been considerably lower than the annual increment, resulting in both growing stock and annual increment exceeding twice the level documented by the first National Forest Inventory in the 1930's. The annual increment in Norway is now approximately 25 million m^3.

Fisheries and aquaculture

Fishing has always been an important basis for settlement and employment along the Norwegian coast. The Norwegian fishing and aquaculture industry currently supplies seafood to consumers in more than 150 countries worldwide. According to the United Nations Food and Agriculture Organization, the consumption of seafood worldwide is set to increase substantially over the next 20 to 30 years. In 2001 consumption of seafood amounted to 99 million tonnes, whereas the estimate for consumption by 2030 is in the range of 157 to 174 million tonnes. The fishing and aquaculture industry

is one of Norway's foremost export industries and is vital for settlement and activities along the Norwegian coast.

Fisheries

Over the last decade, fisheries have become an environmental issue. While the industry always has depended upon the ocean environment for its productivity, its relationship to the environment has taken on a new meaning. Various types of pollution as well as climate change may affect the fisheries. Along with an increase in the level of CO_2 in the atmosphere, the ocean absorbs an increasing level of CO_2. This causes ocean acidification, which could be a growing concern for the marine ecosystems and fisheries.

Technological developments and improved fishing methods and vessels have made possible a restructuring of the fishing-fleet, which today catches much larger quantities per man, per vessel and per trip than a few decades ago. This has by large reduced the general fuel-consumption of the fleet. The overall carbon footprint of the national fishing fleet is to be considered low. Norwegian fisheries are mainly based on "passive fishing tools" – meaning tools that stand still in water. About 70 per cent of our total catch of cod is conducted in this way, and furthermore, the major part of the fishing-fleet operates within 12 nautical miles from shore.

The implementation of the precautionary approach, the ecosystem-based approach and the integrated oceans management approach are significant aspects of the current oceans policy in Norway, and stand as examples of how a concept from the realm of the environment is introduced in a fisheries context. The approach provides an inventory of the various uses of our national waters, including fisheries, aquaculture, transportation, petroleum-related activity, and an assessment of the qualities of the natural environment. The management plans provide the basis for decision-making on major initiatives for activities in the area, such as the opening of an area for drilling for petroleum.

Strict regulation – partly in cooperation with other countries – based on set quotas and control mechanisms is necessary for sustainable development, and will ensure that future generations can harvest the wealth of the sea.

Aquaculture

Norway has productive marine environments with excellent conditions for conducting environmentally friendly aquaculture. The Norwegian aquaculture industry is a modern, internationally competitive industry that produces high quality food in an efficient manner. In terms of value, aquaculture products account for almost half of the total Norwegian fish export.

Growth in the aquaculture industry cannot be determined solely by market demand; it must take place within the limits that the environment can tolerate. Thus, a ceiling has to be set for how large the industry can become, and ensuring that production remains within environmental sustainable boundaries is a determinative factor in making the assessment for long-term development and growth.

A sustainable aquaculture industry is one which is run with consideration for the environment, and adapted to the marine environment and biological diversity. As a food producer, the aquaculture industry depends on good environmental conditions and water quality, which means that in order to protect their own businesses, fish farmers have an obvious interest in maintaining good water quality and avoiding any negative impact on their surroundings.

It is important to ensure a clean marine environment and good production locations for aquaculture, with minimum impact from long-distance transport emissions and pollution from more local sources. Similarly, the authorities and industry must cooperate to ensure that aquaculture is run to the benefit of its surroundings, and not to their detriment.

3. GREENHOUSE GAS INVENTORY INFORMATION, INCLUDING INFORMATION ON NATIONAL SYSTEMS AND NATIONAL REGISTRIES

3.1 Descriptive summary

The Norwegian National greenhouse gas Inventory Report (NIR) has been prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories, and generally the estimation methods follow the Guidelines for National Greenhouse Gas Inventories published by the Intergovernmental Panel on Climate Change (IPCC). The latest national greenhouse gas inventory report was submitted to the UNFCCC Secretariat 15 April 2009. Some of the results from the report are highlighted in this chapter. All data and information are consistent with the information provided in the annual inventory report.

The National Inventory Report covers emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorcarbons (PFCs), sulphur hexafluoride (SF_6) and hydrofluorcarbons (HFCs) from 1990 to 2007.

In December 2006, Norway submitted the Initial Report. This report includes a description of the national system for greenhouse gas inventory and the national registry. A summary of these two descriptions are also given in this chapter.

Table 3.1 Emissions of greenhouse gases in Norway during the period 1990-2007. Units: CO2 and CO2–eq. in Mtonnes (Mt), CH4 and N2O in ktonnes (kt) and other gases in tonnes (t).

Year	CO2 Mt	CH4 kt	N2O kt	PFC t	SF6 t	HFC1 t	Total CO2 eq Mt
1990	34.8	219.7	15.2	503.6	92	0.1	49.7
1991	33.4	222	14.8	447.5	87	0.4	47.7
1992	34.2	225	12.9	343	29.5	0.9	45.9
1993	35.9	228.3	13.7	344.9	30.9	2.6	48
1994	37.9	231.8	14	305.2	36.7	6.9	50
1995	37.8	230.8	14.2	301.4	25.4	15.1	49.7
1996	40.9	231.8	14.4	274.7	24	27.6	52.7
1997	41	232.8	14.4	245	24.3	43.8	52.6
1998	41.1	226.9	14.7	223.1	30.4	67.1	52.8
1999	42	220.1	15.3	208.5	36.6	94.7	53.8
2000	41.6	226.6	14.6	198	39.1	124.8	53.4
2001	43	227.2	14.3	199.4	33.1	157.6	54.6
2002	42	219.2	14.9	215.3	10	188.9	53.3
2003	43.4	220.4	14.4	135.7	9.8	215.2	54
2004	43.9	218.8	14.9	131.5	11.5	240.7	54.7
2005	42.9	211.1	15.3	124.3	13.1	274.4	53.7
2006	43.3	202.8	14.2	110.7	8.9	303	53.5
2007	45	210.1	13.7	119	3.2	328.7	55.1
Changes 1990-2007	**29 %**	**-4 %**	**-10 %**	**-76 %**	**-97 %**	**-**	**11%**

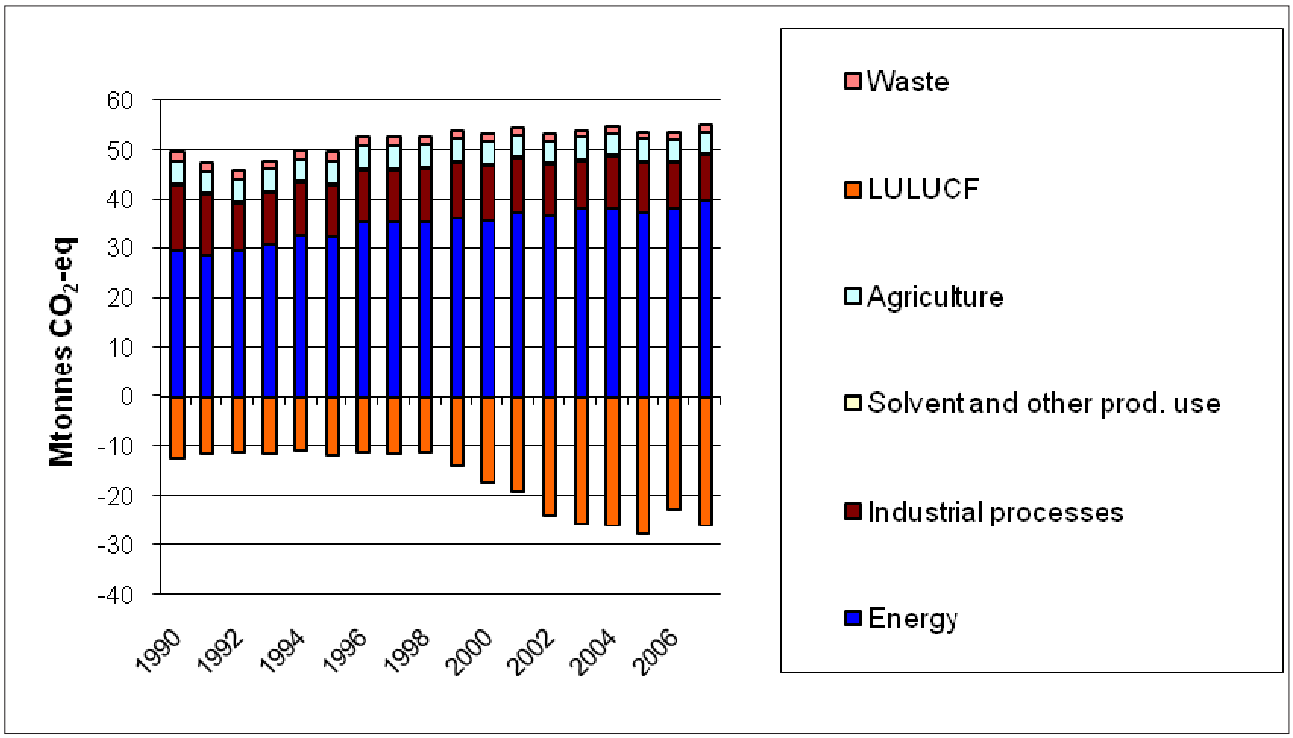
[1] *HFCs are given as actual emissions (Tier 2). Source: Statistics Norway/The Norwegian Pollution Control Authority*

Table 3.1 presents emission figures for all direct greenhouse gases, expressed in absolute emission figures and total CO_2 equivalents. The total emissions of greenhouse gases, measured as CO_2 equivalents, were about 55.1 million tonnes in 2007. The total emissions show a marked decrease between 1990 and 1992 and an increase thereafter with small interruptions in 1995, 2000 and 2002. The emissions fluctuated between 53.4 and 55.1 tonnes in the period 2000-2007. For the period 1990-2007 the increase in the emissions expressed in CO_2 equivalents was about 11 per cent. Figures for 2008 show somewhat lower emissions (53.8 CO_2 equivalents).

The net greenhouse gas emissions including all sources and sinks were 24.2 million tonnes in 2006. The total contribution from different sources from 1990 to 2007 is illustrated in Figure 3.1. Figure 3.2 illustrates the development of emissions of greenhouse gases from various sectors (disregarding LULUCF) in changes in per cent. The overall increased emissions of greenhouse gases caused by the energy sector has been slowed by the reduced emissions from waste and industrial processes.

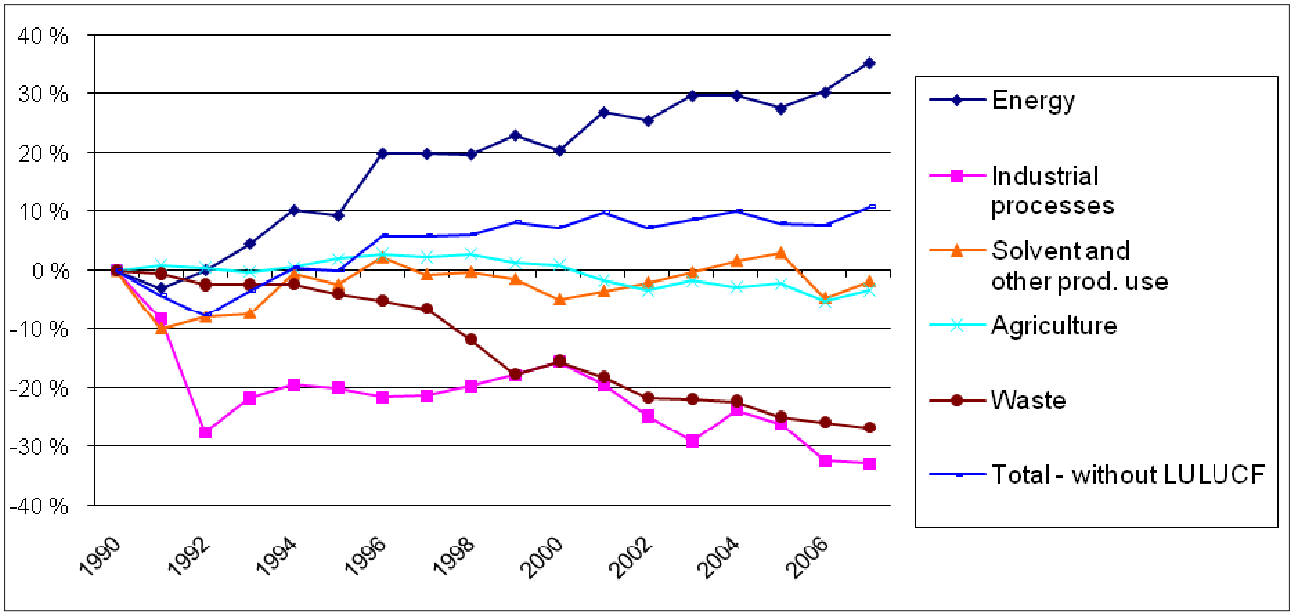
Norway has experienced economic growth since 1990, which partly explains the general growth in emissions. In addition, the off shore petroleums sector has significantly expaned the past 20 years. Figure 3.3 shows that the overall increasing trend mainly caused by higher CO_2 emissions from most sources, has been weakened by decreased emissions of fluorinated gases. The sharp increase in CO_2 emissions in 2007 increased the share of CO_2 in total greenhouse gas emissions from 2006 to 2007. The increase is partly temporarly and was caused by start-up problems at the NGL plant at Melkøya. The emissions in 2007 by gases are illustrated in Figure 3.4.

Figure 3.1 Total emissions of all GHG emissions calculated as CO2 equivalents from different sectors.



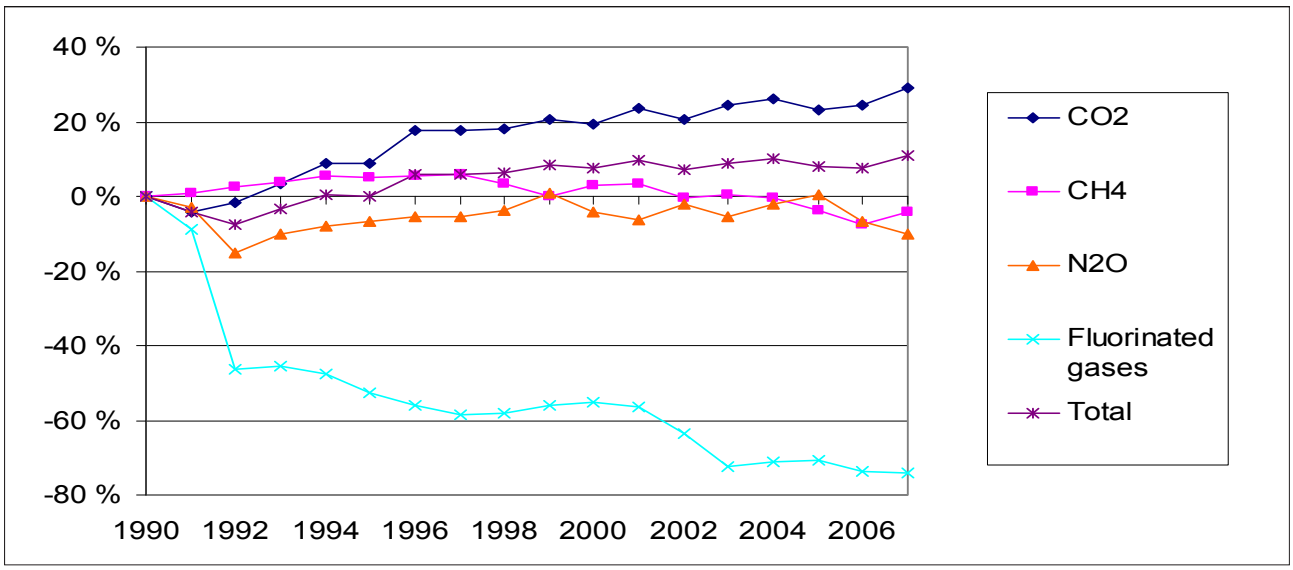
Source: Statistics Norway/The Norwegian Pollution Control Authority

Figure 3.2 Changes in total greenhouse gas emissions by UNFCCC source categories during the period 1990-2007 compared to 1990.



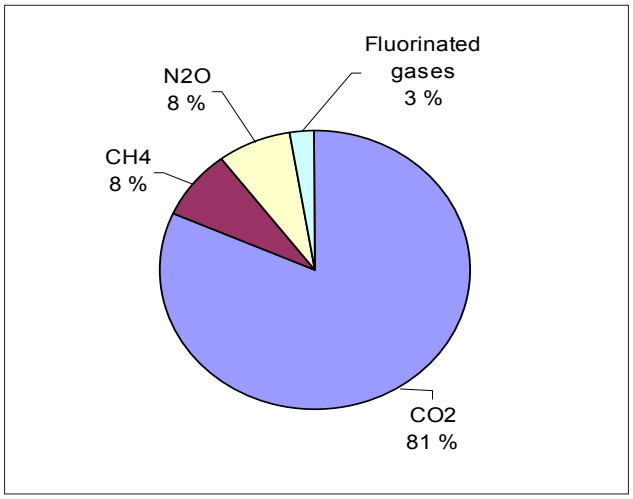
Source: Statistics Norway/The Norwegian Pollution Control Authority

Figure 3.3 Changes in emissions of greenhouse gases by gas in Norway 1990-2007, compared to 1990.



Source: Statistics Norway/The Norwegian Pollution Control Authority

Figure 3.4 Distribution of emissions of greenhouse gases in Norway by gas, 2007.



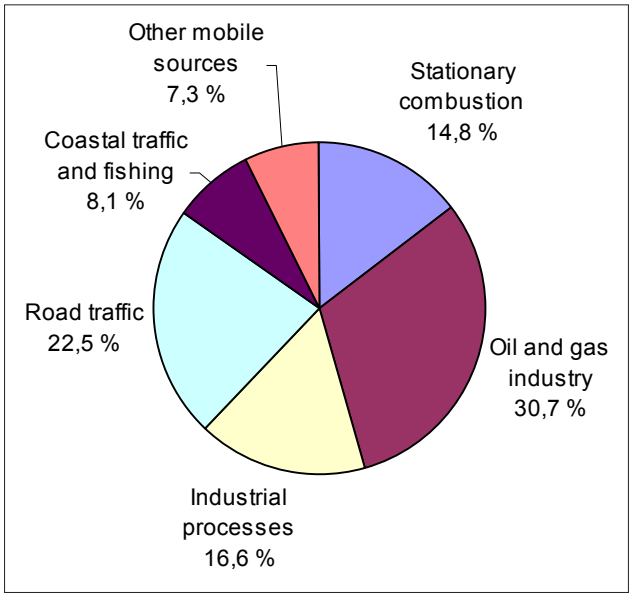
Source: Statistics Norway/The Norwegian Pollution Control Authority

Emissions of CO_2

The emissions of CO_2 in 2007 were 45.0 million tonnes. The Norwegian CO_2 emissions originate primarily from industrial sources related to oil and gas extraction, the production of metals, and the transport sector. Since generation of electricity is almost exclusively hydroelectric, emissions from stationary combustion are dominated by industrial sources and internal energy use.

The distribution of CO_2 emissions in 2007 on various categories is shown in Figure 3.6

Figure 3.5 Distribution of CO_2 emissions in Norway by source in 2007.



Source Statistics Norway/The Norwegian Pollution Control Authority

Table 3.2 lists CO2 emissions from each source category for the whole period 1990-2007.

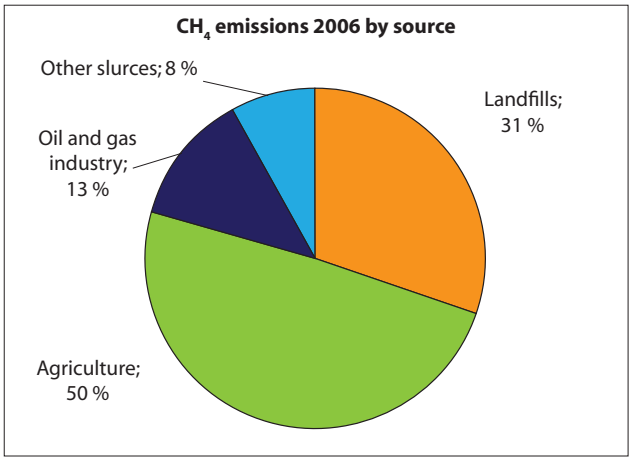
In the period from 1990 to 2007 the total emissions of CO_2 increased by 29 per cent, or by 10.2 million tonnes. The major sectors contributing to the increased emissions have been the oil and gas industry and transportation (road traffic, other mobile sources and to a lesser extent coastal traffic and fishing). On the other hand, emissions from stationary combustion have decreased by 0.6 million tonnes CO_2 from 1990.

Emissions of methane (CH_4)

The total emissions of methane (CH_4) were 210 100 tonnes (4.4 Mtonnes CO_2 equivalents) in 2007. About 81 per cent of the emissions in 2007 originated from landfills and agriculture. CH_4 emissions from agriculture are dominated by releases from enteric fermentation. Combustion and evaporation/leakage in the oil- and gas industry accounted for 13 per cent of the total emissions in 2007. Other sources include emissions from among others petrol cars, domestic heating, coal mining and oil refineries.

Figure 3.6 illustrates the distribution of Norwegian CH4-emissions in 2007.

Figure 3.6 Distribution of Norwegian CH_4 emissions in 2007.



Source: Statistics Norway/The Norwegian Pollution Control Authority

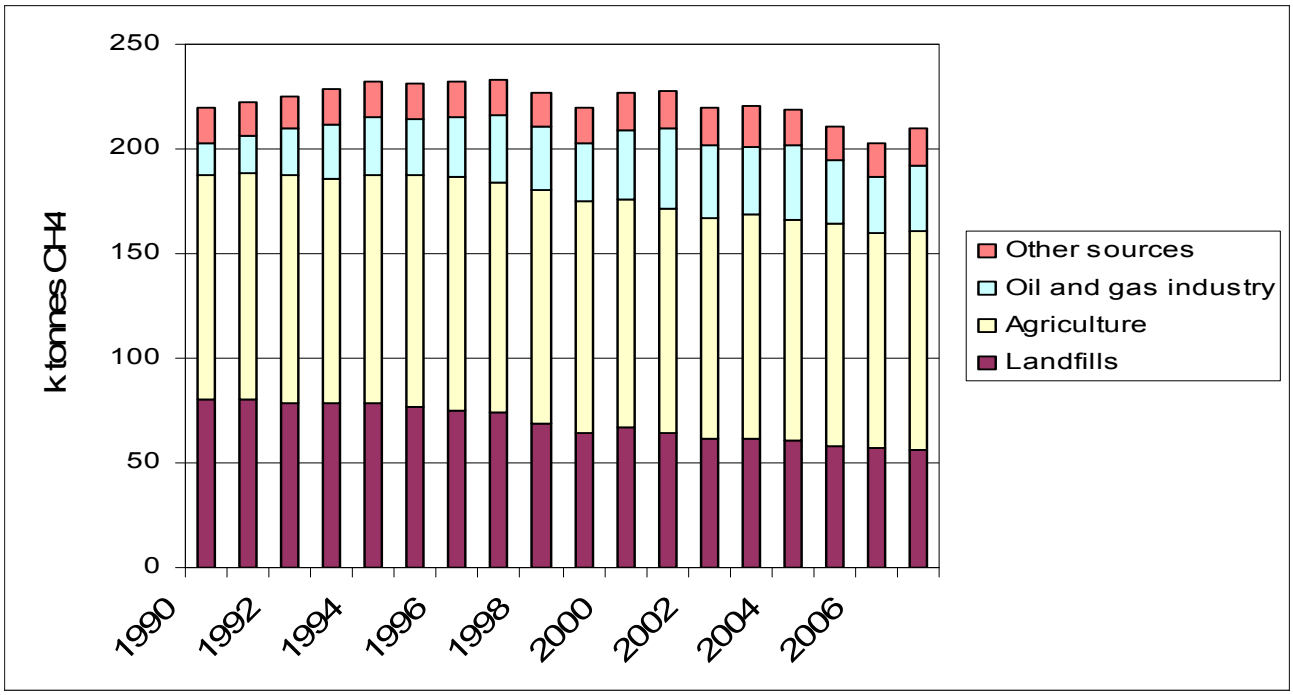
During the period 1990-2007, the total CH_4 emissions decreased by 4.7 per cent. Figure 3.7 shows that this decrease is primarily due to decreased emissions from landfills which more than compensated for the growth in emissions from the oil- and gas industry. The waste volumes have increased during the period (1990-2007), but this effect has been more than offset by increased recycling and incineration of waste and increased burning of methane from landfills. Agricultural emissions are relatively stable from year to year and are little affected by short-term economic cycles.

Table 3.2 CO_2 emissions from different source categories for the period 1990-2007. Emissions in million tonnes CO_2

Year	Stationary combustion	Oil and gas industry	Industrial processes	Road traffic	Coastal traffic and fishing	Other mobile sources	Total
1990	7.3	7.4	7.0	7.6	3.2	2.3	34.8
1991	6.9	7.3	6.4	7.6	3.0	2.2	33.4
1992	6.8	7.8	6.6	7.7	3.1	2.2	34.2
1993	7.0	8.1	7.1	8.2	3.3	2.1	35.9
1994	7.9	8.8	7.5	7.9	3.2	2.5	37.9
1995	7.2	9.0	7.5	8.1	3.3	2.6	37.8
1996	8.7	9.8	7.7	8.3	3.5	2.8	40.9
1997	8.0	10.2	7.8	8.3	3.8	2.8	41.0
1998	8.0	9.8	8.0	8.6	4.0	2.8	41.1
1999	7.7	10.3	7.9	8.5	4.3	3.2	42.0
2000	6.8	11.6	8.4	8.4	3.9	2.5	41.6
2001	7.2	12.5	8.0	8.9	3.8	2.7	43.0
2002	7.0	12.3	7.4	9.0	3.7	2.7	42.0
2003	7.8	12.7	7.6	9.1	3.7	2.5	43.4
2004	7.0	12.9	8.0	9.4	3.7	2.8	43.9
2005	6.6	12.8	7.6	9.6	3.7	2.7	42.9
2006	7.1	12.5	7.3	9.9	3.6	3.0	43.3
2007	6.7	13.8	7.4	10.1	3.7	3.3	45.0

Source: Statistics Norway/The Norwegian Pollution Control Authority

Figure 3.7 Changes in CH_4 emissions for major Norwegian sources between 1990 and 2007.



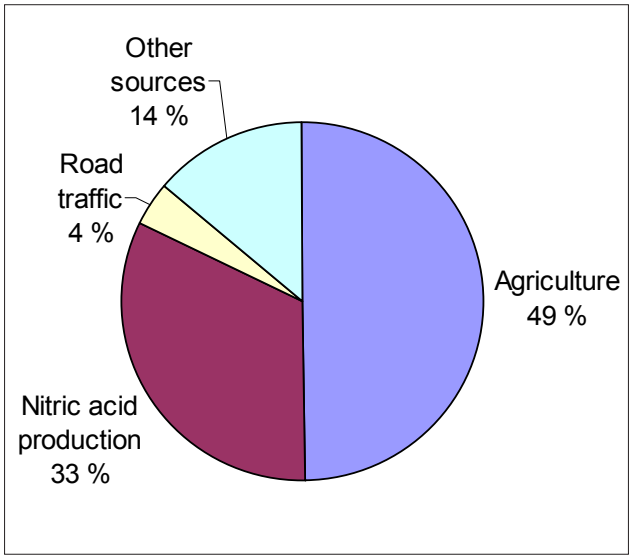
Source: Statistics Norway/The Norwegian Pollution Control Authority

Emissions of N_2O

The total emissions of N_2O were 13.66 ktonnes (4.2 million tonnes CO_2 equivalents) in 2007.

Figure 3.8 shows that 49 per cent of the Norwegian emissions of N_2O are of agricultural origin, with agricultural soils as the most prominent contributor. The second most important source is production of nitric acid from two plants, which is one of the steps in the production of fertilizer. These emissions account for 33 per cent of the total. The contribution from road traffic amounted to 4 per cent in 2007, with emissions originating from the use of catalytic converters in mobile sources. Included under "other" are emissions from e.g. fuel combustion, manure management and wastewater handling.

Figure 3.8 Distribution of Norwegian N2O emissions by major sources in 2006.



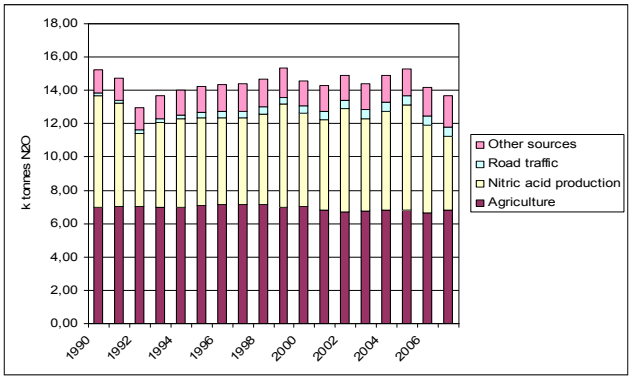
Source: Statistics Norway/The Norwegian Pollution Control Authority

During the period 1990–2007 the total N_2O emissions decreased by 10 per cent, see figure 3.9.

Emissions of N_2O from agriculture have been fairly stable for the whole period since 1990. Changes in the production processes of nitric acid led to decreased emissions from this source in the beginning of the 1990s, while there was a moderate increase in emission in the following years due to increased production volumes. Improvements in the production process brought the emissions down again in 2006, and even further down in 2007, to a level which is 34 per cent lower than in 1990. From 2006 to 2007, emissions from this source fell by over 15 per cent.

The increasing use of catalytic converters in light vehicles has increased the emissions of N_2O from road traffic with 0.4 ktonnes, corresponding to more than a threefold increase over the period 1990-2007.

Figure 3.9 Changes in N_2O emissions for major Norwegian sources between 1990 and 2007.



Source: Statistics Norway/The Norwegian Pollution Control Authority

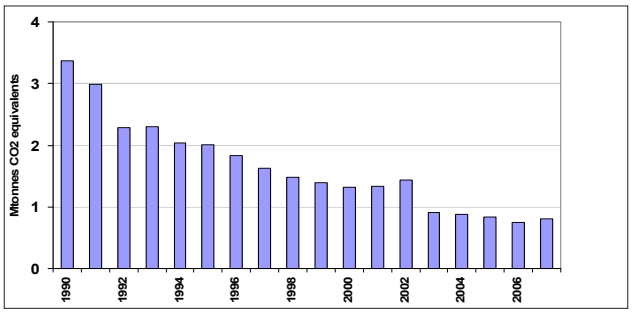
Emissions of PFCs

The emissions of PFCs (CF_4 and C_2F_6) from Norwegian aluminium plants were calculated to 0.8 Mtonnes CO2 equivalents in 2007, which covers virtually all Norwegian PFCs emissions.

The total emissions of PFCs decreased by 76 per cent in the period 1990-2007 following a steady downward trend as illustrated in Figure 3.10. The decline can be explained by improved technology, process control and the conversion to Prebake technology, which has contributed to a considerable reduction of the PFC emissions per tonne aluminium produced.

Since a tax on import and production of PFCs was implemented in 2003 the introduction of PFCs in new or modified applications has fallen to an insignificant level.

Figure 3.10 Emissions of PFCs in Norway 1990-2007. The emissions are given in million tonnes CO_2 equivalents.



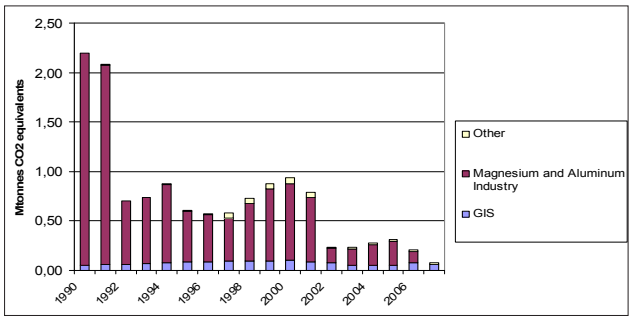
Source: Statistics Norway/The Norwegian Pollution Control Authority

Emissions of SF_6

The emissions of SF_6 in 2007 were 3.3 tonnes (0.08 Mtonnes CO_2 equivalents), which is 97 per cent lower than in 1990. This trend is illustrated in Figure 3.11. The main emission source originates from electrical switchgear[4] (GIS) and other high-voltage applications. Since the signing of a voluntary agreement in 2002, emissions from this sector had decreased 26 per cent by 2007.

Up to 2007 the largest source of SF_6 emissions in Norway was magnesium production, where SF_6 was used to cover the surface of liquid magnesium to prevent it from oxidizing. Relative emissions were reduced in the early 1990s due to improvements in technology and process management, as well as reductions in production levels. Fluctuations from 1992 to 2001 are mainly influenced by production volumes. Primary production stopped in 2002, resulting in a drop in emissions to about one quarter of the previous level. The production of remelting magnesium stopped in 2006 and there were no emissions from this source in 2007. Similar use of SF6 in the aluminium industry in the early 1990s has also ceased.

Figure 3.11 Emissions of SF_6 in Norway 1990-2007. The emissions are given in Mtonnes CO_2 equivalents.



Source: Statistics Norway/The Norwegian Pollution Control Authority

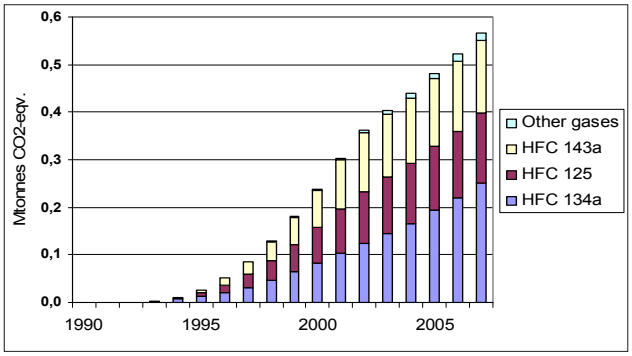
Emissions of HFCs

The actual emissions[5] of HFCs were 0.57 Mtonnes CO_2 equivalents in 2007, amounting to about 1 per cent of total emissions of greenhouse gases in Norway. The emissions in 1990 were insignificant.

These emissions gained significance in the mid-1990s, when HFCs were introduced as substitutes for ozone-depleting substances. The application category refrigeration and air conditioning contribute by far to the largest part of the HFCs emissions. A trend of exponential growth was slowed after a tax on import and production of HFCs and PFCs was introduced in 2003. Due to increased demand caused by the phasing out of CFCs and HCFC, future growth in these emissions cannot be ruled out. However, it is presumed that better maintenance of equipment and more use of low-GWP[6] HFCs and alternative substances will result in a reduced growth rate compared to previous scenarios.

HFC-134a, HFC-125 and HFC-143a are the most important emissions, see Figure 3.12.

Figure 3.12 Actual emissions of HFCs in Norway 1990-2007. The emissions are given in Mtonnes CO_2 equivalents.



Source: Statistics Norway/The Norwegian Pollution Control Authority

3.2 National systems in accordance with Article 5, paragraph 1, of the Kyoto Protocol

The Norwegian national system for greenhouse gas inventories is based on close cooperation between the Norwegian Pollution Control Authority, Statistics Norway and the Norwegian Forest and Landscape Institute. Statistics Norway is responsible for the official statistics on emissions to air. The Norwegian Forest and Landscape Institute is responsible for the calculations of emission and removals from Land Use and Land Use Change and Forestry (LULUCF).

The Norwegian Pollution Control Authority has been appointed by the Ministry of the Environment as the national entity through the budget proposition to the Norwegian Parliament for 2006. The Norwegian Pollution Control Authority as the national entity is in charge of approving the inventory before official submission to the UNFCCC.

To ensure that the institutions comply with their responsibilities, Statistics Norway and the Norwegian Forest and Landscape Institute have signed agreements with the Norwegian Pollution Control Authority as the national entity. Through these agreements, the institutions are committed to implementing the Quality Assurance/Quality Control (QA/QC) and archiving procedures, providing documentation, making infor-

4 Switchgear is used in association with electrical power grids to isolate electrical equipment. Gas insulated switchgear (GIS) uses pressurized SF6 to insulate conductors, contacts and other electrical parts of the grid

5 Actual emissions take into account the time lag between consumption of substitutes for ozone-depleting substances and emissions. A time lag results from the fact that a chemical placed in a new product may only slowly leak out over time, often not being released until end-of-life. E.g. a household refrigerator emits little or no refrigerant through leakage during its lifetime and most of its charge is not released until its disposal, many years after production.

6 Global Warming Potential

mation available for review, and delivering data and information in a timely manner to meet the deadline for reporting to the UNFCCC.

Details of the methods and framework for the production of the emission inventory are given in the reports "The Norwegian Emission Inventory 2008. Documentation of methodologies for estimating emissions of greenhouse gases and long-range transboundary air pollutants", and "Emissions and removals of greenhouse gases from land use, land-use change and forestry in Norway". These reports are updated annually in conjunction with important methodological changes and used as a basis for the National Inventory Report.

The main emission model has been developed by - and is operated by - Statistics Norway. Emissions from road traffic, methane from landfills and emissions of HFC, PFC and SF_6 from products are calculated by side models, and are incorporated into the main model along with emissions from point sources collected by the Norwegian Pollution Control Authority.

The Norwegian Forest and Landscape Institute is in charge of estimating emissions and removals from LULUCF for all categories where area statistics is the activity level. LULUCF are based on statistics from National Forest Inventory (NFI). The NFI utilizes a 5-year cycle based on a re-sampling method of the permanent plots.

Norway is implementing the formal QA/QC plan. All three institutions prepare a QA/QC report annually, according to the plan. Based on these reports, the three institutions collaborate on which actions to take to further improve the QA/QC of the inventory.

The Norwegian greenhouse gas emission inventory has in 2009 been recalculated for the entire time series 1990-2006 for all components and sources, to account for new knowledge on activity data and emission factors and to correct for discovered errors in the calculations. There is also a continuous process for improving and correcting the inventory and the documentation of the methodologies employed, based on questions and comments received in connection with the annual reviews.

In general, the data contained in the Norwegian emission inventory are available to the public, both activity data and emission factors. In terms of spatial coverage, the emission reporting under the UNFCCC covers all activities within Norway's jurisdiction.

Designated representative – contact information

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3.3 National registry

The Norwegian Pollution Control Authority is the responsible entity for the operations of the national registry. The registry operates as a stand-alone registry, and is not part of any consolidated registry system.

The national registry began live operations with the International Transaction Log (ITL) and the Community Independent Transaction Log (CITL) on 23 October 2008. All parties included in the EU greenhouse gas Emissions Trading Scheme (EU ETS) are obliged to have their registries connected to both ITL and CITL.

Registry administrators – contact information

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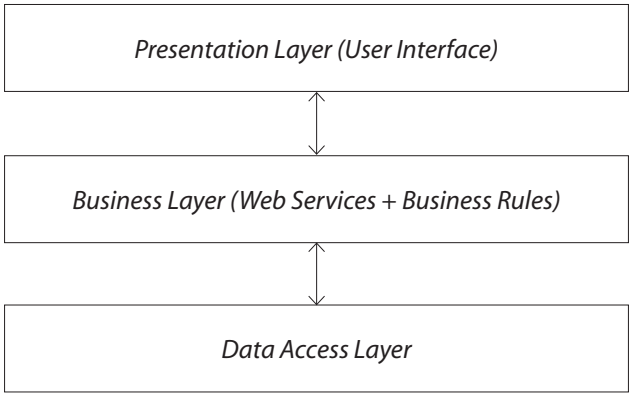
Technical description
The following provides a brief description of the architectural design of the registry:



Presentation Layer
This layer is for the user to interface with the required system, i.e., the information that is shown for display or capture on the user screens. The user interface of the Norwegian registry is customized in order to be in line with local design. In general terms the user interface element consists of all codes above the web service layer.

Business Layer
This is where the specific scheme rules and processing will be performed. This layer interacts with the Data Access Layer below and the Presentation Layer above. In practice, this layer is implemented as 2 sub-layers. The Web-services layer that is visible to the Presentation Layer modules with pre-defined interfaces, and the Business Rules layer that is visible to the web-services.

Data Access Layer
This is the layer for accessing the database for data retrieval and applying updates. It interacts with the Business Layer above.

The software uses the Microsoft SQL Server 2005 database. The servers running the application and the database are situated at the premises of the Norwegian Pollution Control Authority and managed by the section for Information Technology in the Norwegian Pollution Control Authority. The database possesses more than sufficient data capacity. This is illustrated by the fact that it can process up to 3000 unit blocks in one single transaction, which is far more unit blocks than have been experienced in the live production environment.

Conformance to DES and procedures to minimize discrepancies
All transaction processes in the registry are implemented in the registry software program in accordance with specifications set out in the data exchange standards (DES) for registry systems under the Kyoto protocol – Technical Specifications. This minimizes the risk of any discrepancies in issuance, transactions, cancellation and retirement of Emission Reduction Units (ERUs), Certified Emission Reduction (CERs), Assigned Amounts (AAUs) and Removal Units (RMUs) occurring.

All transaction involving the Norwegian registry, ITL and CITL will not be finalised until the transaction has passed all ITL and CITL checks and been registered on servers of all systems. The proposed transaction will be cancelled if it does not pass all checks. The registry administrator will undertake manual corrections if directed by the ITL and/or CITL administrator. Detailed administrative and technical procedures are implemented and will be executed in case of any discrepancies occurring.

The Norwegian registry was not involved in any discrepant transactions in 2008.

Security measures
There are security measures on both the network and physical level. Network security includes NATing, multiple firewalls, external monitoring and access restrictions on IP and port level. Web and Database servers are secured by user id and password, the latter defined by internal policy. Servers are physically sited in a restricted area only accessible to authorized personnel. There is also camera surveillance in this area.

The registry application is supplied with a default user name and password authentication module. The module is capable of generating a unique user name and a temporary password for each new user for initial logon. On their first logon, each user will be required to specify a new password to replace their temporary password. In addition, to prevent the situation whereby two users have the same password, the "SALT + Password" technique is applied.

The security related to the broadcasting over internet is handled by HTTPS protocol (Secure Socket Layer) when logging on to the system. Transfer of data to and from the registry is handled by VPN encryption.

Publicly available information
Reports with information from the Norwegian registry can be downloaded from the registry's own website. These include the following reports:

- User details reports – unchanged, updated and created.
- Account details reports – unchanged, updated, created and rejected.
- Operator holding account reports – unchanged, updated and created.
- Commitment Period Reserve Report.
- ERU and CER Allowed Quantity Report: the quantity of ERUs and CERs which the operators are allowed

to use when surrendering for compliance purposes.
- Holding and Transaction Report: information on amongst others. Kyoto units issued, units acquired from external registries, units transferred to external registries, and units cancelled where this information is considered as publicly available according to EU regulations.
- Compliance Status Report: information on the annual verified emissions from the operators, the amount of units surrendered and their compliance status.

More information on the accounts in the Norwegian registry, and the users of the different accounts, can be found on the search pages of CITL: www.ec.europa.eu/environment/ets/.

Internet address

The internet address of the interface to the registry is www.kvoteregister.no. The website contains updated information on registry issues in both Norwegian and English.

Both Norwegian and foreign individuals and organizations may apply for an account. The online pages to apply for an account are in Norwegian. English speaking organisations and individuals can apply for an account by submitting a complete account application form to the Norwegian Pollution Control Authority.

Measures to safeguard, maintain and recover data

Access to the room where registry hardware is stored is restricted to IT personnel only. The registry servers are located on virtual servers, i.e. our VMware ESX Enterprise server farm. This ensures availability in case of server hardware failures. Registry servers will automatically be moved to a healthy member of the ESX farm if hardware faults are imminent. Full database backup is taken two times daily with transaction logs on a daily four hour schedule. Full file backup is taken on each Friday and incremental file backup once every day between.

There is an off-site facility which also has a VMware environment. The registry servers can then be restored from backup medium in a short timeframe, i.e. typically within hours in case of a disaster at the Norwegian Pollution Control Authority's head office.

Testing of the registry

The performance, procedures and security measures of the Norwegian registry was thoroughly tested before the registry began live operations with the ITL. Different functionalities of the registry are tested every week in the ITL test environment, and internal administrative and technical procedures to safeguard the integrity of the registry are tested and revised on a frequent basis.

4. POLICIES AND MEASURES

4.1 Policy-making process

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

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

Norway is working towards an ambitious global climate agreement that will ensure a maximum global mean temperature rise of 2° C compared to the pre-industrial level. This is necessary to avoid dangerous climate change that threaten life on earth, and will require political leadership by all nations. Global emissions will have to be reduced by 50-85 per cent by 2050, most likely closer to 85 per cent.

White paper on Climate policy / national emission targets

The latest white paper on Norwegian climate policy is Report No. 34 (2006-2007) to the Storting[7]: Norwegian climate policy. This white paper and the subsequent Storting debate and recommendations are the foundation for the Norwegian climate policy. In these documents the general targets and the policy instruments to reach these targets are outlined. The main Norwegian climate targets are as follows:

- Under the Kyoto Protocol, Norway has an international obligation to ensure that its average annual greenhouse gas emissions in the period 2008–2012 do not exceed the 1990 emission level by more than one per cent. The Kyoto Protocol provides for parties to use the Kyoto mechanisms as a supplement to national measures in fulfilling their emission commitments.
- Strengthen Norway's Kyoto commitment by 10 percentage points, corresponding to 9 per cent below the 1990 level.
- Reduction of global greenhouse gas emissions by the equivalent of 30 per cent of our 1990 emissions by 2020. The Government considers that a realistic target is to reduce Norwegian emissions by 15-17 million tonnes CO2 equivalents relative to the reference scenario presented in the National Budget for 2007, when CO2 uptake by forests is included. In this case, about two-thirds of the cuts in total emissions by 2020 will take place in Norway.
- Norway has made a political pledge to achieve carbon neutrality, undertaking to reduce global greenhouse gas emissions by the equivalent of 100 per cent of its own emissions by 2050 at the latest.
- If an ambitious global climate agreement is achieved, in which other developed countries also take on extensive obligations, Norway will undertake to achieve carbon neutrality by 2030 at the latest.
- It is also a long-term objective for Norway to become a low-emission society.

The Government will in particular consider measures that will be cost effective with a projected rise in carbon prices over the lifetime of the investments, and that will not necessarily be implemented in response to current policy instruments. In this connection, priority will be given to measures that promote technological developments. Measures may also be considered to encourage the population as a whole to begin a changeover to a low-emission consumption pattern sooner than they would as a result of the projected rise in carbon prices alone.

In addition to the targets mentioned above, the political platform from the red green coalition government formed in October 2009 says that the 30 per cent target can be increased to correspond to a 40 per cent cut in emissions from the 1990 level by 2020, if this can contribute to agreement on an ambitious climate regime that includes specific emissions commitments on the part of the major emitters.

Policy instruments

Effectiveness, cost effectiveness and the polluter-pays principle are key criteria in development of policy instruments (see chapter 4.3.1.1). General policy instruments are a central element of the Government's domestic climate policy. Cross-sectoral economic instruments form the basis for decentralised, cost-effective and well informed measures to ensure that the polluter pays. More than 70 per cent of domestic

7 *The Norwegian parliament*

greenhouse gas emissions are either covered by the emissions trading scheme, subject to the CO2 tax or other taxes directed to reduce greenhouse gas emission. Certain sources of emissions cannot be incorporated into the emissions trading scheme or made subject to the CO_2 tax. In such cases, the authorities must use other instruments to reduce greenhouse gas emissions.

The Government's view is that further regulation should as a general rule be avoided in areas that are already regulated by means of general policy instruments. However, the Government wishes to retain the possibility of using other policy instruments in addition to emissions trading and taxes in these sectors too. For example, the petroleum sector is included in the emission trading scheme but is also subjected to CO_2 taxation.

In addition to demand-side instruments like emission trading and taxes, there is a need to support research on and innovation of climate friendly technologies such as renewable energy solutions and carbon capture and storage (CCS). Such measures should provide complementary support where markets do not provide the solutions.

To secure that the 2020 goal for national emission reductions is fulfilled the Government put in place the group "Klimakur 2020" in 2008. The group will propose tools and measures for achieving the 2020 emission target. Klimakur is a group lead by the Norwegian Pollution Control Authority which also includes the Public Roads administration, the Norwegian Petroleum Directorate, the Norwegian Water Resources and Energy Directorate and Statistics Norway. The Government intends to make five-yearly reviews of progress and how the use of policy instruments at national level should be further developed. The Ministry of the Environment plans to give its first review of the climate policy to the Parliament in 2010. Klimakur will be an important input to this review. For more information on Klimakur, see below.

In the white paper on Norwegian climate policy (Report No. 34 (2006-2007) to the Storting) the Norwegian emissions were subdivided into four sectors: Petroleum and energy, Transport, The manufacturing industries and Primary industries and waste management. The white paper sets out sectoral targets for these four sectors with the respective ministries as the responsible sector authority.

To meet the targets, action plans have been drawn up for the following sectors: petroleum and energy, transport, the manufacturing industries, primary industries and waste management, the municipalities, and functions in the state sector. The main purpose of the action plans is to identify measures that will result in cost-effective emission reductions that are not currently implemented in the sector concerned. This is also the starting point for the targets set out for each sector. The sectoral targets are based on estimates, and will have to be reconsidered in response to any changes in projections, costs, technological advances and other relevant factors. The current estimate for the technical emission reduction potential for each sector is presented, together with measures the Government intends to initiate.

Responsibilities for the different institutions

The Storting, sets the overall national climate policy, and the government implements and administers the most important policies and measures, such as economic instruments and direct regulations. Most policies and measures in the area of climate policy are developed through interministerial processes before the political proposals are tabled. The Ministry of the Environment has the overarching cross-sectoral responsibility for co-ordination and implementation of the Norwegian climate policy. The other Ministries are responsible for implementation in their respective sectors.

Local government is responsible for implementing policies and measures at the local level, for example through waste management, local planning and some transport measures. In September 2009 the Government introduced new guidelines for climate and energy planning in the municipalities (see chapter 5.3.1.1).

The Norwegian Pollution Control Authority is a government agency that reports to the Ministry of the Environment. The Norwegian Pollution Control Authority implements government pollution policy, and some of the most important fields of work include climate, hazardous substances, water and the marine environment, waste management, air quality and noise. The Norwegian Pollution Control Authority manages and enforces the Pollution Control Act, the Product Control Act and the Greenhouse Gas Emission Trading Act.

The Norwegian Pollution Control Authority grant permits, establish requirements and set emission limits, and carry out inspections to ensure compliance.

The Norwegian Pollution Control Authority also monitors and informs about the state of the environment. They have an overview of the state of the environment and its development. Together with other expert agencies the Norwegian Pollution Control Authority provide environmental information to the public. The main channel is State of Environment Norway: www.environment.no.

The Norwegian Pollution Control Authority supervises and monitors the County Governors' work on pollution, coordinates the County Governors' inspection

work and organises joint inspections. The Norwegian Pollution Control Authority provides guidelines for the County Governors and also deal with appeals against decisions made by the County Governors.

The Norwegian Pollution Control Authority participates in a series of international processes, where they work for regional and global agreements that reduce serious environmental problems. Moreover, the Norwegian Pollution Control Authority also cooperates with the environmental authorities in other countries, sharing competence and contributing to environmental improvements.

In the new policy platform for the red green coalition government it is stated that the Norwegian Pollution Control Authority will become the Climate and Pollution Agency.

Greenhouse gas budgets

In connection with the follow-up of Norway's strategy for sustainable development (see below) and the ordinary budgetary processes, reports and greenhouse gas budgets will be presented; these will evaluate the effects of climate policy on greenhouse gas emissions and present trends in emissions and progress in the implementation of climate policy. The Ministry of the Environment has published first generation greenhouse gas budgets in the 2009 and 2010 budget propositions. The greenhouse gas budgets will be further developed in the coming years.

Klimakur 2020

The project "Klimakur 2020" was initiated by the Government in June 2008 with the mandate to evaluate whether existing policy measures are sufficient to reach the Norwegian climate objectives in 2020, and to elaborate additional mitigation options and policy measures. The project will also evaluate the need for mitigation options and measures in a longer perspective. Klimakur 2020 will deliver its findings in February 2010. The Klimakur project has both a bottom up approach through in depth analysis of each sector (industry, oil manufacturing, energy production, energy use in buildings, transport, agriculture, and waste handling) as well as a top down approach through macroeconomic analysis of the total economy. Existing and additional mitigation options and policies in the various sectors are drawn up and analysed. The macroeconomic model can give an indication of the total cost, measured by the welfare loss, of the measures in the economy.

The main report from Klimakur 2020 will outline the main findings concerning possible compositions, effects and properties of necessary additional policy measures. The project has already published a report on price scenarios of future costs of emission trading allowances within the EU ETS scheme, and will also publish a report on international climate policies influencing Norwegian emission development and policy making.

Sustainable development

In the 2008 National Budget the Government presented a new National strategy for sustainable development covering the following policy areas:

- International cooperation to promote sustainable development and combat poverty.
- Climate change, the ozone layer and long-range air pollution.
- Biological diversity and the cultural heritage.
- Natural resources.
- Hazardous chemicals.
- Sustainable economic and social development.
- Sami perspectives on environmental and natural resource management.

To follow up the ambitious goals on sustainable development, Norway has integrated sustainability into the most important political and economic steering documents – the annual national budgets. Eighteen indicators, including one on Norwegian emissions of greenhouse gases compared with the Kyoto target, have been developed for monitoring progress in a systematic manner. All ministries report about their policies to the Ministry of Finance, which is responsible for coordinating the Government's work on sustainable development. Moreover, Statistics Norway reports annually on developments in all indicators.

A committee of state secretaries headed by the Ministry of Finance was established in 2002 to ensure political coordination of the efforts to promote sustainable development. From 2008, the committee also deals with climate issues. In 2008, a new arena for dialogue between government and civil society – the Meeting place for sustainable development – was created.

4.2 Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures

4.2.1 Domestic and regional legislative arrangements and enforcements

Norway has several legislative arrangements in place in order to reduce emissions of greenhouse gases, like for instance the Pollution Control Act, the Greenhouse Gas Emissions Trading Act, and the Petroleum Act. The relevant arrangement will be discussed in more detail in chapter 4.3.

4.2.2 Provisions to make information publicly accessible

Norway has undertaken extensive provisions to make climate information public available. This issue is discussed further in chapter 4.3 and 9.3.

4.3 Policies and measures and their effects

This chapter describes some of the most important policies and measures to reduce greenhouse gas emissions in Norway. For some of these policies and measures the effects on the greenhouse gas emissions have been calculated. These results are described in chapter 5.3.

4.3.1 Cross-sectoral policies and measures

4.3.1.1 Introduction

Effectiveness and cost effectiveness are two key criteria in environmental policy development, as in other policy areas. The polluter-pays principle is another key element of environmental policy. It lays down that the polluter should bear the costs of environmental damage.

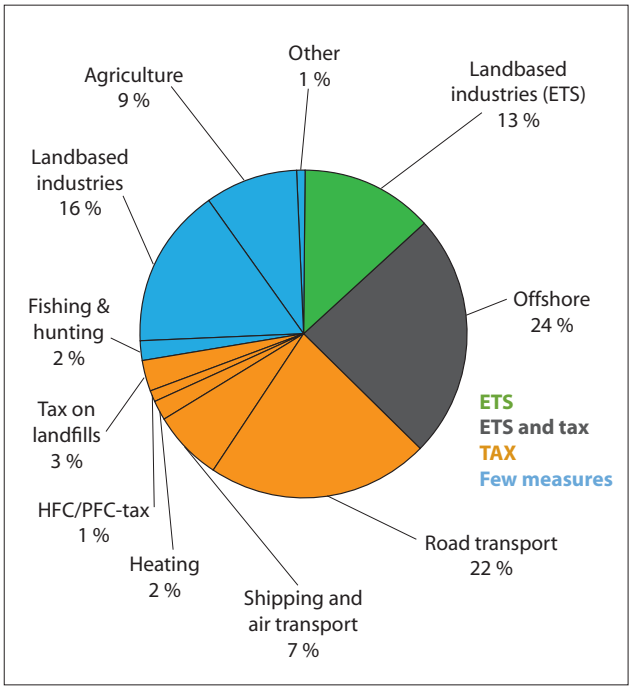
The effectiveness of policy instruments is measured by how reliably they lead to the achievement of policy targets. This is particularly important in relation to international commitments and national targets. In this case, the effectiveness of policy instruments to reduce greenhouse gas emissions is linked to whether Norway succeeds in complying with its Kyoto commitment by means of a combination of national measures and use of the Kyoto mechanisms. Effective policy instruments are also needed to ensure the implementation of new technologies that has not yet been commercialised.

Supply-side policies (e.g. research and development measures) to promote further development and innovation of climate technologies may also be coordinated with demand led policies in order to encourage both invention and adaption of climate technologies.

Cost effective policy instruments result in the implementation of measures that give the greatest possible emission reductions relative to the resources used. If policy instruments are not cost effective, society must accept an unnecessary loss of welfare in other areas in order to achieve environmental goals.

Climate policy instruments can be made cost effective by giving decision-makers in all sectors of society the same incentive to reduce greenhouse gas emissions. A cross-sectoral environmental tax is in principle a cost-effective policy instrument. However, the Government wishes to retain the possibility of using other policy instruments in addition to taxes or emissions trading. For example, the petroleum sector is included in the emission trading scheme but is also subjected to CO_2 taxation. Figure 4.1 shows climate measures by industry.

Figure 4.1 Climate measures by industry



Source: Statistics Norway, the Norwegian Pollution Control Authority and the Ministry of Finance.

4.3.1.2 Emissions trading

On 1 January 2005 Norway adopted the Greenhouse Gas Emissions Trading Act, thereby establishing an emissions trading scheme (ETS) that was to operate from 2005-2007. The establishment of the scheme from 2005 was an important step towards fulfilling Norwegian climate goals and quantitative commitments under the Kyoto Protocol.

The Norwegian emissions trading scheme for the period 2005-2007 closely resembled the EU ETS, and applied to about 10-15 per cent of total Norwegian greenhouse gas emissions. Emissions subject to CO_2 tax

were not included. Allowances for the period 2005-2007 were allocated to operators free of charge. The general rule was to allocate 95 per cent of average emissions in the period 1998-2001.

The Act was amended in June 2007 and February 2009. The amended Act gave the basis for the emissions trading scheme in the Kyoto Protocol commitment period (2008-2012). In this period the Norwegian ETS is linked with EU ETS. The total Norwegian cap is set about 20 per cent below the 2005 emissions from the installations concerned. The off shore petroleum sector does not receive any allocations free of charge, and have to buy all the allowances they need in the market, see also section 4.3.3. About half of the total quantity of allowances will be auctioned by the Government.

In addition to the sectors already included in the EU ETS, Norway decided in February 2009 to include emissions of nitrous oxide from the production of nitric acid. Such emissions constituted about 4 per cent of Norwegian greenhouse gas emissions in 2005. The emission trading scheme for the 2008-2012 period covers about 36 per cent of total Norwegian greenhouse gas emissions.

It is still to be decided how the EEA EFTA states will implement the revised EU Emissions Trading Directive for the period 2013-2020.

Operators included within the scope of the emissions trading scheme must report their CO_2 emissions the previous year to the Norwegian Pollution Control Authority by 1 March each year. If an operator does not submit an emission report in accordance with the provisions on reporting by 1 April, Norwegian Pollution Control Authority will suspend the operator's right to transfer allowances to other account-holders. The Norwegian Pollution Control Authority can also impose coercive fines and even penal measures in the event of serious contravention of its provisions. Excess emission fines are imposed if an insufficient amount of allowances is surrendered by 30 April. In addition, the operator must surrender an amount of allowances equivalent to the deficit the following year.

4.3.1.3 Green taxes

Green taxes are taxes imposed on activities that are harmful for the environment so that businesses and individuals must take into account the environmental cost of their activities on society. Some of these taxes are put directly on CO_2 emissions and have a climate motivation, others can be implemented for other reason but will often have an indirect impact on the greenhouse gas emissions. Table 4.1 gives an overview of the green taxes in Norway in 2009 and table 4.2 gives more detailed information about the CO_2 tax in particular.

4.3.1.4 The Norwegian CO2 tax scheme

CO_2 taxes were introduced in 1991 as a step towards a cost-effective policy to limit emissions of greenhouse gases. Except for some adjustment of coverage in the first years of operation, some extensions of the coverage in 1999, and abolishment of the tax on the marginal usage on coal and coke for energy purposes in 2003 the main structure of the tax has remained relatively stable.

Additional to these changes the CO_2 taxation of mineral oil usage in domestic aviation, domestic shipping of goods and for the supply fleet was raised from the reduced tax rate to the general tax level in 2006. In 2008 the tax rate of mineral oil usage in domestic aviation was raised even further to a level of NOK 0.10 per litre above the general tax rate.

As of 2009 the general tax level on CO_2 emissions corresponds to 214 NOK per tonne CO_2, but as can be read of from table 4.2 the tax level differs across energy products and range of use.

For the budget period of 2007 it was decided to expand the CO_2 tax to include gas for heating purposes in buildings. Due to the lack of an approval from EFTA Surveillance Authority (ESA), the tax has not yet been implemented. The Government has in the budget proposition for 2010 suggested to introduce the CO_2 tax on natural gas and LPG for heating purposes from 1 April 2010. This extension of the CO_2 tax will be accompanied by an energy tax on all usage areas of natural gas and all but heating for LPG. The energy taxes correspond to minimum rates of the Energy Tax Directive (2003/96/EC) and are introduced in order to get approval from ESA for the CO_2 tax.

In 2008 pricing of emissions through EU ETS (see chapter 4.3.1.2) replaced CO_2 taxes on use of mineral oil in land based industries, which is a part of EU ETS. Also the offshore petroleum sector was included in the scheme. Due to the fact that the Government wanted to keep the overall CO_2 pricing for this sector at approximately the same level as before the introduction of the scheme, CO_2 taxes were only reduced partly. Taxes were reduced on the basis of an expected allowance price of 160 NOK/ton CO_2. The CO_2 tax is now levied on about 55 per cent of total greenhouse gas emissions.

Table 4.1 Norwegian green taxe

Tax	Tax rate	Introduced
Tax on CO_2 emissions in petroleum activities on the continental shelf	varies, se table 4.2	1991
Tax on NO_x emissions in petroleum activities on the continental shelf, NOK/kg	15.85	2007
Petrol tax, NOK/litre		1933
Sulphur-free	4.46	
Low sulphur	4.50	
Auto diesel tax, NOK/litre		1993
Sulphur-free	3.50	
Low sulphur	3.55	
Lubrication oil tax, NOK/litre	1.77	1988
CO_2 tax	varies, se table 4.2	1991
Sulphur tax, NOK/litre per started 0,25 per cent weight share sulphur	0.074	1970
Tax on the final treatment of waste		1999
Landfills for waste disposal		
Landfills – High environmental standard, NOK/tonne	447	
Landfills – Low environmental standard, NOK/tonne	583	
Incineration plants, NOK/emission unit	varies	
CO_2 –tax on waste to be incinerated, NOK/tonne	62.35	
Tax on health- and environmentally damaging chemicals		2000
Trichloreten, NOK/kg	60.97	
Tetrachloreten, NOK/kg	60.97	
Tax on greenhouse gasses HFC and PFC, NOK/tonne CO_2 -equivalents	204.99	2003
Tax on emissions of NO_x, NOK/kg	15.85	2007
Base-tax on disposable packaging, NOK/unit	1.00	1994
Environmental tax on beverage packaging		1973
Carton and cardboard, NOK/unit	1.22	
Plastics, NOK/unit	2.95	
Metals, NOK/unit	4.88	
Glass, NOK/unit	4.88	
Electricity consumption tax		1951
General rate, NOK/kWh	0.1085	
Low rate (manufacturing), NOK/kWh	0.0045	
Base-tax on mineral oil		2000
General rate, NOK/litre	0,870	
Low rate (paper and pulp, dyes and pigments), NOK/litre	0.12	
Motor vehicle registration tax	varies	1955
Annual tax on motor vehicles	varies	1917
Annual weight-based tax on vehicles	varies	1993

Source: Ministry of Finance

Table 4.2 Norwegian CO_2 taxes 2009

	Tax rates NOK/litre, NOK/kg or NOK/Sm^3	Tax ratesNOK/ tonne CO_2
Petrol	0.84	363
Mineral oil		
High tax rate (domestic aviation)	0.67	
Jet kerosene		263
General tax rate	0,57	
Light fuel oil, diesel		214
Heavy fuel oil		182
Low tax rate (paper an pulp industry and fishmeal industry)	0.29	
Light fuel oil, diesel		109
Heavy fuel oil		92
Gas used for heating purposes		
Natural gas	0.49	209
LPG	0.64	213
Petroleum activities		
Light fuel oil, diesel	0.46	173
Heavy fuel oil	0.46	147
Natural gas	0.46	197

Source: Ministry of Finance

The petroleum sector accounted for 24 per cent of the total Norwegian greenhouse gas emissions in 2007. Consumption of mineral oil and petrol used for transportation purposes (inclusive domestic aviation and shipping), accounted for about 30 per cent of the total emissions. Additional to the CO_2 tax, a tax is levied on products which emit the greenhouse gases HFC and PFC, see section 4.3.1.7 and on greenhouse gases from final treatment of waste in landfill and in incineration plants, see section 4.3.8.

It is a challenge for a small open economy 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. Imports from regions without emission regulation may also replace domestic products. However, it is assumed that the design of the CO_2 tax system has not had significantly negative impacts for the competitiveness of Norwegian companies. Both the effectiveness of a cap and trade system, like the EU ETS, and the risk of carbon leakage from such scheme are largely dependent on the size and scope of the scheme. A more comprehensive scheme will help reduce the risk of carbon leakage as well as increasing the overall cost-effectiveness of the scheme.

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. Based on reports from the companies operating on the Norwegian Continental Shelf it is estimated that emissions of CO_2 from the petroleum sector in year 2000 were 2 million tonnes lower than they would have been in the absence of the CO_2 tax. In addition, 1 million tonnes of CO_2 per year (equivalent to 2 per cent of domestic emissions of greenhouse gases) has been separated from the Sleipner West's gas production and reinjected into the Utsira formation (an aquifer) since 1996. (See Section 4.4.1) This is also a response to the CO_2 tax. Thus, the tax may have reduced emissions by 3 million tonnes CO_2 in 2000, equivalent to 5 per cent of total greenhouse gas emissions in Norway. Energy efficiency measures, reduced flaring and

electrification (supply of power from the mainland) has reduced emissions by 1.5 million tonnes annually in 2004-2007. Carbon capture and storage (CCS) has furthermore been initiated for natural gas production on the Snøhvit field, reducing emissions by 0.7 million tonnes annually. Added together the estimates by the oil industry and the Norwegian Petroleum Directorate indicate that the CO_2 tax and the quota system contribute to emission reductions of approximately 5 million tonnes CO_2 in 2010. New planned measures like electrification and expected technology improvements might raise this estimate to almost 7 million tonnes CO_2 in 2020. It is emphasised that the forecasts of the future effects of the CO_2 tax and the quota system are very uncertain.

The CO_2 tax represents together with the basic tax on heating oil a modest proportion of approximately 15 per cent of the consumer price of heating oils to households. Emissions from heating purposes in households under the CO_2 tax, account for about 2 per cent of the national total emissions of greenhouse gases. The taxes will motivate households and construction industry to implement alternative heating systems, apply better isolation and to use energy more efficiently.

For some goods such as petrol, other tax elements (basic tax, VAT) constitute a larger proportion of the price than the CO2 tax. For example, in 2009 the basic tax on petrol is NOK 4.46 per litre, whereas the CO_2 tax is NOK 0.84 per litre. There is also a SO2 tax on mineral oil. Thus, the total tax on such goods must be taken into account when comparing tax levels with other countries. Taxes and rates as of 2009 are shown in Table 4.1 and 4.2. However, to the extent that the CO_2 tax has increased the price of transport fuels, it is reasonable to assume that it must also have limited the increase in the volume of transport somewhat, led to some changes in choice of transport medium and encouraged the purchase of more fuel-effective vehicles than would otherwise have been bought.

In recent years the Government has skewed the taxation of the vehicle purchase tax towards green taxes, please view Section 4.3.4 about transportation.

4.3.1.5 Sectors not covered by economic instruments

Sectors not covered by a tax on greenhouse gases or emissions trading are mainly emissions from most of the process industry, agriculture and fishing. Emissions from agricultural are subject to CO_2 tax on use of fossil fuels, but there are no such measures in place for emissions that are associated with methane and nitrous oxide from animal husbandry, fertilisation and soil management. Such emissions are estimated to originate about 9 per cent of the greenhouse gas emissions in Norway (se chapter 4.3.6).

The process industry is also liable to CO_2 tax on their use of mineral oil. Emission from certain processes is also a part of the emission trading scheme, and if following the EU ETS for the next period, a larger part of these emission will be liable to deliver allowances.

The fishing sector is exempted from the CO_2 tax on mineral oil. CO_2 emissions from this sector are estimated to about 2 per cent of national greenhouse gas emissions. Steps have been taken to evaluate how the fishing sector can contribute to emission reduction and this work is currently in progress.

In chapter 4 of the National Budget 2009-2010 the Ministry of Finance reports on tax expenditures and tax sanctions including among others the CO_2 tax, fuel taxes and other relevant environmental taxes.

4.3.1.6 Regulation by the Pollution Control Act

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

As a general rule, the emitter is granted a discharge permit for CO_2 corresponding to the amount in the application. Greenhouse gas emissions are to a large extent covered by other specific policy instruments such as the CO_2 tax, the emission trading scheme and specific agreements with the industry to cap emissions. These instruments have been regarded as more efficient tools for reducing greenhouse gas emissions than quantitative limitations set in the installations' individual discharge permits.

The Emission Trading Act has reduced the need for specification of emissions limits for greenhouse gases. The Pollution Control Act may still be used to specify technological requirements relevant to emissions. These technological requirements will be formed as conditions laid down in the permit issued in accordance with the Pollution Control Act, for instance a requirement to implement carbon capture and storage. This is currently a prerequisite for all new gas fired power plants.

In the waste sector, regulations under the Pollution Control Act are used to ensure minimum environmental standards of landfills and incineration plants, and to regulate the handling of certain waste fractions. The EU directives on waste are implemented. The waste regulation includes the following measures:

- Requirement to collect methane from landfills (gradually introduced from 1998).
- Prohibition of depositing biodegradable waste (introduced 1 July 2009 with an opening for exemptions until 2013).
- Requirement to utilize energy from incineration.

From 2002 landfilling of wet-organic waste has been prohibited. This prohibition is replaced by the wider prohibition of depositing that applies to all biodegradable waste.

The waste regulation includes a formulation that incineration plants should be designed and operated with a view to energy utilization. This is normally followed up in the concessions of the plants by a condition that at least 50 per cent of the energy from the incineration should be utilized.

For the effects of these measures, see section 4.3.8 and 5.3.

4.3.1.7 Tax and reimbursement scheme for HFC

The growth trend in HFC and PFC emissions changed from exponential to linear after a tax on import and production of HFCs and PFCs was introduced in 2003. The tax is NOK 204.99 (approximately EUR 24) per tonne CO2 equivalents of gas imported or produced. This approximately equals the CO_2 tax rate on mineral oil. In 2004, this tax was supplemented with a refund scheme, which prescribes a similar refund when gas is destroyed. Combined and over time, these two schemes amount to a proxy tax on emissions of HFC.

The tax and reimbursement scheme has resulted in better maintenance and improved routines during discharge of old equipment. It also gives a strong incentive for choosing HFCs with lower Global warming potential or alternative substances and processes (for example indirect systems).

The tax has significantly reduced growth in emissions compared to pre-tax scenarios, which forecast very strong growth due to substitution of CFCs and HCFCs by HFCs. However, a moderate linear annual growth in HFC emissions is still observed.

4.3.1.8 Environmental technology and innovation

Environmental technology is a prioritized area in the Norwegian public support system for R&D and innovation.

Through different schemes n the Research Council of Norway and Innovation Norway, it is granted approximately NOK 1.8 billion to this purpose on an annual basis. In addition, financial support to development of climate- and energy technologies is granted by Enova and Gassnova. Especially in the areas of renewable energy, energy efficiency and carbon-capture and storage there has been a substantial increase in public funding of R&D in the period from 2008 to 2010 with NOK 600 million.

To promote innovation of environmental friendly technology there is need for supply-side instruments like R&D as well as demand side instruments like regulations, emission trading scheme and other economic instrument. Public procurement may also be important to promote innovation of climate friendly technologies.

The Norwegian Government is currently developing a national strategy for environmental technology, in consultation with a Strategic Council for Environmental Technology with representation from industry, knowledge societies, environmental organisations and trade unions.

4.3.1.9 Accounting for the Kyoto mechanisms

Norway was found eligible to participate in the Kyoto mechanisms on 22 April 2008. The Norwegian Pollution Control Authority has been assigned the tasks as Designated National Authority for the Clean Development mechanism (CDM), as well as Designated Focal Point for Joint Implementation (JI). The Norwegian Pollution Control Authority also operates the Norwegian registry.

Acquisitions and transfer of Kyoto units to and from the Norwegian registry will take place under all three mechanisms; trade with Assigned Amount Units (AAU), CDM and JI. According to the projections in chapter 5, to achieve the commitment in the Kyoto Protocol's article 3, it will be necessary to realize about a further 7.2 Mt annually through national measures and/or net acquisitions of Kyoto units (see table 4.3). Net acquisition of Kyoto units will also be crucial in achieving Norway's target of reducing emissions by 10 percentage points more than its Kyoto commitment.

Norway's emissions trading scheme for Norwegian companies is part of the emissions trading scheme under the Kyoto Protocol, since each unit in the scheme is backed by an Assigned Amount Unit (AAU). Norway's total quantity of allowances in the trading system is fixed at 15 Mt/year and is about 7 Mt/year lower than projected emissions for this sector of 22 Mt/year. This implies that the system in itself will lead to a net acquisition of Kyoto units that will both close the projected gap and lead to projected average surplus of 1.3 Mt/year. The trading scheme also allows companies the use of units from CDM and JI, but this use is capped at a level of about 3 Mt/year (20 per cent of the total quantity of allowances). This cap is applied through a domestic regulation, allowing each installation to use project based units up to 13 per cent of their actual emissions. This figure reflects that the total quantity of allowances is considerably lower than projected emissions for the trading sector.

Table 4.3 Norway's Kyoto inventory. Annual averages[1]. Million tonnes CO_2 equvialent

	Million tonnes CO_2 equvialents	
A. Norway's emissions. Projection 2010	57.3	
B. Norway's assigned amount (Kyoto-quota)	50.1	
C. Gap between 2010 emissions and assigned amount (A-B)	7.2	
D. Effect of forest management	1.5	
E. Net import of quotas from the EU (i-ii-iii)	7.0	
i) Emissions from ETS-businesses. Projection 2010		22.0
ii) Quotas to ETS-businesses free of charge [2]		8.7
iii) Sale of EU-ETS quotas from Norway		6.3
F. Kyoto commitment after net import from the EU (D+E-C)	1.3	
G. Target about overfulfilment of the Kyoto agreement[3]	6.7	
H. Governmental need to buy quotas. Projection 2010 (G-F)	5.4	

1) Projected emissions in 2010 are used as annual averages in the Kyoto-period.
2) Includes a quota reserve of 0.8 million tonnes annually, that can be sold if not used.
3) Includes a strengthening of Norway's Kyoto commitment by 10 per cent, quotas equivalent to the uptake of CO2 in forests, governmental employees international air travel etc.
Source: Ministry of Finance.

Further, a governmental purchase programme has been established under the Ministry of Finance (please view www.carbonneutralnorway.no). This programme will acquire Kyoto units and will ensure that the fulfilments under the Kyoto Protocol are met. The Ministry of Finance is authorized by the Parliament to contract delivery of carbon credits from the Kyoto Protocols flexible mechanisms. The combined authorization and appropriation for 2009 is NOK 7 billion, or about EUR 600 million. The Ministry has planned to contract some 25 to 30 million tons for delivery during 2008-2012, corresponding to 5-6 Mt/year for the period. Since emissions has grown less than anticipated when the program was established, this may entail a lower need for net acquisitions. By the end of 2009 the delivery of about 12 Mt is contracted under the program.

4.3.2 Sector specific policies and measures

4.3.2.1 Electricity production on the mainland

Almost all electricity produced on the Norwegian mainland is based on hydropower. Thus, nearly all CO_2 emissions from electricity production are related to offshore petroleum production. These emissions and the measures for reducing them are accounted for under chapter 4.3.3.

Norway has two gas-fired power plants in operation. Statoil is operating an integrated gas-fired liquefaction plant in northern Norway and Naturkraft AS is operating the gas-fired power plant at Kårstø. These two plants have a maximum production capacity of 5 TWh and could generate total CO_2 emissions of about 1.5 million tonnes per year. The government has decided to halt the procurement process for the assignment of contracts to construct the CO_2 capture and storage facility at Kårstø, until the gas-fired power plant's operational pattern becomes clearer or other solutions that ensure regularity of production and emissions of CO_2 from the power plant become evident. At the same time, the Government will consider an integration of energy systems between the power plant and the gas processing facility at Kårstø, which may contribute to a reduction of total emissions.

The Government has granted construction and operating licences for three other gas-fired combined cycle power plants in Norway. Statoil has received licence to a power plant at Mongstad, which is now under construction. A carbon capture and storage project on Mongstad is based on an implementation agreement between the Norwegian State and Statoil, and an emission permit issued by the Ministry for the Environment (see chapter 4.3.9). Industrikraft Møre and Industrikraft Midt-Norge have received licenses for Fræna and Skogn. For these licences no investment decision has been taken. These three plants would have a maximum production capacity of approximately 12 TWh/year. Total CO_2 emissions from Mongstad and Skogn may be up to about 2.5 million tonnes per year. The licence given to Industrikraft Møre requires carbon capture and storage and therefore CO_2 emissions from this power plant will not exceed 0.17 million tonnes per year.

Gas-fired power plants are covered by the Greenhouse Gas Emissions Trading Act, and the gas-fired power plant at Kårstø has been given allowances free of charge according to the Act.

4.3.2.2 *Use of new renewable energy sources and energy efficiency*

In Norway there is an integrated strategy for increased production of renewable energy and energy efficiency. As a part of this strategy the development of wind power and renewable heat production has been singled out with its own quantitative targets. The Government's targets are to develop 3 TWh/year wind power, 4 TWh/year renewable heat production by 2010 and 14 TWh new bioenergy by 2020.

The national energy agency Enova SF is responsible for promoting the integrated strategy for renewable energy and energy efficiency. Enova SF is a public enterprise owned by the Norwegian Ministry of Petroleum and Energy. Enova SF`s main mission is to contribute to environmentally sound and rational use and production of energy, relying on financial instruments and incentives to stimulate market actors and mechanisms to achieve national energy policy goals. The most important criteria for project selection is kilowatt-hours saved (energy efficiency projects) or new capacity installed (energy supply projects) in relation to funding. Enova also participates in international activities and acts as an adviser to the Ministry of Petroleum and Energy in questions related to energy efficiency and renewables. The Norwegian Water Resources and Energy Directorate is responsible for tasks related to implementation of the legal framework and policy questions concerning the demand and supply of energy

Renewable energy

Enova's energy goal is 18 TWh new renewable energy production or energy savings by the end of 2011. It is also stated that the ambition is to reach 40 TWh by 2020. The goals for wind power and renewable heat are an integrated part of the long term goal. Enova's most important measure is investment support granted from the Energy Fund.

The grant of investment support is based on competition between projects which fall within Enova's scope. The targeted policy for development of wind power and the support programme has led to great interest among the industry, which again has led to a great number of planned projects, applications for licenses and wind farms being constructed. By medio 2009 there were around 45 wind power projects that had applied for license with a total electricity generating capacity of 5000 MW, 35 projects with a total capacity of approximately 1500 MW were granted licenses and another 18 projects with a total production capacity of 428 MW were completed. Like other forms of energy production, wind power influences the environment and other interests and the challenges of wind power plants in marine and terrestrial environments are different. It is therefore a precondition that the development of wind power is done in a sustainable way. The Norwegian licensing system plays an important role in securing a sustainable wind power sector in Norway. The licensing process is regulated in the Energy Act and the Planning and Building Act. Besides taking energy system impacts into account, the licensing process involves a thorough assessment of possible environmental impacts and influence on other interest as for example tourism and defence matters.

For the period 2002 – 2008 the total energy result from Enova`s activity within renewable energy was 5.3 TWh/year. The energy results are shown by adding up the energy amounts in the contracts Enova signs with actors who have been allocated funds for their projects (contractual results). The projects included in the reporting are therefore not necessarily completed in the year in which they are reported.

A memorandum of understanding between Sweden and Norway establishing the principles for a common green certificate market was signed 7 September 2009. The understanding establishes some key principles, such as equivalent ambitions in both countries, the time of implementation (1.1.2012) and a principle of non-discrimination between technologies.

Energy efficiency

Measures to limit energy consumption have been a part of Norwegian energy policy since the 1970s. Several measures are financed today through Enova. Energy use is also influenced by the provisions of the Energy Act and the Planning and Building Act, labelling requirements and standards for electrical equipment, various grant schemes and taxes.

The schemes for increased energy efficiency and energy savings are an integrated part of the energy agency Enova's programme structure. Enova's energy efficiency programmes are aimed at measures in all industrial sectors as well as the building sector and the household sector, see also Section 9.7. Enova reports results from the allocation of grants to projects in the form of contractual energy results. For the period 2002 – 2008 the total energy result from Enova`s activity within energy efficiency is 5.5 TWh/year. Improvements in energy efficiency in buildings and industry account for roughly 50 per cent of the total results so far of 10.8 TWh.

4.3.3 The petroleum sector

4.3.3.1 Emissions

CO_2 emissions

The petroleum sector emitted 13.4 million tonnes CO_2 in 2007. CO_2 emissions from the petroleum sector are expected to increase until 2019 and then decrease. The majority of CO_2 emissions from the petroleum sector stem from combustion of natural gas and diesel in turbines on offshore installations. In 2007 this accounted for 75 per cent, while the corresponding figure in 2006 was 90 per cent. Other CO_2 emissions originate from onshore oil and gas terminals and indirectly from NMVOC emissions (process emissions). Total CO_2 emissions from the sector have grown year by year, primarily as a result of increased activity level, more mature oil fields and increased gas production and sales.

Increased total emissions in absolute numbers have coincided with a more efficient petroleum production. Emissions of CO_2 per standard cubic meter oil equivalent are 47 kg compared to an international average of 120 kg. Improvements in the utilization of energy and reductions in flaring have, however, not been significant enough to counterbalance the increase in energy consumption from higher levels of activity. Emissions linked to the production of a unit of oil equivalent will vary both between fields and over a single field's lifetime. Transport distances to the gas markets and reservoir conditions are factors that cause the energy requirements, and hence emissions, to vary from field to field. In addition, a field will have higher emissions per produced unit the older it gets, due to the fact that the proportion of water in the well stream increases as the field ages. The trend on the Norwegian Continental Shelf towards more mature fields and the movement of activities northwards is leading towards increased emissions per produced unit.

Methane emissions

Methane emissions in the oil and gas industry accounted for 31.500 tonnes in 2007. These emissions are largely caused by landing and loading of crude oil offshore. Methane emissions from the oil and gas industry have been increasing since 1990 due to higher production.

4.3.3.2 Measures

1 January 1991 the Norwegian government introduced a CO_2 offshore tax regime which includes all use of natural gas, oil and diesel in connection with petroleum activities on the Norwegian Continental Shelf. As of 1 January 2009 the CO_2 tax is NOK 0.46 per litre of oil and per standard cubic metre of natural gas (equivalent to NOK 197 per tonne of CO_2 for natural gas and NOK 147-173 per tonne CO_2 of mineral oil depending on product quality). The CO_2 tax has so far been the most important instrument for reducing emissions in the petroleum sector and has had a significant impact. The low level of CO_2 per produced oil equivalent is to a great extent due to general improvements in technology and emission reducing measures, as a result of the introduction of the CO_2 tax in 1991. Another important consequence is the CO_2 storage projects at Sleipner and Snøhvit.

Under the Petroleum Act, companies may not flare more gas than absolutely necessary to ensure normal operation. Governmental approvals have to be given under both the Pollution Control Act and the Petroleum Act.

The Greenhouse Gas Emission Trading Act established a system of tradable CO_2 allowances. The system is linked to EU's Emission Trading Scheme. From 2008 offshore activities were included in the emissions trading system while the sector is still subjected to a CO_2 tax, although at a lower level (see chapter 4.3.1.4).

In adddition to the overarching policy instruments, there are also concrete, practical measures on the Norwegian Continental Shelf. Both the petroleum authorities and the oil companies have a strong commitment to research and technology development aiming to reduce emissions in the sector. The petroleum authorities facilitate several research programs. This has yielded results, and many of the solutions first applied in Norway have become export commodities.

The Sleipner project

Norway has extensive experience in storing CO_2 in geological formations. As a result of the CO_2 tax introduced in 1991, the Sleipner CO_2 storage project in the North Sea was initiated in 1996. One million tonnes of CO_2 per year have been separated from the natural gas produced on the Sleipner West field in the North Sea and stored in the Utsira formation; a saline aquifer located 1.000 meters below the seabed. The aquifer consists of unconsolidated sandstone and thin horizontal shale layers that spread the CO_2 laterally. The seal consists of an extensive and 800 meter thick shale layer. The Sleipner Project is unique being so far the only facility in the world where large quantities of CO_2 are stored in a geological formation below the seabed and for emission mitigation purposes. All the results from the Sleipner project are made publicly available at: www.co2store.org.

The Utsira formation is by no means an unusual geological formation in terms of storage potential, and the Sleipner storage operation represents just one of many subsurface storage scenarios.

The second CO2 storage project in Norway is in the Barents Sea. The Snøhvit field provides gas to the world's first Liquefied Natural Gas plant with carbon capture and storage. The first amount of CO_2 was injected and stored from the Snøhvit field in April 2008. At full production, 700.000 tonnes of CO2 will be separated from the natural gas annually and then piped back 160 km and reinjected and stored in the Tubåen Formation, a saline aquifer. This formation is located 2.600 metres below the seabed.

A program has been set up for monitoring the behaviour of the injected CO_2. The monitoring program builds on the experience gathered in the Sleipner Project and involves several companies and a series of research institutions partly financed by the European Union (the CASTOR-project) under the 6th Framework Program. The overall goal of the CASTOR project is to develop and validate, in public/private partnerships, all the innovative technologies needed to capture and store CO_2 in a reliable and safe manner. Regarding the storage, the objective is to obtain secure management of storage sites by improving assessment methods, defining acceptance criteria, and developing a strategy for safety-focussed, cost-effective site monitoring. The "Best Practice Manual" has been improved by adding four European cases, one of these being the Snøhvit-case. Another partly EU financed research project, the CO2ReMoVe project, aims to develop innovative research and technology for the monitoring and verification of geological storage of CO_2. The consortium behind this project proposes a range of monitoring techniques, applied over an integrated portfolio of storage sites.

In accordance with the Pollution Control Act and the Petroleum Act, Statoil has been required to monitor the CO_2 storage in the Utsira and Tubåen reservoirs and to report the results to the Norwegian Pollution Control Authority annually.

4.3.3.3 Indirect CO_2 emissions from NMVOC

Non-methane volatile organic compounds (NMVOC) is not one of the six gases in the Kyoto protocol. Nevertheless NMVOC emissions may lead to indirect CO_2 emissions, and therefore measures taken to reduce the NMVOC emissions also reduce the CO_2 emissions.

The petroleum sector is the primary source of NMVOC in Norway accounting for 41 per cent of the total emissions in 2007. The emissions come from the storage and loading of crude oil offshore. The petroleum sector's share is decreasing as a result of the phasing in of emission reducing technology.

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

Starting from 2001, emissions of NMVOC linked to offshore loading and storage of crude oil have been governed under the emission permit system, pursuant to the Pollution Control Act.

For a number of years, several oil companies have worked to make technology for recovering NMVOCs available to storage vessels and shuttle tankers. Proven recovery technology now exists, and this technology reduces emissions from loading by around 70 per cent. Several vessels have installed emission reducing technology. A recovery installation for NMVOCs was deployed at the crude oil terminal at Sture in 1996.

From 1 January 2003, a requirement was issued that all vessels must be fitted with equipment for recovering NMVOCs, and ships are not normally granted access to the installation without the necessary equipment.

Table 4.4 Summary of the policies and measures in the transport

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Statusc	Implementing entity or entities
Energy efficient car park	Influence car ownership decisions	CO_2	Purchase tax, vehicle tax,CO_2 tax, promoting electric vehicles,	Ongoing	State
Low and zero emission vehicles and fuels	Influence car ownership decisions	CO_2	Turnover requirement, biofuels, promoting EVs and hydrogen vehicles, R&D, Subsidy scheme (Transnova), tax incentives	Onging	State
Reduce transport volums	Influence travel decisions	CO_2	Restrictive measures (parking and urban road pricing scheme), land use planning	Ongoing	State, regional and local authorities
Modal shift	Transfer freight and private transport away from road and air	CO_2	Build and maintain railway, ports and bicycle lanes, subsidize public transport, CO_2 tax on domestic aviation	Ongoing	State, regional- and local authorities

4.3.4 Transport

The transport sector includes road transport, civil aviation, navigation, railway and off road vehicles and other machinery. The table 4.4 shows a summary of policies and measures in the sector.

4.3.4.1 Emissions

CO_2 emissions

About 32 per cent of the total Norwegian greenhouse gas emissions originate from transport[8]. Out of this about 20 percentage points originate from road transport and aviation. The last decades have shown a substantial increase in emissions from the sector, and the Government's goal is that existing and new measures in the transport sector will result in a reduction in emissions between 2.5 and 4.0 million tons CO_2 equivalents (12 to 19 per cent) in relation to expected emissions in 2020.

Nitrous oxide (N_2O)

The transport sector was responsible for 1500 tonnes of N_2O emissions in 2007, corresponding to 11 per cent of total N_2O emissions. The main source is motorised tools and road traffic. Road transport is responsible for 500 tonnes. General measures to reduce emissions from road traffic may also reduce the emissions of N_2O in the transport sector, but no specific measures to reduce N_2O emissions have been introduced.

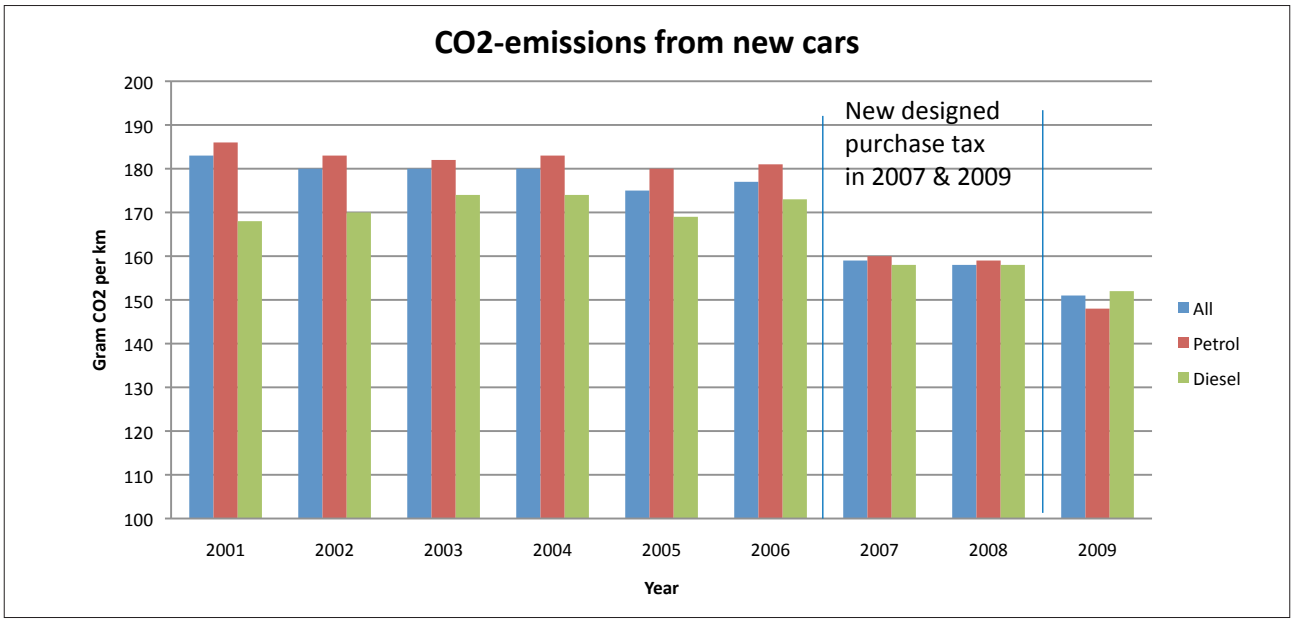
4.3.4.2 Measures

Economic incentives together with research and technological development are major priority areas in the climate action plan presented in the most recent white paper on climate policy (Report No. 34 (2006-2007) to the Storting) (see chapter 4.1). Norway is designing instruments that promote transport user behaviour which is energy- and climate conscious. In addition, technological advances are vital if we are to find better and cheaper ways of reducing emissions in Norway and other countries.

The CO_2 tax is the main instrument for limiting CO_2 emissions from the transport sector. The tax rates as of 2009 are NOK 0.84 per litre petrol. Since 1 January 1999, fuel for domestic air traffic have also been subject to the CO_2 tax, and the tax rate is currently NOK 0.67 per litre jet kerosene, NOK 0.10 above the general CO_2 tax on mineral oil. International air traffic is still exempted from the CO_2 tax due to international regulations. In addition, the overall tax level on transport fuels in Norway is of the highest in the world, though

8 The transport sector includes road transport, civil aviation, navigation, railway and off road vehicles and other machinery.

Figure 4.2 CO_2 emissions from new passenger cars1.



[1] *Figures for 2009 are from January through September 2009. Source: www.ofv.no*

in line with other Western European countries. Great Britain and Germany have even higher tax levels.

Changes in the vehicle purchase tax towards a system that rewards vehicles with low CO_2 emissions and penalize vehicles with high emissions has lead to reduced emissions from new cars. The registration fee on cars depends on the weight, engine and CO_2 emissons of the car. The registration fee on CO_2 emissons was introduced in 2007 and gives strong economic incentives to choose cars with low emissions. This is reflected in the average CO2 emission from new cars, which has been reduced from 177 g/km in 2006 to 151 g/km in the period January to September 2009, see figure 4.2. The Government wants to reduce the average CO_2 emission to 120 g/km within 2012, and the skewing towards green taxes will be enhanced in 2010. It is reasonable to assume that the positive trend with lower emissions will continue.

The blue column shows average emissions from new cars (g/km), the red emissions from new petrol cars and the green emissions from new diesel cars. The blue stripes indicate the introduction and the adjustment of the CO_2 element in the purchase tax in 2007 and 2009.

Norway believes that technology neutral policies are best suited to push forward the best technologies. Through the Agreement on Norway's climate policy the government are increasing the effort on research, development and demonstration of climate friendly transport technology. In addition, the government aims to provide necessary infrastructure for vehicles that can use renewable energy (electric vehicles, hydrogen vehicles and flexifuel vehicles on biofuels). In 2009, the Government established a subsidy program – Transnova – to subsidize demonstration projects and market introduction of climate friendly transport technologies. Transnova's total budget for 2009 was NOK 100 million, and the amount for 2010 will be NOK 52 million.

Norway provides strong user incentives for zero emission vehicles: electrical cars and hydrogen cars are exempted from the purchase tax and the road toll, and they can drive in the public transport lane. In order to increase the number of electrical vehicles further, the government has introduced a charging infrastructure scheme as well as initiated a Scandinavian partnership for electrification of the transport sector.

In order to increase the use of biofuels, there is a mandatory biofuels turnover in Norway. In 2009, there will be 2.5 per cent by volume biofuels in the Norwegian fuel market. The Government has signalized an intention to increase the mandatory biofuels turnover to 5 per cent by volume. It is also intended that sustainability criteria's for biofuels will be introduced together with an increase in the mandatory biofuels turnover volume. In addition, the Norwegian Government is working on a strategy for increased research and development on second generation biofuels.

The tax system is designed so that Norway has high CO_2 taxes on petrol and diesel, while bio ethanol, biodiesel and hydrogen are exempted from these taxes. Currently biodiesel is also exempted from the high

general tax on auto diesel. The Government has in the budget proposition for 2010 signalized a phase in of auto diesel tax on bio diesel since the auto diesel tax is meant to price external road cost which is largely independent of fuel type. Biofuels with bioethanol content above 50 per cent, like E85, will still be exempted from the high general petrol tax. Flexifuel vehicles have lower purchase tax than cars running on petrol and diesel.

It is vital that mobility needs in larger urban areas are met with modes of transport that result in as little air pollution, noise and land-use as possible. Normally this means a modal shift from private cars to public transport. To achieve this, there is a need to develop a competitive public transport system, as well as introducing measures to manage and curb road traffic. The Government therefore seeks to introduce a wider congestion charging system in order to reduce congestion, reduce air pollution, and noise in the city centres. Congestion charging needs to be initiated locally and to stimulate the use of this measure the government uses a reward scheme as an incentive.

The reward scheme for the largest cities was established in 2004 to make grants available to those local governments that achieve positive results increasing shares of public transport at the same time as managing traffic growth with private cars. The grant should be spent on increased level of service for public transport (higher frequency, improved travel speeds etc), and the local governments are encouraged to apply restrictions in automobile use (congestion charges, local fuel taxes, reduced parking, building regulations etc). Since 2004, the scheme has grown both in the number of cities included and with respect to the total grant.

The Government gives high priority to public transport, especially railway transport. Over the last four years the investment in new railways as well as funding maintenance of existing railways has increased substantially, and is planned to continue to rise within the next 10 years period.

Policies and measures are also implemented in order to stimulate walking and the use of bicycles. There is a potential for increased cycling in Norway, and there is a national goal of 8 per cent bicycle share of total number of daily travels within the next 10 years period.

The largest emission challenge in air traffic is related to large airplanes and long distance flights and Norway therefore welcomes international regulations on international aviation. Norway will work to promote the inclusion of international air traffic in future international agreements on climate change.

4.3.5 Industry

4.3.5.1 Emissions

CO_2

CO_2 emissions from industrial processes were 7.4 million tonnes in 2007, including both emissions from processes and emissions from stationary combustion. The same emissions in 1990 were 7.0 million tonnes. The CO_2 emissions from industrial processes accounted for 16.6 per cent of total CO_2 emissions in 2007.

About 64 per cent of the CO_2 emissions from industry are from metal production. Metal production in Norway includes plants producing iron, steel, ferroalloys, aluminium, nickel, zinc and also magnesium until spring 2006. Production of anodes is also included. Emissions of CO_2 from metal production were 4.8 million tonnes in 2007, where aluminium production and ferroalloys production accounted for about 2.2 and 2.1 million tonnes respectively. CO_2 emissions from metals manufacturing derive primarily from the use of coal, coke and charcoal as a reducing agent, and are therefore primarily dependent on the volume of production. Hydropower is used as the main energy source, causing virtually no direct CO_2 emissions from energy use.

Mineral production is the second largest emission source in manufacturing industries, and with 1.0 million tonnes of emissions, accounting for about 14 per cent of the emissions from industry. The largest emissions in this sector in 2007 originated from cement production and lime production.

Manufacturing of chemicals accounted for about 6 per cent of the CO_2 emissions from industry. In 2007, emissions from chemical industry in 2007 were 0.4 million tonnes, where ammonia production accounted for 0.3 million tonnes.

CO_2 emissions from stationary combustion constituted about 15 per cent of the total CO_2 emissions in 2007, a decrease of 6 per cent compared to 1990. The reduction in CO_2 emissions is mainly caused by a change in energy use from oil to electricity. However, these emissions are very sensitive to winter temperatures and fuel prices, since many heating system can switch to oil when electricity prices are high.

Nitrous oxide (N_2O)

The main industrial source of emissions of nitrous oxide is the production of nitric acid. There are two plants in Norway where nitric acid is produced. In 2007, emissions of nitrous oxide from this sources amounted to about 1.38 million tonnes CO_2 equivalents, corresponding to about 3 per cent of total greenhouse gas emissions in Norway. The emissions of nitrous oxides have decreased by 34 per cent from 1990-2007 while the production of nitric acid increased by 22 per cent. The

observed reduction is due to improved technology in the nitric acid production. Since 2008 N_2O-emissions from these two plants are included the emission trading scheme.

Emission of PFCs from aluminium production

Aluminium production is the main source of emissions of the perfluorocarbons (tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6)) from industry.

The emission of CF_4 and C_2F_6 from Norwegian aluminium plants in 2007 were 108.7 tons and 10.3 tons respectively, corresponding to a total of 0.8 million tons of CO_2 equivalents. PFCs emission from production of aluminium contributes to 1.5 per cent of the total GHG emission in Norway in 2007.

Total emissions of PFCs were decreased by 76 per cent in the period 1990-2007. The emission of CF_4 decreased by 77 per cent, while the emission of C_2F_6 decreased by 72 per cent in the same period. PFCs reductions are caused by improved technology and process control, which has led to 84 per cent decrease in the amount of PFCs emitted per ton aluminium produced during the period from 1990 to 2007. In 1990, the emissions of PFCs were 3.88 kg CO_2 equivalents per ton aluminium produced, decreasing to 0.60 kg per ton aluminium om 2007.

Emissions of SF_6

Up to 2007 the largest source of SF_6 emissions in Norway was magnesium production. The consumption of SF6 was reduced through the 1990s due to improvements in technology and process management and reduced production. The plant that used to produce magnesium in Norway closed down the production of primary magnesium in 2002, and only the secondary production was retained. During 2006 also the production of remelting magnesium stopped and there were no emissions from this source in 2007.

The main other source of SF_6 is in gas insulated switchgears (GIS) and other high-voltage applications. Since the signing of a voluntary agreement in 2002, emissions from this sector have decreased 26 per cent until 2007.

Emissions of HFCs

The total actual emissions from HFCs used as substitutes for ozone depleting substances amounted to 0.57 million tons of CO_2 equivalents in 2007. The category refrigeration and air conditioning contributed by far with the largest HFCs emissions in 2007. The other categories foam/foam blowing and fire extinguishing contributed small amounts to the overall emissions of HFCs.

4.3.5.2 Measures

Emissions from manufacturing industries are partly covered by the emission trading scheme. In addition the Government has concluded a number of agreements concerning the reduction of greenhouse gas emissions in specific sectors of industry not covered by ETS. The CO_2 effects of these agreements are estimated in chapter 5.3. The CO_2 effects are uncertain, and emissions have also been reduced at similar plants in countries with no climate measures.

Emissions of SF_6 from the electro industry

In June 2001, a non-profit trust, which by an agreement with the Government is in charge of the collection, recirculation and destruction of discarded electric and electronic equipment, established a SF_6 recovery facility. In March 2002, this was followed up by a voluntary agreement between the Ministry of the Environment and the business organizations representing most users of gas-insulated switchgear (GIS) and the single producer. According to this agreement, emissions were to be reduced by 13 per cent in 2005 and 30 per cent in 2010 relative to base year 2000. In 2008 emissions were 55 per cent below the 2000 emission level. This achievement is due to a coordinated effort by the electric utility sector to improve maintenance and recovery. Future emissions for single years might however be significantly higher if, for example, large accidents occur.

Agreements to reduce emissions in the processing industry

In 2004, the Ministry of the Environment agreed on an arrangement with the processing industry in general to reduce emissions by 2007. For more information regarding this arrangement, please view chapter 4.4

In September 2009 the Ministry of the Environment entered into an agreement with processing industry not covered by the emissions trading scheme. This agreement sets a limit on emissions of 6.2 million tonnes of greenhouse gases per year for the years 2008-2012. This is a reduction of 44 per cent compared to the emissions in 1990. In 2007, emissions from the processing industry were 6.4 million tonnes. This agreement means that nearly all emissions from the processing industry are either included in the emissions trading scheme or in the agreement. From 2013 onwards emissions from these installations will be included in the emissions trading scheme, given EEA EFTA acceptance of the revised EU Directive on emissions trading.

4.3.6 Agriculture

The white paper on Norwegian climate policy, Norwegian climate policy, (Report No. 34 (2006-2007) to the Storting) and the subsequent Storting debate and recommendations are the foundation for Norwegian climate policy in the agricultural and forestry sector. The Norwegian Ministry of agriculture and food presented a white paper on agriculture and climate change in June 2009; Climate Challenges -Agriculture part of the Solution (Report No. 39 (2008-2009) to the Storting).

CO_2 emissions

Agricultural CO_2 emissions are mainly related to conversion of former peatlands to grasslands and croplands. The emissions are estimated to be in a total range of 2.1 million tons CO_2 per year, where emissions from former peatlands converted to grasslands account for 1.9 million tons CO2. Due to lack of annual inventories and measurements of such areas, these values are kept stable in the GHG reports. CO_2 removals in the LULUCF sector are described in chapter 4.3.7. Agricultural CO_2 emissions associated with burning of fossil fuels are not reported in the agricultural sector but included in the emissions from the energy sector. These emissions account for 0.473 mill tons of CO_2 in agriculture and 0.057 mill tons CO_2 in the forestry sector.

N_2O emissions

Emissions of N_2O from agriculture were estimated at 6 800 tonnes in 2007. The emissions have been fairly stable through the 1990s and have been reduced by 2.8 per cent from 1990 to 2008. In 2007, 50 per cent of the total N_2O emissions came from the agricultural sector. Emissions can be reduced by more efficient use of manure and mineral fertilizer, management of crop residues and reduction in cultivation of histosoils. However, some of these measures may cause other environmental problems. Measures can have both positive and negative economic effects. Reduced amount of fertilizers and reduced soil erosion may have a positive effect, while reduced harvest may lead to increased costs in production. Improved soil cultivation practices can reduce the risk of erosion, loss of nutrients and the associated emissions. The sector is putting efforts to improve the use of fertilizing schemes based on increased use of analyses of soil, harvest crop residues, and more efficient use of manure as these are important tools to obtain emission reductions without decreasing harvests. The Norwegian Government has the ambition to increase ecological farming which, under some circumstances, have a potential for reduced emissions compared to conventional agriculture. Information about enhanced practices is disseminated to farmers mainly by the Norwegian Agricultural Extension Service, which is a private enterprise owned by farmers. Information is also given by up-stream companies, governmental agricultural institutions and Yara, the Norwegian supplier of mineral fertilizers.

Methane emissions

Methane emissions from the agricultural sector were estimated at about 104 300 tonnes in 2007, and constitute about 49 per cent of total Norwegian methane emissions. The emissions are stable, and have been reduced by 2.6 per cent from 1990 to 2007. Most of the methane emissions from the agricultural sector are generated as an inevitable by-product of digestion in ruminants. These emissions are mainly affected by the national market for red meat and general agricultural policies and measures. The livestock numbers in Norwegian agriculture has been fairly stable through the 1990s, but have been reduced during the last decade. This is partly due to more efficient dairy cows. Intensified feeding strategies can reduce the emissions further. Storage and disposal of manure account for about 14 per cent of the methane emissions from agriculture. Biogas production facilities can reduce methane emissions. Biogas production based on manure is a high political priority but still in an initial phase in Norway, and do not so far account for a significant reduction in methane emissions.

4.3.7 Forestry and CO_2 sequestration

Forests contribute significantly to reducing the net emissions of greenhouse gases in Norway. A huge amount of carbon is stored in biomass and soil. In recent years, net CO_2 uptake in Norwegian forests has been in the order of 25–31 million tonnes per year. This corresponds to approximately half of the total Norwegian greenhouse gas emissions. Net CO_2 uptake varies somewhat from year to year, partly as a result of natural variation in growth conditions, climate change, forest management and felling of timber. Recent studies indicates that the Norwegian forest capacity as a carbon sink has reached a top level and is likely to decline over the next decades without new measures.

The Norwegian Ministry of agriculture and food presented a white paper on agriculture and climate change in June 2009; called “Climate Challenges -Agriculture part of the Solution” (Report No. 39 (2008-2009) to the Storting).

This paper forms the basis for the Government’s selection and decision of targets for the forest and agricultural sectors, and measures to be implemented in the national climate change policy. The paper recognizes the important role of forests in combating climate change. Since forest and forest soil are important carbon sinks, it is essential that these are preserved and further developed. Growing forest takes up CO_2, and active management of forest resources may play a part in increasing this uptake. It is a goal to maintain a high level of wood production in order to further increase carbon sequestration in forests. Among the actions to be taken is the facilitation of increased planting, plant breeding, fertilization and forest management aimed at increasing forest production. Greater use can be made of forest resources as a climate policy instrument.

Norwegian forestry has great potential for delivering renewable bio energy based on timber. In Norwegian forestry, only approximately 50 per cent of the annual growth increment of forest is currently felled, and there is thus considerable technical potential for increased production of bio energy although the economic incentives for this are currently limited. In constructions, timber could increasingly replace less climate-friendly

materials, and timber may replace coal, petroleum and gas as a source of energy.

At the same time, forests are very important for biodiversity conservation and associated with cultural- and recreational values. 48 per cent of the species on the 2006 list of endangered species in Norway live in forest habitats, and forestry is considered to be the most important negative factor for red listed species living in Norwegian forests.

The white paper on agriculture and climate change gives priority to climate motivated measures which will have positive or acceptable effects on biodiversity conservation and other important environmental values. In the paper it is proposed to strengthen the environmental considerations in relation to forestry, to ensure biodiversity conservation when biomass harvesting from the forests is increased.

Increased harvesting of forests will decrease the forest carbon stocks significantly for a period of several decades. This effect should be considered in relation to the need to keep the atmospheric carbon level as low as possible for the next decades in order to avoid irreversible "tipping point" effects due to climate change. Increased harvesting of old forests also can have negative impact on biodiversity and other environmental values. It also has to be taken into consideration the whole range of economic and ecological services from old and robust ecosystems.

Environmental considerations are incorporated in national forest and environmental legislation and monitoring and control at municipal, county and national level. Relevant stakeholders in the Norwegian forest sector (land owner associations, environmental NGOs and trade union representatives) have implemented standards for sustainable forest management. Standards and guidelines are in accordance with relevant international forest processes (e.g. United Nations Forum on Forests (UNFF) and Ministerial Conferences on the Protection of Forests in Europe) and relevant environmental obligations (e.g. CBD[9]). Close to 100 per cent of commercial timber sales in Norway are certified.

4.3.8 Waste management

The largest emissions in the waste sector still come from landfill gas. In 2007 the methane emissions from landfills were approximately 56 000 tons, corresponding to 2.2 per cent of the total greenhouse gas emissions in Norway. The landfill gas emissions have been reduced by approximately 15 per cent from 2000 to 2007 and 30 per cent from 1991 to 2007. As an effect of the prohibition of depositing biodegradable waste, we expect that the emissions from landfills will continue to decrease to about one third of today's level in 2040.

9 *The Convention on Biological Diversity*

In 2007 the emissions from incineration and flaring of landfill gas were approximately 184 000 tonnes CO_2 equivalents. These emissions have increased by about 60 per cent from 1991 and 17 per cent from 2000. The increase is a consequence of increased extraction of landfill gas and a shift from landfill to incineration. As energy from waste and landfill gas incineration to some degree replaces fossil fuels, these emissions are partly offset by avoided emissions from fossil fuel incineration. Average energy utilization for waste incineration is approximately 75 per cent.

The main priorities in the waste policy are to ensure safe handling of waste with respect to minimizing emissions of hazardous substances, and to reduce the portion of waste that is delivered for final treatment and thereby increase recovery. The measures to reduce greenhouse gas emissions are to a large degree concurrent with measures to increase recovery. The most important measures are:

- Regulations under the Pollution Control Act, including prohibition of depositing biodegradable waste and requirements to extract landfill gas, see below.
- Tax on the final treatment of waste, see below.
- Extended producer responsibility for specific waste fractions.

The systems of extended producer responsibility are partly based on voluntary agreements between the Government and relevant industries, partly on requirements in the waste regulation and to some degree on tax incentives.

Tax on final treatment of waste

Norway introduced a tax on the final disposal of waste (including both landfills and incineration) from 1 January 1999. The purpose of the tax is to put a price on the environmental costs of emissions from landfills and incineration plants, and thereby act as an incentive to reduce emissions, increase recycling and reduce the quantities of waste. In 2009 the tax rate for landfilling is NOK 447 or 583 per tonne waste depending on the quality of the landfill site. On 1 July 2009 a prohibition of landfilling of biodegradable waste was introduced. The prohibition implies that future waste to landfills will have low climate gas potential. The Government has proposed to reduce the tax on landfilling to NOK 275 per tonne waste in 2010 to reflect the lower environmental cost of future landfilling. In a period of transition it will be possible to obtain dispensations from the prohibition of landfilling, but for such biodegradable waste the Government has proposed the higher tax of NOK 455 per tonne of waste.

The tax on incineration is differentiated according to emissions for all substances except CO_2. The CO_2 part of the tax is, in 2009, NOK 62.35 per tonne waste delivered for incineration. Average total tax level for in-

Table 4.5 Summary of policies and measures in the waste sec

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Statusc	Implementing entity or entities
Requirement of landfill gas collection	Collection of methane from landfills	CH_4	Direct regulation	Implemented	Ministry of the Environment
Prohibition of landfilling easily degradable organic waste	Reducing methane emission from landfills	CH_4, CO_2	Direct regulation	Replaced by prohibition of landfilling all biodegradable waste from 2009	Ministry of the Environment
Prohibition of landfilling biodegradable waste	Reducing methane emission from landfills	CH_4, CO_2	Direct regulation	Implemented. Some exemptions until 2013.	Ministry of the Environment
Tax on landfilling	Reducing waste to disposal by internalizing environmental costs	CH_4, CO_2	Tax	Implemented	Ministry of Finance
Tax on incineration	Stimulating measures to reduce emissions and reduce waste to disposal by internalizing environmental costs	CO_2	Tax	Implemented	Ministry of Finance
Requirement to utilize energy from incineration	Replacing other energy sources	CO_2	Direct regulation (in concessions)	Implemented	Ministry of the Environment
Extended producer responsibility	Safe handling and recovery of certain waste fractions	CO_2, CH_4, HFK,	Regulations and voluntary agreements	Implemented	Ministry of the Environment

cineration is approximately NOK 100 per tonne waste.

Effects of measures

The effect of the measures in total has been a large increase in waste to recovery rather than landfill and extraction of landfill gas at practically all operative landfills. This implies notable reductions in greenhouse gas emissions from waste management despite large increases in the amounts of waste. The emission effects for some measures in the waste sector are estimated in chapter 5.3.

4.3.9 Carbon Capture and Storage

According to IPCC carbon capture and storage (CCS) has the second largest potential for global emission reductions. An enforced effort to stimulate development, deployment and dissemination of this technology at a global scale will be vital to keep the increase in global average temperature within 2˚C.

The Norwegian Government has ambitious plans for carbon capture and storage. It intends to build on the experience gained from the Sleipner and Snøhvit CO2 storage projects so that Norway can continue to play a leading role in the development and deployment of CCS (please view chapter 4.3.3 for more info about the Sleipner and Snøhvit projects). The CSS projects at Mongstad will achieve more than to capture CO_2 from

gas fired power plants in Norway. Norway wishes to contribute to technology development, deployment and dissemination and knowledge-sharing and thereby making CCS a cost-effective tool for reducing CO2 emissions internationally.

The CCS projects at Mongstad are based on an implementation agreement between the Norwegian State and Statoil, and an emission permit issued by Ministry of the Environment which has clearly defined CCS requirements. The first project covers construction and operation of the European CO_2 Technology Centre Mongstad (TCM), a capture testing facility. The second part of the project is the full-scale capture of approximately 1.5 million tonnes of CO_2 per year, that shall be in place by the end of 2014.

The planning of the TCM project began immediately after the emission permit was granted and the implementation agreement signed. The Ministry of Petroleum and Energy signed in June 2007 an agreement on cooperation with industrial participants in the planning and preparation of TCM. The Norwegian State's interests in the agreement were transferred to the state enterprise Gassnova SF[10] in October 2007.

The Norwegian Government presented in January 2009 a proposition regarding the investment in TCM, and on May 7 2009 the Storting authorised the Ministry of Petroleum and Energy to invest in TCM. Based on this, Statoil, Shell and the State (through Gassnova) decided to establish a technology company and commence construction of TCM. The construction of the TCM started in July 2009 and the construction time is estimated to be approximately 30 months.

To ensure that the experiences from the Technology Centre have the broadest relevance, the Technology Centre will test CO_2 capture on two types of flue gases using two capture technologies. One source of emissions is the existing catalytic cracker facility at the Mongstad Refinery and the other is emissions from the gas fired combined heat and power plant, which is under construction. Two technologies will be tested in parallel; amine technology and chilled ammonia technology. The choices of technologies were made by the TCM project on the basis of assessments of the technologies' potential for improvements, possibilities of implementation as retrofit solutions, possibilities of full-scale application, technical maturity, environmental burden, and the possibilities of capture from sources such as coal, natural gas, and refining.

10 Gassnova SF is the Norwegian state enterprise for CCS. From 2005-2007, Gassnova was a state administrative body, established to stimulate R&D through the CLIMIT-programme with funds from the Norwegian Gas Technology Fund. In 2007 the Government transformed Gassnova into a separate legal entity fully owned by the Norwegian State. Gassnova is responsible for the Government's participation in national CCS projects.

Technologies for carbon capture from exhaust gases are not fully matured, and although some technologies are more mature than others, many years of development is needed. The technology centre at Mongstad will be a significant Norwegian contribution to international development of technology through the establishment of such a testing arena.

The Norwegian Government has the ambition that the CO_2 Technology Centre creates an arena for targeted development, testing, and qualifying of technology, as well as contributes to international diffusion of these such that the costs and risks of CCS may be reduced. A successful implementation of this project will create the foundations for further developments of technology for many years to come.

4.3.10 International transport – Aviation and marine bunker fuels

Norway has for a number of years worked actively through the IMO to pursue limitation of greenhouse gas emissions from international shipping. Since the last National Communication submitted by Norway, work has progressed within the IMO on developing an energy efficiency design indicator, an energy efficiency operational index and on various tools for more energy efficient operation and management of ships. Norway has submitted a number of papers to the IMO's Marine Environment Protection Committee on these issues and worked actively to enhance progress. These indicators are now technically finished and are in voluntary use. Discussions on possible mandatory application of these indices will continue and decisions should be reached in 2010.

Norway is also pursuing the introduction of market based instruments to reduce emissions from international shipping. This was discussed in depth at an intersessional meeting in the greenhouse gas working group in 2008, hosted by Norway.

In 2008-2009, Norway has jointly with Germany and France further developed a proposal for an emission trading system for international shipping. The issue was discussed at the most recent meeting in the IMO's environment committee.

Within the ICAO, Norway has as an observer in the Civil Aviation Environment Program (CAEP) and as a part of the European Civil Aviation Conference (ECAC), participated actively with a view to limiting greenhouse gas emissions from international aviation. For international aviation Norway is pursuing the introduction of targets for emission reductions and use of market based measures to achieve such targets.

To contribute to further progress, Norway has proposed that the UNFCCC at its Copenhagen meeting addresses international aviation and shipping in a sep-

arate decision, stating that these sectors must undertake emission reductions as ambitious as the overall emission reductions to be achieved.

At the national level, Norway implements all relevant provisions of the IMO to limit or reduce emissions. In addition, Norway has promoted the introduction of gas fuelled ferries through public procurement and as a climate measure. Development of more energy efficient technologies for shipping is also enhanced through research and development programmes under the Research Council of Norway.

Norway has accepted to implement in the EEA Agreement EU Directive 2008/101/EC which establishes an international emission trading scheme for aviation. The inclusion of this Directive in the EEA Agreement will effectively extend the scope of the scheme to cover all relevant flights, including international flights, to and from airports within the EEA.

4.4 Policies and measures no longer in place

Emissions from the production of aluminium

In 1997, the major aluminium producers signed an agreement with the Ministry of the Environment to reduce emissions of greenhouse gases (CO_2 and PFCs) per tonne aluminium produced by 50 per cent in 2000 and 55 per cent in 2005, compared to 1990 levels. The end result was a reduction of 62 per cent in 2005. It is difficult to separate the effects of the agreement from other effects such as restructuring. The emissions covered by this agreement are now covered by the EU emission trading scheme and the new agreement with the processing industry.

Arrangement to reduce emission in the processing industry

In 2004, the Ministry of the Environment agreed on an arrangement with the processing industry in general, with the exception of gas refineries and petroleum terminals. Sources included the aluminium, ferro-alloy, carbon, mineral fertilizer and carbide industries accounting for approximately 30 per cent of total Norwegian greenhouse gas emissions at the time. This arrangement also included some installations covered by emissions trading. The arrangement ensured that operators in the processing industry – some of which at that stage were not included in the emissions trading scheme – agreed that total emissions of greenhouse gases in the process industry were not to exceed 13.5 million tonnes of CO_2 equivalents (all six Kyoto gases) by the end of 2007. Actual emissions were significantly lower than this.

5. PROJECTIONS AND THE EFFECT OF POLICIES AND MEASURES, AND SUPPLEMENTARITY RELATING TO THE KYOTO PROTOCOL MECHANISMS

5.1 Introduction

This chapter describes in more detail the projections of greenhouse gas emissions in Norway up to 2020. The baseline scenario was first presented in the White Paper on Long-term Perspectives for Norwegian Economy (Report No. 9 (2008-2009) to the Storting) published in January 2009. In line with international reporting guidelines under the Framework Convention on Climate Change these projections are based on current measures and policies. Measures and policies adopted after autumn 2008 are therefore not included in the baseline scenario. Thus, the projections are not a prognosis for the future development in greenhouse gas emissions and do not reflect the Governments targets in the climate policy. The baseline scenario, along with key macroeconomic assumptions and a description of the methodology, are presented in Section 5.2. To illustrate the uncertainty in the projections, a discussion of how recent events might impact on the projections and an analysis of the sensitivity of the projections to changes in key macroeconomic assumptions are also discussed in this section. Projections of other gases having an indirect effect on greenhouse gases are presented in 5.2.5, while projections of CO_2 sequestration in forest are briefly discussed in Section 5.2.6. The estimated impact of adopted measures and some new proposals are provided in Section 5.3. In Section 5.4 supplementarity relating to the mechanisms under the Kyoto Protocol is discussed.

The projections do not include the impacts of the global economic crises. It is expected that the 2010 emissions will be lower the than projected in the White Paper.

Table 5.1 A Greenhouse gas emissions by sector. Baseline scenario. Million tonnes CO2 equvivalents and percentage change 1990-2020

	Million tonnes				Percentage change		
	1990	2007[1]	2010	2020	1990-2007	1990-2010	1990-2020
Total Energy	29.5	40.0	42.4	41.8	35 %	44 %	42 %
- Oil and gas production[2]	8.5	14.5	15.4	13.3	71 %	82 %	57 %
- Petroleum Refining	1.0	2.1	2.1	1.8	119 %	113 %	89 %
- Public Electricity and Heat production[3]	0.3	0.5	1.5	1.1	42 %	347 %	237 %
- Manufacturing Industry and Construction	3.7	3.6	3.6	4.1	-2 %	-2 %	12 %
- Transport[4]	11.3	16.1	15.8	17.3	42 %	40 %	53 %
- Other sectors[5]	4.8	3.3	4.1	4.2	-31 %	-15 %	-13 %
Industrial Processes	13.9	9.4	9.4	9.5	-32 %	-33 %	-32 %
Agriculture	4.4	4.3	4.2	4.2	-3 %	-5 %	-5 %
Waste	1.8	1.3	1.4	1.0	-27 %	-24 %	-45 %
Total	**49.7**	**55.0**	**57.3**	**56.5**	**11 %**	**15 %**	**14 %**

1) When the projections were made the sectoral distribution of emissions was not known.

2) Including emissions from gas terminals and on and offshore oil loading.

3) Including emissions from gas-fired power plants. The figures are calculated without information on future uptime on the power plants and are not a signal on expectations on future uptime from the authorities.

4) The transport sector includes road transport, civil aviation, navigation, railway and off road vehicles and other machinery

5) Including mobile emissions from forestry, fisheries and agriculture.

Source: Statistics Norway, Norwegian Pollution Control Authority and the Ministry of Finance.

5.2 Projections

5.2.1 The baseline scenario

In the baseline scenario, total greenhouse gas emissions are projected to increase by 15 per cent from 1990 to 2010, and then to fall by 1 per cent from 2010 to 2020 (Table 5.1 A). The development is highly dependent on emissions from oil and gas production, which constitute a large share of total Norwegian emissions. Strong economic growth and an escalation in the extraction of oil and gas, during the 1990s, account for most of the increase in historic emissions (see chapter 3). In the projections, oil and gas production is anticipated to start falling before 2020. Emissions from transport are estimated to continue to grow.

CO_2 emissions, excluding forest sequestration, are projected to increase from 34.8 million tonnes in 1990 to 47.4 million tonnes in 2020 (Table 5.1 B). The aggregate emissions of other greenhouse gases are projected to continue to fall until 2020. Due to emission-reducing measures in the metal producing industries and the close down of the plant producing magnesium, emissions of PFC and SF_6 are estimated to drop by 83 and 96 per cent, respectively, between 1990 and 2020. Emissions of HFCs are expected to increase as HCFCs

Table 5.1 B Greenhouse gas emissions by gas. Baseline scenario. Million tonnes CO_2 equvivalents and percentage change

	Million tonnes				Perchentage change	
	1990	2007	2010	2020	1990-2010	1990-2020
CO_2	34.8	44.9	47.6	47.4	37 %	36 %
CH_4	4.6	4.4	4.4	3.8	-6 %	-19 %
N_2O	4.7	4.2	3.9	4.1	-17 %	-14 %
PFC	3.4	0.8	0.8	0.6	-75 %	-83 %
HFC	0.0	0.6	0.5	0.6		
SF_6	2.2	0.1	0.1	0.1	-97 %	-96 %
Total	**49.7**	**55.0**	**57.3**	**56.5**	**15 %**	**14 %**

Source: Statistics Norway, Norwegian Pollution Control Authority and the Ministry of Finance.

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

	CO^2	CH_4	N2O	PFC	HFC	SF_6
Total Energy	41.0	0.9	0.5			
- Oil and gas production[1]	14.8	0.6	0.0			
- Petroleum Refining	2.0	0.1	0.0			
- Public Electricity and Heat production[2]	1.4	0.0	0.0			
- Manufacturing Industry and Construction	3.5	0.0	0.0			
- Transport	15.4	0.0	0.4			
- Other sectors	3.8	0.2	0.1			
Industrial Processes	6.7	0.0	1.3	0.8	0.5	0.1
Agriculture	0.0	2.1	2.1			
Waste	0.0	1.3	0.1			
Total	**47.6**	**4.4**	**3.9**	**0.8**	**0.5**	**0.1**

1) Including emissions from gas terminals and on and offshore oil loading.

2) The figures are calculated without information on future uptime on the power plants and are not a signal on expectations on future uptime from the authorities.

Source: Statistics Norway, Norwegian Pollution Control Authority and the Ministry of Finance.

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

	CO_2	CH_4	N_2O	PFC	HFC	SF6
Total Energy	40.6	0.8	0.5			
- Oil and gas production[1]	12.8	0.5	0.0			
- Petroleum Refining	1.8	0.0	0.0			
- Public Electricity and Heat production[2]	1.1	0.0	0.0			
- Manufacturing Industry and Construction	4.0	0.0	0.0			
- Transport	16.9	0.0	0.3			
- Other sectors	3.9	0.2	0.1			
Industrial Processes	6.8	0.0	1.4	0.6	0.6	0.1
Agriculture	0.0	2.2	2.1			
Waste	0.0	0.9	0.1			
Total	**47.4**	**3.8**	**4.1**	**0.6**	**0.6**	**0.1**

1) Including emissions from gas terminals and on and offshore oil loading.
2) The figures are of course calculated without information on future uptime on the power plants and is not a signal on expectations on future uptime from the authorities.
Source: Statistics Norway, Norwegian Pollution Control Authority and the Ministry of Finance.

are phased out. Moreover, use of HFCs in small equipment is assumed to increase. Emissions of CH_4 are predicted to continue to decrease slowly, and to be 19 per cent below the 1990 level by 2020. Table 5.1 C and D give a more detailed picture of the development.

5.2.1.1 Methodology and key assumptions

The emission projections for Norway presented in this report uses various sources and methodologies. For energy-related emissions, the projections are largely based on macroeconomic model simulations supplemented by available micro studies. The macroeconomic model is described in more detail in Annex C. Projections of CO_2 emissions from the petroleum sector are based on information collected by the Norwegian Petroleum Directorate. Projections of emissions of other greenhouse gases than CO_2 are mainly based on sector- and plant-specific information, collected by the Norwegian Pollution Control Authority from the industries concerned. Key assumptions and methods are described in more detail below.

The baseline scenario is based on measures adopted and implemented by 2008. In particular, recent events such as the entry into EU emission trading scheme for greenhouse gases, a new voluntary arrangement with the processing industry and the EEA-relevant Renewable Directive are not incorporated. Moreover, the projections are based on information up to September 2008, where the Norwegian economy was assumed to gradually normalise from a high level of activity. Since then, the international recession has also hit the Norwegian economy, and especially exporting industries and construction. 2010-emissions have not been adjusted for temporary effects of the recession. As production is assumed to rebound to trend, emissions may possibly return to the projected path in the medium to longer run. Revised estimates of emissions from oil and gas production might also indicate somewhat lower emissions in 2010 than assumed earlier. At the same time, the emissions from this sector are revised upwards by 2 million tonnes CO_2 equvialents in 2020. Notwithstanding, emission projections are uncertain and the descriptions in this report are based on the last official Norwegian emissions projection presented in the White Paper on Long-term Perspectives (Report No. 9 (2008-2009) to the Storting).

5.2.1.2 Macroeconomic assumptions and CO_2 emissions from the mainland economy

In the projections current policies are assumed to be continued. Accordingly, CO_2-taxes are maintained at 2008-level in real terms. Also the carbon price for industries included in the emission trading scheme is assumed to stay at the current level in real terms.

In the projections, total factor productivity is on average assumed to grow annually by almost 1½ per cent in the mainland economy. As a result, emissions per unit produced in each sector will continue to fall over time. Moreover, for some emission sources it is assumed stronger than average growth in emission technology, such as carbon capture and storage (CCS) from gas fired power plants. Consequently, the amount of emissions in these sectors will not increase proportionally to the production or the use of factor input.

The model based projections of emissions from road transport have been adjusted, taking on board calculations from Statistics Norway's road model. Road

Table 5.2 Macroeconomic developments and energy use. Baseline scenario

	2007	2007-2010	2010-2020
	Billion NOK	**Annual average growth rate**	
Gross domestic product	2277.1	2.2	2.1
- Petroleum activities and ocean transport	553.0	3.9	-0.9
- Mainland Norway	1724.1	1.8	2.7
-- Manufacturing	215.4	3.7	2.3
Consumption (private and government)	1388.7	1.7	3.4
Gross fixed capital formation	484.6	1.3	0.8
- Petroleum activities and ocean transport	130.3	5.4	-3.7
- Mainland Norway	354.3	-0.3	2.3
Population (1000 persons)	4799	0.8	1.0
Number of persons employed (1000 persons)	2538	1.2	0.5
Net domestic energy use[1]			
- Petroleum products (Mtonnes)	9.1[2]	1.8	0.5
- Electricity (TWh)[3]	115.0	1.2	0.1
Oil price (Level 2009-NOK)	483	400	400

1) Except use in ocean transport
2) 2004
3) Based on technical assumptions.
Source: Statistics Norway and the Ministry of Finance

transport is anticipated to grow at the approximately same rate as the average annual growth from 1990 to 2006. At the same time, other trends in consumption mirrored in the sales of fuels, but not intercepted in the road model, are anticipated to continue. Use of bio fuels is assumed to increase to about 2 per cent of fuel sales by 2010. All in all, the projections imply somewhat lower growth in the emissions from road transport than experienced in the period 1990-2007.

Emissions in 2020 will depend on structural developments, particularly in the energy intensive industries. Production and emissions from energy intensive manufacturing are strongly correlated with electricity consumption in this sector. In the long run, as a technical assumption, demand for electricity from energy intensive manufacturing is anticipated to stay relatively stable at the same level as before the financial crisis hit. In the short run the international recession will affect energy intensive industries. For example, electricity consumption in energy intensive industries (basic metals and chemicals) has fallen by more than 20 per cent the first 7 months of 2009. This suggests that both electricity consumption and baseline emissions in energy intensive industries might be overestimated in the short run. As a consequence of increased productivity, production in the energy intensive industries is assumed to increase somewhat in the longer run.

Norway is the sixth largest hydro power producer in the world. Emissions from electricity production are small in Norway, as about 99 per cent of the supply of electricity originates from hydro power. In the projections, the production of renewables (e.g. hydro and wind power) is exogenously determined.

The forecasted macroeconomic development implies a moderate growth in the consumption of electricity in the long run, after staying relatively stable the past couple of years. In the long run, the two gas fired power plants already in place are, based on a technical assumption, projected to produce almost 6 TWh of electricity and heating with a high degree of CCS.

Norwegian electricity production is currently more or less in line with demand. In the projections, domestic supply and demand of electricity is assumed to balance also in 2020.

Table 5.2 lists key macroeconomic assumptions in the Norwegian emission projections. In the baseline scenario average annual GDP growth is estimated at 2.2 per cent in 2007-2010 and at 2.1 per cent in 2010-2020. Growth in the mainland economy, i.e. total GDP excluding petroleum activities and ocean transport, is estimated at 1.8 per cent in 2007-2010 and 2.7 per cent in 2010-2020. On average, value added from petroleum extraction, pipeline transport and ocean transport is

assumed to fall by 0.9 per cent annually between 2010 and 2020, while investments in the petroleum sector may decrease some 4 per cent annually. This outlook is contingent on the assumption that petroleum extraction increases to about 258 million Sm^3 oil equivalents in 2015, before gradually dropping to about 232 million Sm^3 oil equivalents in 2020.

Domestic consumption of petroleum products is expected to increase by 1.8 per cent annually from 2004 to 2010 and by 0.5 per cent annually from 2010 to 2020. In the forecast, electricity consumption is expected to grow by 1.2 per cent per year from 2007 to 2010 and 0.1 per cent from 2010 to 2020. These forecasts are based on continued improvements in average energy efficiency (see Annex C). In the baseline scenario, the international quota price in the Kyoto period from 2008-2012 is assumption to have only minor impact on long-term energy prices.

5.2.1.3 CO_2 emissions from the petroleum sector

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

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

5.2.1.4 Emissions of other greenhouse gases

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

- Methane emissions: the model for calculating inventory figures for methane emissions from Solid Waste Disposal Sites (SWDS) was revised by the Norwegian Pollution Control Authority in 2005 (SFT, 2005) in 2005.[11] As a consequence, estimated methane emissions from SWDS have been almost halved (for 2002 estimated methane emissions from SWDS were revised downwards by about 46 per cent). The revised model complies with the Revised IPCC 1996 Guidelines for National Greenhouse Gas Inventories and the IPCC Report on Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories as approved by the UNFCCC. From 2009, deposition of wet organic waste on landfills is prohibited. The effect of this measure is taken into account in the baseline scenario. The effect of licensing requirements for collection and combustion of methane from landfills is not fully taken into account in the projections. Methane emissions from the agricultural sector are expected to remain stable as the emissions are little affected by short-term economic cycles.
- N_2O and SF_6 emissions: projections of N_2O emissions from nitric acid production are based on information about the N_2O reducing technology per 2008. Newer information from the producer indicates that the N_2O reducing technology is much more effective than expected in the projections. Emission projections of perfluorocarbons (CF_4 and C_2F_6) from aluminium production are based on the assumption that all production in 2020 uses pre-baked technology and that total production is somewhat higher than in 2007.
- HFC emissions: emission projections of HFCs are prepared by the National Pollution Control Authority, drawing on available research. A tax on import and production of HFCs and PFCs was implemented in 2003.

5.2.1.5 Uncertainty and sensitivity to changes in key macroeconomic assumptions

Long-term projections of greenhouse gas emissions are subject to considerable uncertainty. This is due to different circumstances. The macroeconomic models give a simplistic description of the economy, even though the models are comprehensive and based on broad empirical research. In addition, available information about current developments in both economic and other emission related variables will often be imperfect, while both the emission inventory and the national accounts are subject to revisions. The starting point of the projections, cyclical developments and the underlying features can therefore turn out to be different from the initial assumptions. Moreover, unexpected events may happen, such as technological changes that can affect the underlying mechanisms and the development path in the economy.

New information will always present an opportunity to adjust the projections. The current economic crisis is an example of an unexpected occurrence that will affect the projections, at least in the short term. The scale of the impact of the economic downturn on the emissions is uncertain. For example, the sale of petroleum prod-

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

ucts was almost 2 per cent lower in August 2009 than in the same period the year before. The slump in sales of petroleum products in the second half of 2008 have however stopped in 2009, and the sale has picked up somewhat the past months. Greenhouse gas emission from road transport increased by 0.4 per cent in 2008, as opposed to an annual growth rate of 2 per cent in the period 1990-2007.

Manufacturing production has dropped substantially due to the recession and lower export. The situation has improved slightly the past months, but the market situation is still uncertain and it is unlikely that the production will ascend to previous levels already in 2009 or 2010. Production of basic metals and chemicals, which accounts for a large share of emissions from manufacturing, has been hit particularly hard by the international recession. Falling demand has lead to closure of production lines, and demand for electricity from these sectors has been reduced by more than 20 per cent the first seven months of 2009.

Updated emission estimates from the petroleum industry suggest slightly lower emissions in 2010 than previously projected. At the same time, however, the estimate for 2020 is revised upwards by 2 million tonnes CO_2 compared to the projections in the White Paper. The reason for these adjustments is that the introduction of some of the new fields in the projections is postponed, while tail production in mature fields is assumed be extended.

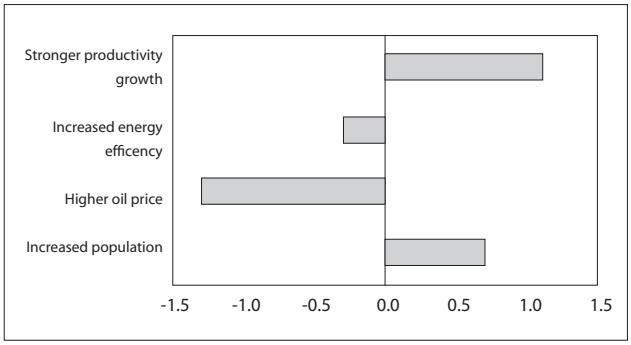
As mentioned earlier in the communication, technological improvement in the production of mineral fertilizer has reduced emissions of N_2O considerably. The projections presented in the White Paper were based on the assumption that most of the reduction in emissions from production of fertilizer with the new technology was already realised by 2007. It looks, however, like the technology is going to be even more efficient than previously assumed, suggesting that future emissions might be somewhat lower than assumed in the White Paper.

To sum up, there are several elements that may well imply lower emissions in 2009 and 2010 than forecasted in the White Paper, and presented in this report. However, economic activity is likely to pick up again as the cyclical situation improves.

The uncertainty in the projections can be illustrated by sensitivity analyses where the impact of alternative assumptions about the future development in key indicators is calculated. The macroeconomic model is used to assess how alternative assumption about productivity growth, oil and gas prices and population growth will impact on emissions in 2020.

– **Stronger growth in total factor productivity** means that the input factors used in the production process are better utilised, including labour, capital and energy. To the extent that less input of oil and other fossil energy sources is needed to produce the same amount of goods and services, the emissions of greenhouse gases per unit produced will be reduced. If increased productive capacity leads to increased production and higher living standards, and not more leisure, the emissions of greenhouse gases are nevertheless likely to increase. To illustrate the total impact on emissions of an increase in productivity growth, the productivity growth in all mainland industries is increased by 0.25 percentage points from 2011 annually in all production sectors. In the calculation, input of labour is assumed to be equal to the baseline. Based on these assumptions, real disposal income per capita will increase by 3 per cent in 2020 compared to the baseline scenario, while total emissions of greenhouse gases in Norway will increase by 1.1 million tonnes CO_2 equivalents, see figure 5.1.

Figure 5.1 Emissions of greenhouse gas in 2020 by different assumptions. Change compared to base line. Million tonnes CO2 equivalents



Source: The Ministry of Finance.

– **Increased productivity in the use of fossil fuels.** While the calculations above assumed higher productivity in all input factors, it is in this calculation assumed that only the productivity in the use of fossil fuels is increased. The decline in emissions per produced unit is equal in the two calculations. However, increased productivity in the use of fossil fuels has limited impact on the total income and activity level. With a 0.25 percentage points higher annual productivity growth in the use of fossil fuels, the overall emission of greenhouse gases in Norway is reduced by 0.3 million tonnes CO_2 equivalents in 2020 compared to the baseline scenario. The total cut in emissions can be somewhat larger than the reduction in Norwegian emissions alone, because the market share of Norwegian export of energy intensive products will increase due to improved competitiveness.

–

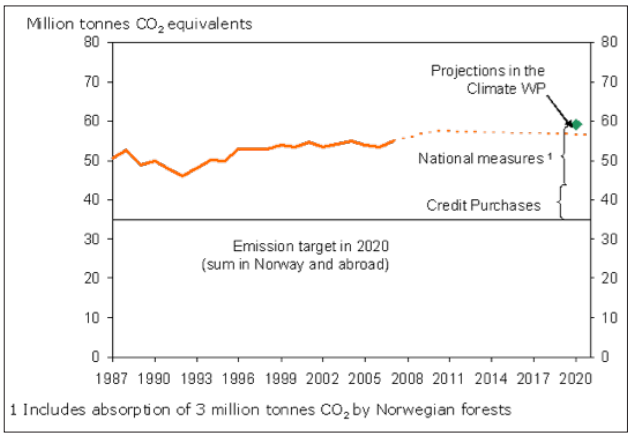
– **Higher oil and gas prices** should over time stimulate adjustments in production methods and consumption patterns towards less oil and gas use. Moreover, higher oil and gas prices should increase profitability of investments in renewable energy. In isolation, these features will lead to lower emissions. However, higher oil and gas prices also imply an income transfer from net importers of oil and gas to net exporters, and enhance investments in oil and gas production. For Norway, the increase in revenue from petroleum export implies an increase in import and consumption possibilities and less need for an export-oriented industry. In this model simulation it is assumed that the long-term oil price rises from NOK 400 in 2009 to NOK 500 in 2010, with the same percentage increase in producer prices for refined oil products. The percentage increase in gas prices is somewhat weaker. Assuming that labour input is the same as in the baseline scenario, and that the spending of oil revenues follows the fiscal rule and that the activity level in the oil and gas industry is not altered, the emissions of greenhouse gases is calculated to fall by 1.3 million tonnes CO_2 equivalents in 2020.

– **Increased population.** In the long-run, the uncertainty in the population projections is first and foremost linked to the assumption on net immigration to Norway. In an alternative simulation, the population in 2020 is increased by 150 000 persons compared to the baseline scenario. A larger population will, over time, lead to stronger growth in both production and consumption, although the estimated growth per capita is somewhat lower than in the baseline scenario. The greenhouse gas emissions in Norway are calculated to rise by 0.7 million tonnes CO_2 equivalents in 2020. In the calculations it is assumed that the increase in electricity demand is met by import. Because the population increase is due to higher labour immigration, and therefore has its counterpart in lower population in other countries, the impact on global emissions might be less pronounced.

5.2.1.6 Emission projection and emission targets

Based on the analysis in the White Paper on Norwegian Climate Policy the Storting in 2008 agreed on the main Norwegian climates targets (see Section 4.1). The agreement states that Norway will undertake to reduce global greenhouse gas emissions by the equivalent of 30 per cent of its own 1990 emissions by 2020. Based on the projections presented in the National Budget 2007, which indicated that the emissions would be in the magnitude of 59 million tonnes CO_2 equivalents in 2020, this target implied a reduction in emissions both at home and abroad of 24 million tonnes CO_2 equivalents. In the agreement it is stated that a realistic target is to reduce domestic emissions by 15-17 million tonnes CO_2 equivalents relative to this reference scenario, when CO_2 uptake by forests is included. In the White Paper on Long-Term Perspectives from 2009 the projected emission level was adjusted downwards by 2 million tonnes CO_2 equivalents, due to new policies and new information (see figure 5.2). Without further measures the emissions in 2020 will nevertheless be significantly higher than the targets agreed upon. The projections thus indicate a need for additional measures in the climate policy.

Figure 5.2 Emissions of GHG and emission targets in 2020.



Source: Statistics Norway, Norwegian Pollution Control Authority and the Ministry of Finance.

5.2.1.7 Other emissions

Nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO) have an indirect effect on the climate through their influence on greenhouse gases, in particular ozone. Sulphur dioxide (SO_2), on the other hand, increases the level of aerosols with a subsequent cooling effect. Hence, emissions of these gases are included in the inventory and in the projections of greenhouse gases.

Table 5.3 shows projected emissions of NO_X, NMVOCs and SO_2 consistent with the baseline scenario. The estimates are based on the same assumptions as for the other gases, as described in Section 5.2. Different measures, not accounted for in the projections, are in place to meet the commitment in the Gothenburg Protocol by 2010.

Table 5.3 Anthropogenic emissions of NO, nmVOCs and SO_2. Thousand tonnes

	1990	2007	2010[1]	2020
NOx[2]	207.7	189.6	183.1 (156)	154.0
SO_2[3]	52.4	19.7	22.6 (22)	23.0
NMVOC	295.3	191.4	157.1 (195)	135.7
NH3	20.4	22.3	22.8 (23)	23.9

1) The Norwegian commitment according to the Gothenburg Protocol in brackets.
2) The agreement between the authorities and industries on NOx reductions is not implemented in the projections.
3) The intentional agreement between the authorities and the processing industry is not implemented in the projections.

Source: Statistics Norway, the Norwegian Pollution Control Authority and the Ministry of Finance.

5.2.1.8 Fuel sold to ships and aircraft engaged in international transport

Table 5.4 summarises the projected emissions of fuel sold to ships and aircraft engaged in international transport

Table 5.4 CO2 emissions from international bunker. Thousand tonnes

	1990	2007	2010	2020
International Bunkers	2 098	3 270	3 195	3 943
Aviation	619	1 248	968	1 211
Marine	1 478	2 022	2 227	2 733

Source: Statistics Norway, Norwegian Pollution Control Authority and the Ministry of Finance

5.2.1.9 Projections of CO_2 sequestration in forest

In 2007, the annual carbon sequestration in Norwegian forests has been estimated to be about 28.7 million tonnes CO_2. By assuming an increase in the global temperature of 2°C, a continuation of the current level of harvest, no significant changes in natural die-off and no new policy, the annual net CO_2 removals will continue to be high, but is expected to decrease to 22.5 million tonnes CO_2 by 2020. This reduction is due to the age structure of the Norwegian forests. Most forest areas have now reached their most productive phase, indicating that the biomass growth rate will decrease in the future. This result is based on a study done by the Norwegian Forest and Landscape Institute[12] and the results are also submitted by Norway to UNFCCC in September 2009. [13] The projections on both short and long term are sensitive to fluctuations and their effects on forestry. In the long run the projections are dependent on the climate development and the effects on forest health and growth.

5.3 Assessment of aggregate effects of policies and measures

There are considerable methodological difficulties in calculating the effect of policies and measures ex post, including establishing a hypothetical baseline and obtaining relevant data. So far there has only been a limited amount of quantitative analysis in Norway of the impact of various policies and measures after they have been implemented. Effects are monitored more systematically in some sectors than in others. The assessment of aggregate effects of policies and measures, which is required by the UNFCCC guidelines, can therefore only be partial and to some extent qualitative, building on information on the main policies and measures.

Table 5.5 summarises the estimated effects of selected measures that have been implemented or adopted. These estimates are based on information derived from studies by the Norwegian Pollution Control Authority, the Norwegian Petroleum Directorate and Statistics Norway. In the absence of these policies and measures, the projected CO_2 emissions in 2010 would be 10.7-13.8 million tonnes higher. The 2020 CO_2 emissions would be 13.6-16.7 million tonnes higher.

The list of measures is not complete, and the estimates are uncertain. In particular, the effects of policies and measures aimed at enhancing energy efficiency, encouraging the use of new renewable energy sources, as well as the effect of measures related to transport and agriculture, are not covered by the analysis.

The estimated effects of some recently adopted measures not included in the baseline scenario are also presented in table 5.3. These measures include a trading scheme for the period 2008-2012 covering about 36 per cent of all greenhouse gas emissions and the effects of the consensus agreement between the industry and the authority from 2009.

12 Unpublished study by Astrup, R., L. Dalsgaard, R. Eriksen and G. Hylen in 2009. Utviklingssenarioer for karbonbinding i Norges skoger.

13 The Norwegian submission to the Ad-Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG- KP) on Land use, land use change and forestry (LULUCF) in September 2009 is based on the same study.

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

	1995	2000	2005	2007	2010	2020
Policy and measures directly related to climate change						
- CO_2 tax offshore[1]	0.6	3.0	3.0	4.5	5.2[10]	6.9[10]
- CO_2 tax onshore[2]		0.8	0.8	0.85	0.85	0.85
- Requirement to collect landfill gas	0.2	0.4	0.4	0.4	0.4	0.4
- Other measures in the waste sector	..	0.01	0.1	0.1	0.1	0.5
- Climate change agreement with aluminium industry[3]	0-1.3[3]	0.5-2.7[3]	1.6-4.5[3]	1.6-4.5[3]	1.5-4.2[3]	1.8-4.5[3]
- Agreement on SF_6 emissions	-	-	0.06	0.06	0.06	0.06
- Tax and recycling schemes on HFCs	-	-	0.3	0.5	0.5	0.5
- Requirement of 2.5 % bio fuels of fuel consumption in road transport from 2009 [4]	-	-	-	..	0.3	0.3
- CO_2 dependent tax for new passenger cars from January 1 2007 [4]	-	-	-	0.04	0.1	0.4
Other regulations						
- VOC regulation offshore	-	-	0.2	0.2	0.3	0.1
- VOC regulation at the Stura terminal	-	0.01	0.02	0.02	0.005	0.005
Voluntary reductions:						
- SF_6 reduction, production of magnesium	1	1.4	1.8[8]	2.1[8]	2.1[8]	2.1[8]
- N_2O reduction, production of nitric acid	0.7	0.6	0.5	1.2	1.2-1.6[9]	1.2-1.6[9]
- Use of bio carbon in the cement production [5]	-	0.03	0.13	0.13	0.13	0.13
Sum effect of implemented policy and measures		**5-7.2**			**8.6-11.7**	**11.5-14.6**
New policy and measures post 2008 [6]						
- Emission trading scheme (EU ETS 2008-2012)	-	-	-	..	0-0.3[11]	0-0.3[11,12]
- Consensus with the processes industry 2009 [7]	-	-	-	-	0.2	0.2

1) Estimates based on KonKraft report 5 and analyses by the Norwegian Petroleum Directorate.

2) Based on an equilibrium analyses for 1990-1999. Bruvoll A. and B.M. Larsen (2004) "Greenhouse gas emissions in Norway. Do carbon taxes work" Energy Policies 32 (4), 493-505, and assessment for the Third National Communication. In addition the effects of the increased rate of the tax for domestic airtransport and shipping in 2006 is included

3) Lowest number reflects direct effect of the agreement, while highest estimate include voluntary measures taken before adopting the agreement in 1997 and after the agreement 2005. Estimates by the Norwegian Pollution Control Authority.

4) The effect is included in the White Paper on Long-term Perspectives 2009

5) The effect on are estimated by the producers.

6) These effects are not in the reference scenario in the White Paper on Long-term Perspectives 2009

7) Includes the effect of the agreement from 2009 for the years 2009-2012 between the process industry and the authority

8) The plant was closed down in 2006

9) Lowest number reflect direct effects of measure included in the White Paper on Long-term Perspectives 2009, while the highest number reflects the effect of measure after 2008 and is not included in the reference scenario in the White Paper on Long-term Perspectives 2009

10) The CO_2 tax for the petroleum sector was substantially reduced in 2008 as a consequence of the extension of the EU-ETS for 2008-2012. The petroleum sector has to pay for all their quotas. The effects in the table therefore show the combined effect of the CO_2 tax and the price of the CO_2 quotas.

11) Based on calculations by Statistics Norway. The N2O emission reduction from nitric acid production is excluded..

12) A revised emission trading scheme from 2013 may include other effects.

According to the baseline scenario, Norway faces an average annual "deficit" of about 7.2 million tonnes CO_2 equivalents for the period 2008-2012, compared to the commitment under the Kyoto Protocol. However, recently adopted measures not included in the baseline projection lower the "deficit" to approximately 7 million tonnes.

CO_2 tax offshore

Based on reports from the companies operating on the Norwegian Continental Shelf it is estimated that emissions of CO_2 from the petroleum sector in year 2000 were 2 million tonnes lower than they would have been in the absence of the CO_2 tax. In addition, 1 million tonnes of CO_2 per year (equivalent to 2 per cent of domestic emissions of greenhouse gases) has been separated from the Sleipner West's gas production and re-injected into the Utsira formation (an aquifer) since 1996 (see Section 4.4.1). This is also a response to the CO_2 tax. Thus, the tax may have reduced emissions by 3 million tonnes CO_2 in 2000, equivalent to 5 per cent of total greenhouse gas emissions in Norway. Energy efficiency measures, reduced flaring and electrification (supply of power from the mainland) has reduced emissions by 1.5 million tonnes annually in 2004-2007. Carbon capture and storage (CCS) has furthermore been initiated for natural gas production on the Snøhvit field, reducing emissions by 0.7 million tonnes annually. Added together the estimates by the oil industry and the Norwegian Petroleum Directorate indicate that the CO_2 tax and the quota system contribute to emission reductions of approximately 5 million tonnes CO_2 in 2010. New planned measures like electrification and expected technology improvements might raise this estimate to almost 7 million tonnes CO_2 in 2020. It is emphasised that the forecasts of the future effects of the CO_2 tax and the quota system are very uncertain.

CO_2 tax onshore

In the Forth National Communication, documentation was also given for estimating the effects of the CO_2 tax in other sectors than the offshore petroleum industry. The effect was estimated to 0.8 million tonnes. On average, emissions in the sectors studied were reduced by 3-4 per cent. From January 2006, domestic aviation, domestic shipping and supply ships are liable to the same CO_2 tax rate as other users of mineral oil. The removal of the tax rebate is estimated to reduce emissions by around 0.05 million tonnes.

Measures in the transportation sector

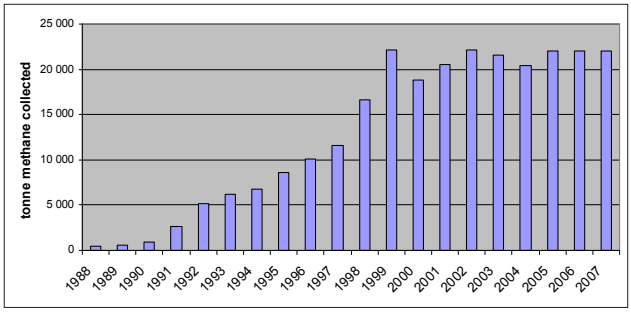
CO_2 labelling for new passenger cars was introduced in 2007. Based on rough estimates it is assumed that the CO_2 emissions decreased by 0.1 million tonne in 2010 and by 0.4 million tonne in 2020. Moreover, the requirement from April 2009 of 2.5 per cent bio fuel sold of the totals of fuel for road vehicles is estimated to decrease emissions by 0.3 million tonne CO_2 in both 2010 and 2020.

Methane – waste

The effect of measures implemented in the waste sector has been good, both in relation to the amount of waste generated, the waste deposited and the collection of methane from landfills. The National Pollution Control Authority has data illustrating how much methane has been collected and either used for the production of energy or flared since 1988, see Figure 5.3. The figure illustrates that collection of methane has reduced the methane emissions by 8 600 tonnes in 1995, 18 800 tonnes in 2000 and 22 000 tonnes in 2005. This is the equivalent of 0.18, 0.40 and 0.5 million tonnes CO_2 equivalents, respectively. It is expected that this measure will give additional emission reduction in 2010 and 2020.

The effect of measures related to reduce the amount of waste generated and waste deposited has been estimated by assuming that the amount of waste deposited after 2000 had an annual increase of 1 per cent without these measures. Taking this assumption into account the effect of the measures in 2010 is 0.1 million tonne CO_2 equivalent and 0.5 in 2020. It is important to have in mind that you cannot compare directly the estimates from the Fourth National Communication. This is because the national methane emissions from landfills have been recalculated and the emission level is lower than in from the Fourth National Communication.

Figure 5.3 Methane emissions and collection from Norwegian landfills 1990-2003



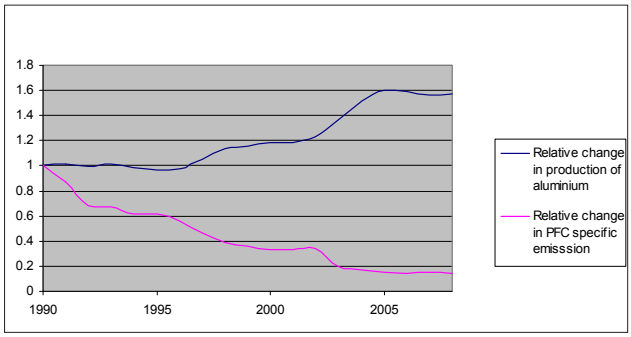
Source: Statistics Norway and the Norwegian Pollution Control Authority

Emissions from the production of aluminium

In 1997, the major aluminium producers signed an agreement with the Ministry of the Environment to reduce emissions of greenhouse gases (CO_2 and PFCs) per tonne aluminium produced by 50 per cent in 2000 and 55 per cent in 2005, compared to 1990 levels. The agreement was followed by a new agreement with the industry for the years 2005-2007, see description below. In 2005 the PFCs CO_2 equivalent emissions per tonne aluminium produced were 85 per cent lower than in 2005 and it was 84 per cent lower in 2007. It is however somewhat difficult to separate the effects of the agreement from other effects. Even before the agreement was signed the aluminium industry had reduced their PFCs emissions substantially i.e. 54 per cent reduction in the PFCs specific emissions per tonne aluminium as CO_2 equivalents. If – as a "business-as-usual" scenario from 1990 – one assumes that the industry would not have changed the level of the emissions voluntarily before 1997 or without the agreement, i.e. no improvements in efficiency, the highest estimate of 4.5 million tonnes can be characterized as the reduction achieved through voluntary action or agreement since 1990. If one only includes the effects after the agreement was signed, i.e. in the agreement period, the estimated reductions are lower, about 1.6 million tonnes CO_2 equivalents in 2007 compared to the "business-as-usual" scenario.

Figure 5.4 shows the relative change in aluminium production and the specific PFC emissions per tonne aluminium produced in Norway from 1990 to 2008.

Figure 5.4 Relative changes in production of aluminium and PFC CO_2 equivalent per tonne aluminium. 1990=1



Source: Statistics Norway and the Norwegian Pollution Control Authority

Arrangement to reduce emissions in the processing industry

In 2004, the Ministry of the Environment agreed on an arrangement with the processing industry in general, with the exception of gas refineries and landing facilities. Sources included were the aluminium, ferro-alloy, carbon, mineral fertilizer and carbide industries that accounted for approximately 30 per cent of total Norwegian greenhouse gas emissions. This arrangement also included some installations covered by emissions trading but then for gases other than CO2. According to the arrangement, total emissions of greenhouse gases in the process industry were not to exceed 13.5 million tonnes of CO_2 equivalents (all six Kyoto gases) by the end of 2007. The 2007 national GHG inventory shows that the emissions from the industries covered by the arrangement were reduced by 1.11 million tonne CO_2 equivalents. These reductions are included in the industry sectors in Table 5.3.

Other voluntary emission reductions

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

Sulphur hexafluoride (SF_6)

Since 1985, Norsk Hydro has reduced its consumption of SF_6 as a blanket gas used in the production of magnesium. The reduction was largest from 1987 to 1989, before SF_6 was known to be a greenhouse gas with a very high global warming potential. From 1987 to 1989, Norsk Hydro reduced its emissions by more than 3 million tonnes CO_2 equivalents. The emissions were also reduced in the beginning of the 1990s. From 1990 to 1995 the emissions were reduced by approximately 1.7 million tonnes of CO_2 equivalents, but there has been a weak increase from 1995 to 2001 due to increased production. The specific emissions (emissions per tonne magnesium produced) were reduced considerably from 1990 to 1995, but were stable from 1995 to 2001. In 2002, the primary production of magnesium and in 2006 also recycling of magnesium was closed down.

Nitrous oxide (N_2O)

Emissions of nitrous oxide from the production of nitric acid amounted to 1.4 million tonnes of CO_2 equivalents in 2007. Improvements in the production process have led to emission reductions of 29 per cent per unit produced from 1990 to 1997, an additional 7 per cent in 2006 and yet another 10 per cent from 2006 to 2007. The reductions in 2006 and 2007 were due to that the producers started installing new catalyst technology in 2006. Full effect of the technology is assumed to be achieved in 2008/2009. In the national emission projection, N_2O emissions per tonne nitric acid produced are assumed to be at the same level as in 2007, while a minor increase in production up to 2020 is assumed. If we assume a business as usual scenario from 1990 without the actual reduction in emissions per unit produced up until 2007, then emissions would have been 1.1 million CO_2 equivalents higher. The technology improvement has reduced the emissions in 2008, additionally. Taking into account the new information about emissions per unit produced in 2008, and building on the forecasted production in the White Paper on Long-term Perspectives 2009, emissions are estimated to be 1.6 million tonne CO_2 equivalents higher in the longer run than they would have been with today's knowledge.

5.3.1.1 New policies

The latest white paper on Norwegian climate policy (Report No. 34 (2006-2007) to the Storting) and the subsequent Storting debate and recommendations are the foundation for the Norwegian climate policy. In these documents the new policy instruments to reach the targets are outlined. Some of these measures are described in chapter 4 while others are described here.

The estimated effects of some recently adopted measures not included in the baseline scenario are also presented in table 5.3. These measures include a trading scheme for the period 2008-2012 covering about 36 per cent of all greenhouse gas emissions and the effects of the consensus agreement between the industry and the authority from 2009. These new measures may add another 0.5 mill. tonn CO_2 equivalent reduction to emissions by 2010.

Moreover, the basic tax on heating oil was significantly increased in 2008. The aim was to prevent that the electricity tax should imply that electricity was substituted by heating oil. In 2008 the basic tax on heating oil was increased to the same level as the electricity tax in terms of net energy (kWh). This tax increase is estimated to reduce the domestic CO_2 emissions by 0.4 million tonnes CO_2 in 2010.

According to the planning part of the new Norwegian Planning and Building Act a national planning guideline regarding climate and energy planning in the municipalities and the regions of Norway, was introduced 4 September 2009. The aim of this guideline is to reduce emissions of greenhouse gases, enhance energy efficiency and contribute to environmental shift in energy use. Through this guideline the local and the regional governments are obliged to incorporate relevant tools and measures in the planning process.

5.4 Supplementarity relating to mechanisms under Articles 6, 12 and 17, of the Kyoto Protocol

Chapter 5.3 indicates that the emissions level in 2010 would have been more than 10 million tonnes CO_2 equivalents higher than actual emissions in the absence of domestic policies and measures taken to mitigate climate change. This estimate is uncertain, but could still be conservative as far from all policies and measures are quantified. Thus, Norway consider this domestic action as a significant element of the effort made to meet its commitment under Article 3, thus being an adequate response to the provision of the Protocol that the use of Kyoto mechanisms shall be supplemental to domestic action.

For comparison, net acquisition of Kyoto units needed to meet the commitment is expected to be about 7 Mt/year (see chapter 4.3.1.9 and 5.3).

6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

6.1 Introduction

Norwegian mainland

Norway is a sub-Arctic country with a long coastline as well as a long mountain chain facing a relatively warm ocean surface to the west. This implies large geographical contrasts in present climate (cf. chapter 2.2) as well as in the projections of future climate change. These contrasts are found both from coast to inland, from north to south and not least from the Norwegian mainland to the Arctic islands (Spitsbergen, Bear Island and Jan Mayen). Climate change at the high Arctic islands is described in a separate paragraph.

In Norway comprehensive studies of regional climate development in a scenario of global warming was initiated in 1997 (http://regclim.met.no) and is since 2007 continued in the NorClim-project (www.norclim.no). The NorClim-project involves a large number of scientists from leading research institutes in Bergen (BCCR, NERSC, UiB, IMR), Oslo-area (met.no, UiO, NVE, CICERO, NILU) and Tromsø (NPI). The activities in NorClim include studies of mechanisms for climate variations on time-scales from years to several decades, production of climate projections up the mid and end of the 21st century with quantification of uncertainties, and providing information on future climate development to governmental bodies, decision and policy makers, researchers, enterprises, NGOs, and the general public. The present activities thus include downscaling and tailoring of climate projections for impact and adaptation studies, and conducting research in improving models and knowledge of uncertainties.

The most recent projections of climate change for Norway from present climate (1961-90) and up to two scenario periods (2021-2050 and 2071-2100) are presented by Hanssen-Bauer et al., (2009). The projections are based on statistical and dynamical downscaling of global climate model results from IPCC (2001, 2007). For temperature, precipitation and sea level both high, low and average projections are estimated. The findings presented below indicate projected average changes (low and high values in brackets) from 1961-90 to 2071-2100 based on the results from Hanssen-Bauer et al. (2009).

The projections indicate a warming in all parts of Norway and during all seasons. The annual mean temperature for Norway (Figure 6.1) is estimated to increase by 3.4 (2.3-4.6) °C. For the Norwegian mainland, the largest annual temperature increase 4.2 (3.0 – 5.4) °C is estimated for the northernmost county (Finnmark) and the smallest 3.1 (1.9-4.2) °C for Western Norway. The largest temperature increase is projected for the winter season, and smallest increase during summer. The growing season is projected to increase by 1-2 months over large parts of the country.

Precipitation changes are probably the more dramatic of the signals. Annual precipitation averaged over the Norwegian mainland is estimated to increase by 18 (5-30) per cent up to year 2100 (Figure 6.2). The largest seasonal precipitation increase is 23 (5-33) per cent for the autumn, while the smallest increase of 9 per cent is found for the summer season. For the summer season the low estimate indicate a reduction (-3 per cent) in the total precipitation for the Norwegian mainland, while the high estimate give an increase of 17 per cent. The low estimate gives reduced summer precipitation over all regions in Southern Norway, and in the southernmost part a reduction of ca. 30 per cent. The tendency of drier summers in the south of Norway reflects the conditions projected for summertime central and southern Europe. Except for the summer precipitation, the seasonal precipitation is projected to increase in all seasons and in all regions.

The average projection indicates more days with heavy rainfall and higher precipitation values in the extreme events all over Norway and in all seasons. This is also valid for the summer season in the regions where the total summer precipitation is projected to be reduced. During winter and autumn the number of days with heavy rainfall may be twice the present level.

For average wind speed, the available projections give small or no changes. The frequency of high wind speeds may increase, but because of systematic weaknesses in the climate models final conclusions may not be drawn.

The annual runoff from the Norwegian mainland is estimated to increase. The runoff is projected to increase during winter and autumn, and be reduced during

summer. On the other hand, in regions with glaciers an increase is estimated even for the summer season.

The snow season is projected to be shorter all over the country. A reduction of 2-3 months is estimated for low-elevation areas. Up to mid-21st century, the maximum snow water equivalent during the winter season may increase in the high-mountain regions and in areas in interior parts of Northern Norway.

For river flooding, the rain floods are projected to increase while the snowmelt floods will decrease. Increasing temperatures cause earlier dates for the snow melt floods during spring, while floods during late autumn and winter may be more intense than the present level.

The sea surface temperature may increase by 0.5°C during 65 years at the western coast of Norway and by 1.0-1.5°C in the western part of the Barents Sea. In the North Sea, the surface temperature may increase by 1.4°C in 100 years. The ocean inflow to the North Sea is estimated to remain unchanged, while the inflow to the Barents Sea may be reduced. Thickness and area of the Arctic ice cover will continue the present tendency of reduction. The Arctic may be ice-free during summertime in the middle of this century, but a substantial variability is expected both on annual and decadal timescales.

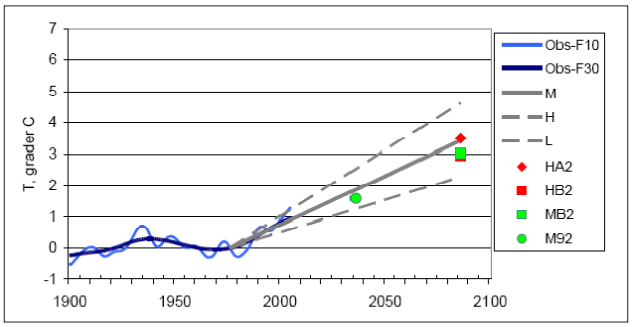
The sea level is estimated to increase by 70 cm at the western and southernmost coast of Southern Norway, by 60 cm in Northern Norway and about 40 cm in interior parts of the Oslo- and Trondheimsfjord. Because of uncertainties in the various factors that govern the future sea level-rise, the increase may be between 20 cm lower and 35 cm higher than the values above.

For extreme wave heights an increase of 6-8 per cent is estimated for the North Sea and Skagerak during this century. Also for the Barents Sea an increase is estimated, but the results in this area are quite uncertain. For the remaining Norwegian ocean areas small changes in wave heights are estimated. The available climate projections 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 websites www.norclim.no and www.klimatilpasning.no.

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

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

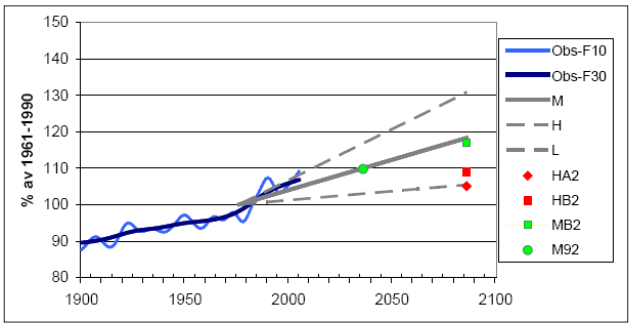
Figure 6.1. Observed temperature development in Norway during the 20th century, and projections for the 21st.[1]



[1] The graphs are representing anomalies (in degrees Centigrade) from observed mean temperature in the period 1961-1990. The observed temperature development is smoothed and show variability on a decadal (light blue) and 30-years (dark blue) time scale. The projections (grey lines) are shown as linear trends. High and low projections (see text) are described by broken lines, while the average projection is a full drawn line. Projections which are exemplified by fine scale maps (1x1 km) are marked by dots.

Source: Hanssen-Bauer et al. (2009).

Figure 6.2. Observed and projected precipitation development in Norway 1900-2100[1].



[1] The graphs are representing deviation (in percent) from observed mean precipitation in the period 1961-1990. For more details, see legend to Figure 6.1.

Source: Hanssen-Bauer et al. (2009).

Norwegian Arctic

The Arctic land areas have over the latest 20 to 30 years experienced more warming than any other region of earth, and the sea-ice cover has decreased in the order of 10 per cent in the same period (ACIA, 2005; IPCC, 2007). IPCC (2007) states that the projected 21st century global warming will be enhanced in the northern high latitudes due to complex feedback mechanisms in the atmosphere-cryosphere-ocean system. The Arctic climate conditions show large variability, both from year-to-year, but also on a decadal scale. Results from IPCC indicate that man-made climate change is prone to be relatively large in the Arctic, but at the same time associated with considerable scatter between climate models. The main reason both for the Arctic amplification of global climate warming as well as the spread, is the Arctic cover of sea ice.

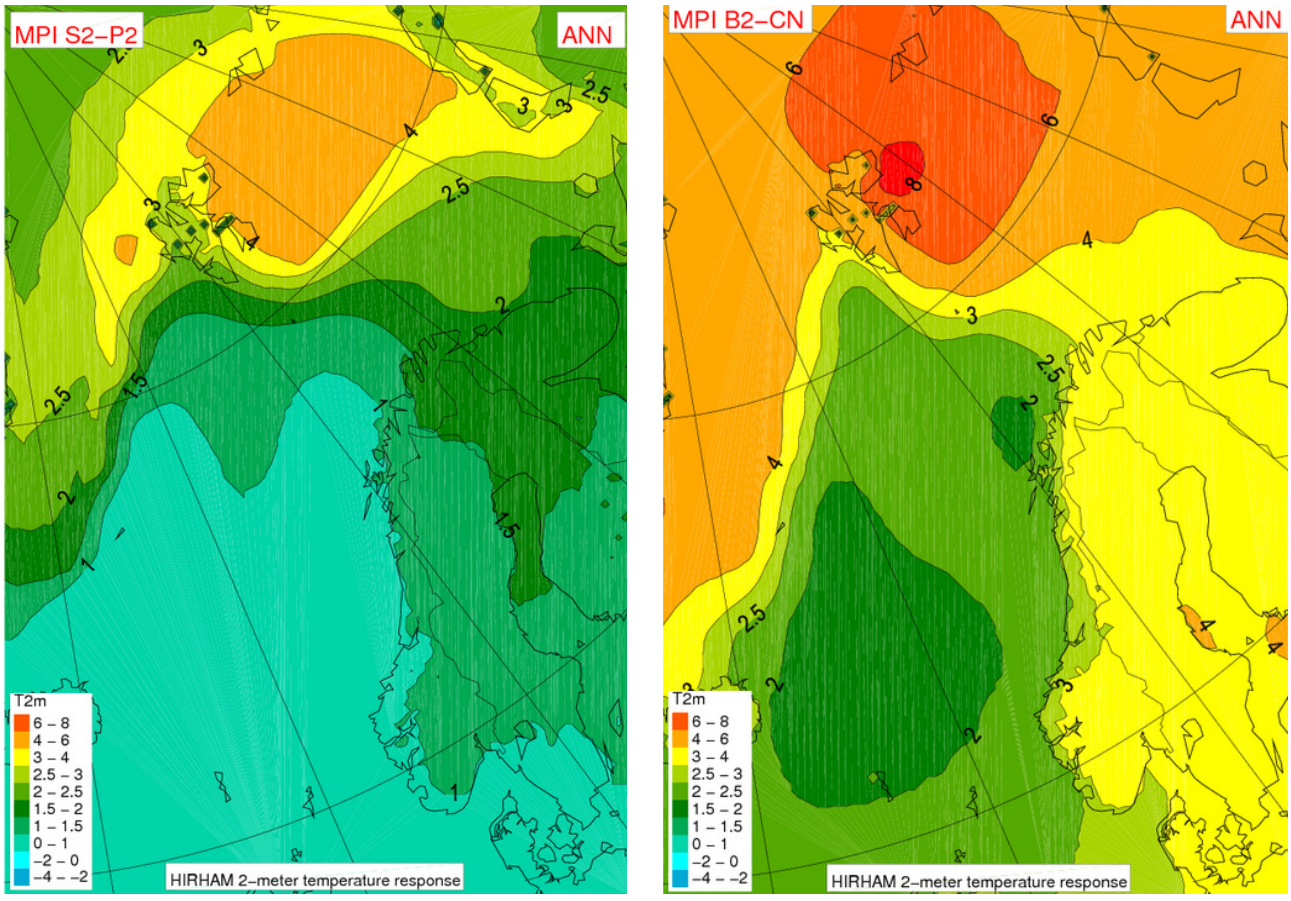
There are large discrepancies in how different global and regional climate models describe both present and future ice conditions in the Norwegian Arctic areas, and the uncertainties in the Arctic climate projections are thus considerable.

Projections from the NorACIA-RCM, a regional climate model developed for the Norwegian Arctic areas, are produced for the scenario periods 2021-2050 and 2021-2050 (Figure 6.3 and 6.4). For Svalbard the increase in annual temperature up to the end of the 21st century varies from ca. 3°C in the southwest and ca. 8°C in the northeast (Figure 6.3b). The projected warming is smallest for the summer season and greatest for autumn and winter. Substantial increase in air temperature is also projected for the ocean areas between Svalbard and Novaja Zemlja. This increase is greatest in areas where sea-ice is replaced by open water (Førland et al. 2009).

Annual precipitation up to 2071-2100 for north-eastern parts of Spitsbergen could increase up to 40 per cent (Figure 6.4b). The seasonal precipitation is projected to increase over the whole region during all seasons;- with the largest increase during winter and spring. It should however be stressed that precipitation is quite scarce in the Svalbard region during the winter season;- implying that despite the large percentage increase the absolute increase in precipitation may be just a few millimetres (Førland et al. 2009).

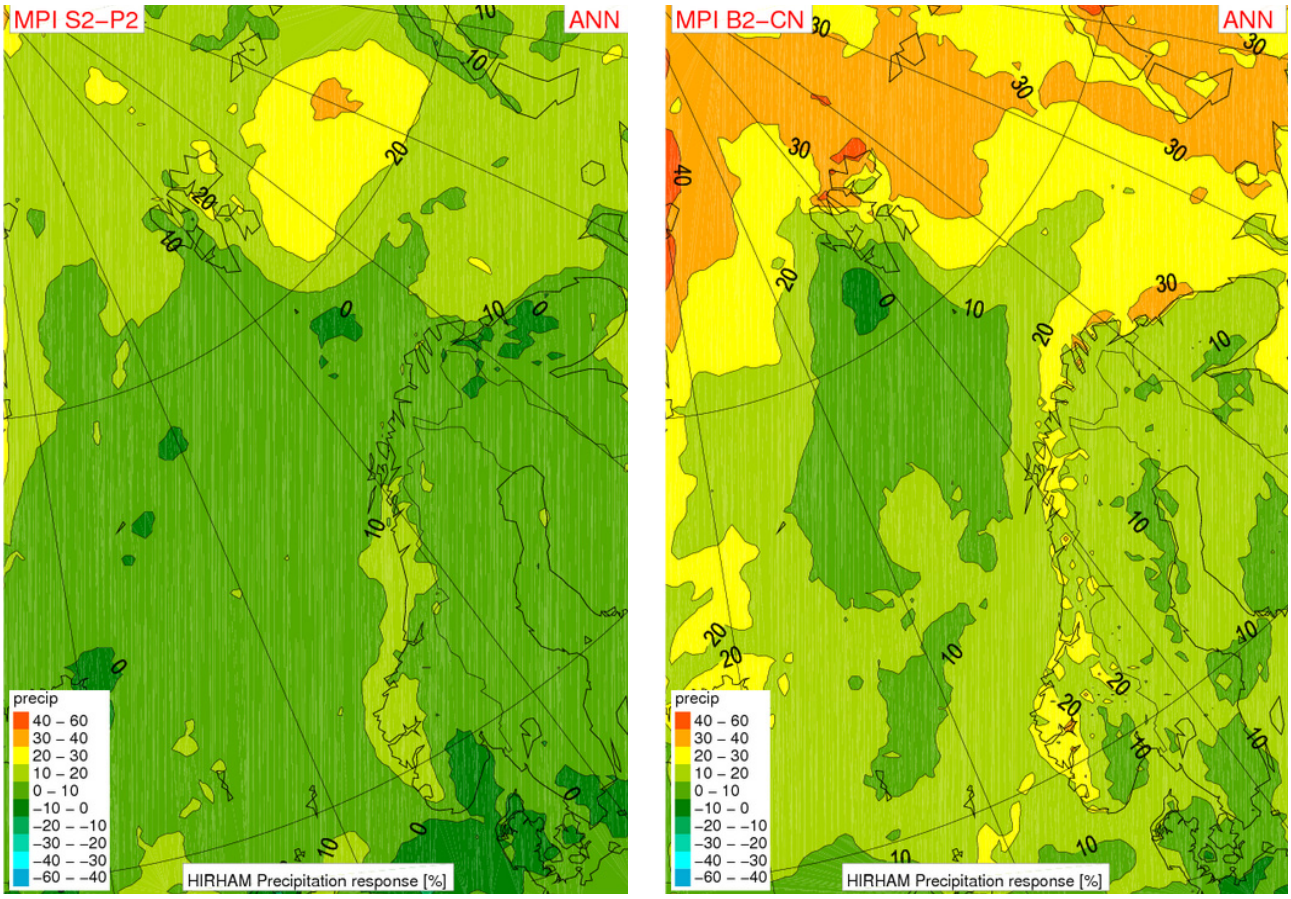
The climate changes seen in the Arctic have already led to major impacts on the environment and on economic activities. If the present climate warming continues as projected, these impacts are likely to increase, greatly affecting ecosystems, cultures, lifestyles and

Figure 6.3. Projected change (°C) in mean annual temperatures from a) 1981-2010 to 2021-2050 b) 1961-1990 to 2071-2100.



Source: Førland et al. (2009)

Figure 6.4 Projected change (in per cent) in mean annual precipitation from a) 1981-2010 to 2021-2050, b) 1961-1990 to 2071-2100



Source: Førland et al. (2009)

economies across the Arctic. The arctic climate is a complex system and has multiple interactions with the global climate system. Changes in the arctic climate are thus very likely to have significant impacts on the global climate system.

6.2 Expected impacts of climate change

6.2.1 The Arctic

The Arctic land areas have over the latest 20 to 30 years experienced more warming than any other region of the earth, and the sea-ice cover has decreased in the order of 10 per cent in the same period (ACIA, 2005; IPCC, 2007). The Arctic climate conditions show large variability, both from year-to-year, but also on decadal to multidecadal scales.

Climate models indicate that anthropogenic global warming will be enhanced in the northern high latitudes due to complex feedback mechanisms in the atmosphere-ocean-ice system. The climate changes seen in the Arctic have already led to major impacts on the environment and on economic activities. If the present climate warming continues as projected, these impacts are likely to increase, greatly affecting ecosystems, cultures, lifestyles and economies across the Arctic. The arctic climate is a complex system and has multiple interactions with the global climate system. Changes in the arctic climate are thus very likely to have significant impacts on the global climate system.

Global climate model simulations (ACIA, 2005) indicate that up to the end of the 21st century, Arctic temperature is projected to increase by 7°C and 5°C for the A2 and B2 emission scenarios, respectively. The strongest warming will occur during autumn and winter. The Multi-Model Dataset used in the regional climate projections for IPCC (2007) projected an annual warming of the Arctic of 5°C at the end of the 21st century.

There are large discrepancies in how different global and regional climate models describe both present and future ice conditions in the Norwegian Arctic, and the uncertainties in the Arctic climate projections are thus considerable.

Results from the NorACIA-RCM, simulations up to year 2050 (Figure 6.3 a) indicate an increase in annual temperature of approximately 1°C in the coastal areas in Nordland and Troms, and between 1.5-2.0°C in eastern parts of Finnmark and southwest of Spitsbergen. A large gradient in the magnitude of the increase is present from south-western to north-eastern parts of the Svalbard region. This pattern is found in many scenarios. The projected decrease in sea-ice coverage will

largely influence the temperature in the lower atmosphere (Førland et al. 2009).

For large parts of Northern Norway the projected increase in annual precipitation from 1981-2010 to 2021-2050 is 20-30 per cent, while for north-eastern parts of Spitsbergen the increase is up to 40 per cent (Figure 6.4a). The seasonal precipitation is projected to increase over the whole region during all seasons;- with the largest increase during winter and spring. It should however be stressed that precipitation is quite scarce in this region during the winter season;- implying that despite the large percentage increase the absolute increase in precipitation may be just a few millimetres (Førland et al. 2009).

6.2.2 Terrestrial ecosystems

In Norway, effects of climate change, particularly a temperature increase, have already been observed on terrestrial ecosystems. One has seen earlier arrival in migrating birds, earlier sexual maturation in some animals, higher production and reproduction in both plants and animals, and earlier budding and pollen production. There are also some signs of plant species having expanded northwards or upwards. Satellite-based mapping indicate that the growing season has increased up to 2-4 weeks in parts of Norway since the 1980s. Melting of palsa mires in recent years has been observed.

Future climate changes in Norway are expected to lead to migration of species and vegetation shifts to higher altitudes and latitudes, or that species will need to adapt to changed living conditions. Migration requires available habitat for migration and recolonisation, whereas adaptation requires strong populations with enough genetic variability to adapt through natural selection. Hence securing corridors or large habitats with climate gradients and protect already threatened species, are important measures for securing biological diversity. At the same time some species i.e. high alpine or arctic, are expected to be lost, due to competition with new species or that they no longer have enough suitable habitat to live in.

Changes in precipitation also affect terrestrial systems, among others through changes in snow conditions. Changes in precipitation in combination with temperature, affect snow thickness, quality and duration. At higher altitudes increase in precipitation leads to more snow. Deep snow has been shown to have negative influence on the population growth in some deer species. Snow duration affects the growth season, whereas more icy-conditions have been shown to have negative effects the grazing conditions for reindeer. Also, the increased precipitation leads to higher erosion and run-off. Further, an increase in temperature and/or precipitation is expected to result in the degeneration of the most marginal palsa peatland areas in the course of a few decades.

Living conditions for alien species also changes with climate change. At present, many invasive species are not able to survive cold winter conditions in large parts of Norway. With the milder winters expected in the future, more of the harmful species will be able to survive and spread. Stronger regulation preventing the import, spread and establishment of invasive, alien species is therefore important.

With higher temperatures and longer growth season, the primary production will increase in most terrestrial ecosystems. Some cultural systems like species rich hay meadows or grazed grasslands, might be vulnerable to such increased production. Many cultural landscapes are already threatened by re-growth due to abandonment, and increased growth will accelerate this process.

6.2.3 Fresh water ecosystems

The predicted temperature rise may lead to changed living conditions in freshwater. The summer stratification period in lakes will be longer and more distinct, which is likely to favour cyanobacterial blooms. High altitudinal and latitudinal lakes are regarded as particularly sensitive to variations in climate, and species respond immediately to changes in ice regime. Lakes in coastal areas may become ice free during winter. The ice-cover period in high altitudinal lakes may be shortened, depending on future snow conditions. With the higher precipitation expected, higher nitrogen concentrations caused by increased runoff from soil, changes in physicochemical and hydrological conditions, and a higher carbon dioxide concentration may lead to changes in competition between some species of primary producers and consumers. The degree to which species will disappear with changed living conditions is uncertain. For specialized species of phytoplankton, zooplankton, vertebrates and cold stenothermic glacial relicts, the forecasted climate changes could be critical in some localities. Fresh water systems are isolated, and some species of fish and crustaceans may be unable to migrate to alternative habitats. In addition, there is a risk for new/introduced invasive species to survive the new conditions and outcompete native species.

Atlantic salmon is an important species in rivers along the coast of Norway and Norwegian rivers are important for maintaining Atlantic salmon. In Southern Norway predictions are that temperatures will increase and summer precipitation will decrease. This can lead to significant increase in water temperature in rivers in Southern Norway during summer. Water temperatures in the upper twenties are considered lethal to salmon. This means that rivers in Southern Norway may in the future be too warm to maintain self sustaining salmon stocks.

6.2.4 Marine ecosystems

Studies of how natural decadal and multi-decadal climatic fluctuations have affected marine ecosystems, have provided insight into what can be expected given the suggested continued warming of the sea. Historically, an increase in temperature of only 2ºC has been documented to have significant impacts on oceanographic features (frontal zones, salt and heat budgets, thermohaline circulation) that drive ecosystem structure and function. Changes in these drivers are already apparent; but it is difficult at present to separate natural fluctuations from human induced climatic changes.

A rise in the sea temperature will have impact on marine ecosystems. In recent years, distributional changes associated with a warmer climate, have already taken place. In the North Sea there has been a change in plankton communities from cold to warm water species. It is reported that the amount of *Calanus finmarchicus* have decreased when the amount of *Calanus helgolandicus* have increased. Similar changes can be expected in the Norwegian Sea and the Barents Sea where arctic species might be replaced by more southern species. Such changes might have large impacts on the "match" with the phytoplankton bloom, and with spawning of major fish stocks, particularly those whose smallest life stages depend on Calanus for food. It has also been reported that the total amount of Calanus species has decreased. This is something that will have a great impact on the higher levels in the ecosystem.

In the Northern part of the Barents Sea it is expected that thinning of the annual sea ice will continue. A marked increase in the melting of sea ice during summer will result in an increased width of the area with seasonal ice cover. Thus, the area covered by annually formed ice will reach farther into the Arctic Ocean. Reduced sea ice cover and thickness combined with a prolonged ice free period will increase primary production, and support an increased biomass of benthos in the eastern and northern parts of the Barents Sea. Expansion of the area covered with seasonal ice will also increase the biological production associated with the marginal ice zone. However, reduction in the extent of sea ice will have negative impacts on ice-associated flora and fauna. Of special concern are the expected negative impacts on several ice-dependent mammal species

Climate change also increases the pollution loads to sea due to increased precipitation, increased run-off from land and changes in the atmospheric transport of contaminants. Changes in water temperatures, ice cover and ocean chemistry (acidification) will also most likely affect degradation processes and uptake of contaminants in biota.

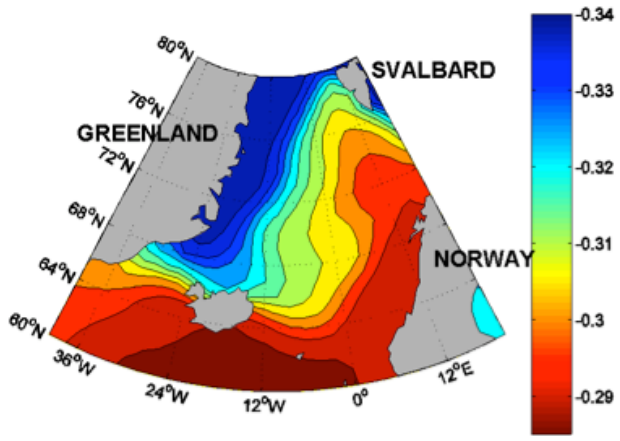
Acidification

Emissions of CO_2 from the burning of fossil fuels do not only contribute to warmer climate, but CO2 is also taken up by the oceans and changes their chemistry. The oceans have absorbed approximately 50 per cent (ca. 525 billion tons) of the carbon dioxide (CO_2) released to the atmosphere since the beginning of the industrial revolution. When carbon dioxide is absorbed by the oceans it reacts with seawater to form carbonic acid. This has caused an increase in the acidity of about 30 per cent. Present changes are at least 100 times more rapid than similar changes experienced over the past 100 000 years. Data on CO_2 in the atmosphere and expected emissions makes it possible to model ocean acidification with a high degree of certainty. By 2100 the reductions are predicted to be in the order of 0,2-0,3 pH units. The ocean acidification is predicted to be a bigger problem at higher latitudes due to colder water.

Changes in ocean carbon chemistry due to elevated atmospheric CO_2 are not only restricted to a reduction in pH but also result in decreased concentration of carbonate ions. This means that it will become gradually more difficult for marine organisms to build calcium carbonate shells and skeletons. Impacts of ocean acidification on biological processes are therefore expected, but their exact nature remains largely unknown and may occur across the range of ecosystem processes.

From a global perspective, the Arctic Ocean is the region most sensitive to changes in its water chemistry due to anthropogenic increases in carbon dioxide. As part of the natural oceanic carbon cycle, the waters entering the Nordic and Barents Seas contain high concentrations of inorganic carbon due to carbon dioxide (CO_2) uptake from the atmosphere as the waters move from lower latitudes. Since the onset of the industrial revolution, the natural carbon enrichment has been supplemented by the uptake of excess carbon resulting from anthropogenic activities: the increased air sea CO_2 gradient resulting in more carbon entering the oceans. Being already high in carbon dioxide, the waters have a low buffer capacity (high Revelle factor) - meaning that for every unit of carbon taken up there is a disproportionately large change in pH than would be commonly found for waters at lower latitudes with a lower Revelle factor. We face an acidification that has not been recorded for millions of years, and the acidification of the oceans have potentially large impacts on the biological diversity (Holmén and Dallmann 2009).

Figure 6.5 The regional variability in surface pH reduction during the 21st century within the Nordic-Barents area. Ocean acidification will be greatest in the Arctic regions.



Source: adapted from Bellerby et al., 2005.

Corals are among the first organisms to display effects of the acidification. There will probably be a clear effect on corals by 2025. In Norwegian waters 70 per cent of the deep ocean corals are located in areas where they will be subjects to a slow dissolution by 2099. Effects are also expected on marine plants and juvenile organisms of the bottom fauna (Holmén and Dallmann 2009). Of particular concern is how acidification will influence overwintering zooplankton in the depths of the Nordic Seas.

6.3 Vulnerability Assessment

6.3.1 Primary industries

Agriculture

Large parts of agriculture are dependent on and adapted to certain climatic conditions, and are more subject to the effects of climate change than other industries. These effects may be positive, in that, in many places, climate will not to the same extent limit biological production. At the same time, climate change will result in negative consequences through changes in precipitation patterns, extreme weather situations, erosion, increased run-off of nutrients, etc. There will also be a risk of increased greenhouse gas emissions and an increased risk of new pests and new plant and animal diseases. Preparedness for pests and plant and animal diseases and measures for adapting to climate change are therefore major priority areas.

Forestry

Rising CO_2 levels and a longer growing season are likely to increase forest productivity across large areas of Norway, where growth is not limited by water or nutrient supply. Changes in the activity, identity and population densities of pathogens and insect and mammal pests are more difficult to predict and may modify these predictions significantly.

Climate change is likely to increase the mean temperature in Norway and the frequency of climatic extremes, such as drought, floods, and storms. Under such conditions, there is high probability that forests will be subjected to increased frequency and intensity of stress due to climatic extremes. Some pathogens may increase their importance and new may arrive. More unstable winter climate may in the future give increased fungi attacks on the Norwegian forests. Longer and warmer growth season will give many pathogens and harmful insects better conditions. This might cause severe damage to the forest, resulting in reduced carbon stocks.

Fisheries and aquaculture

There is a great need for more research on the consequences of the climate change for the fisheries. However, a likely consequence of warmer waters is a change in the composition and abundance of species in different sea areas. In some areas the commercial value may be reduced, while in other areas it might increase. It is also likely that changes in the distribution areas for some species may have impact on fish quotas in the economic zones of some countries. Generally, it is to be expected that the habitat extents of fish species will move northward, and with an ice-free Arctic basin during summer fishing operations may be extended into new areas.

The disease status of farmed fish can be negatively affected by climate change. Increased mean sea temperature and larger temperature variations can lead to increased growth and survival of pathogenic bacteria, viruses and parasites. Changes in temperature and precipitation patterns may alter coastal currents, affecting the dispersal pattern of these pathogens. A higher frequency of extreme weather conditions may also increase the risk of farmed fish escaping from nets. This may affect the genetic interaction between farmed fish and wild stocks.

Climate change may force the farming industry to relocate fish farms. Atlantic salmon and cod in Northern Norway could benefit from enhanced growth rates due to an increase in the mean sea temperature, while more frequent extreme summer temperatures could lead to poorer health and welfare for these species further south. Instead, new species, such as sea bass and turbot, may possibly be farmed in these areas.

6.3.2 Infrastructure, housing and other buildings

Transport and communications

Climate change will lead to an increase in the risk of flooding and landslides affecting roads, railways and airports. This poses a major challenge to the transport and communications sector, and will entail a greater need for maintenance and major investments. Furthermore, climate change may increase the current

maintenance in the road and railway network. Climate change must also be considered in the planning of new infrastructure. Resources for maintaining and operating the road and rail network should be increased in the years ahead in order to best be able to meet these challenges.

In 2007 the Norwegian Public Roads Administration (NPRA) implemented Climate and transport which is a four-year research and development project to improve the routines for planning, design, building, operation and maintenance of the road networks in response to the changing climate conditions. The main topics of the projects are flood, erosion and landslide control, how climate change affects the standard of the road network and consequences for winter operation and emergency preparedness. The project will be carried out in collaboration with other transport sector departments. The results of the project will be implemented through the NPRA's handbooks.

Marine installations face increasing exposure to rising sea levels, extreme weather and an increase in coastal erosion. This must be taken into consideration when building in coastal areas. The Norwegian Coastal Administration maintains a high focus on climate change and the effect this may have on piers, beacons, seamarks, etc. In recent years, there has been an increase in storm damage to such installations. A better design would entail an increase in short-term costs. However, in light of the long lifespan of these installations, such investments might very well be profitable.

Energy supply and petroleum production

Water courses and power production will be affected by climate change. More precipitation could increase energy production, whereas more frequent extreme weather could pose a risk of strain and damage to important infrastructure such as electricity grids, dam constructions and power plants. Furthermore, a change in climate could change the seasonal demand for energy. Mild winters will reduce the need for heating, whereas hotter summers could increase the demand for air-conditioning. A change in climate may also entail changes in the planning and operation of regulating reservoirs, electricity grids and other power supply facilities.

The Norwegian Water Resources and Energy Directorate is working to gain a more thorough understanding of what type of climate changes we can expect in the future and what effect these changes will have on the hydrology and physical conditions of the watercourses. This knowledge will be used in the administration of the water resources and for energy planning.

Norwegian petroleum installations have been designed to withstand extreme weather. However, more frequent extreme weather events could cause more frequent shutdowns of production.

Land use and buildings

Climate change will be an important aspect of regional and local land use planning. Changes in the precipitation pattern, wind conditions, sea level and frequency of landslides and flooding will provide the basis for guidelines on how buildings should be constructed. Land which makes attractive construction areas today, might be unsuitable in the future.

Generally speaking, due consideration should be taken of risk and vulnerability aspects in land use management. Moreover, mapping should be carried out of areas that are particularly vulnerable to climate change. Good tools such as flood zone maps and maps of landslide-prone areas are vital to ensure more robust social planning.

Earlier this year, the Government submitted a proposal to the Storting for new planning legislation to be included in the Planning and Building Act. The new legislation proposes making it mandatory for planning authorities to ensure that risk and vulnerability analyses are carried out. It may also be necessary to assess the need for more detailed guidelines on how the planning authorities can safeguard climate change considerations.

Climate change poses significant challenges for the housing and construction sector. More precipitation and humidity will greatly affect materials and structures in the long and short term, which could reduce the lifespan of buildings. More rain and wind could cause humidity damage, which could impact human health and create a need for costly repairs. It is important to identify climate vulnerabilities to be able to plan and implement adapted construction measures. In future building regulation amendments, climate change challenges will provide guidelines for potential revisions. Furthermore, it is important that local authorities and other players in the housing and building sector have access to local climate information, as well as competence on climate-adapted construction work.

Water and drainage system

Challenges related to water and drainage systems are connected to extreme weather and gradually increasing strain on drainage systems due to heavier rainfall. Climate change may contribute to increased pollution from drainage systems. An increase in the frequency and intensity of precipitation may increase overflow from the sewer system. The risk of sewage in the drinking water may increase, which in turn could entail an outbreak of infectious diseases. In a flood situation, drainage systems could act as bottlenecks, which could

aggravate the flooding situation, particularly in densely populated areas. An increase in temperature could lead to increased algae growth in sources of drinking water and reduce the effect of chemical treatment.

It is important that the local authorities incorporate climate change considerations into their drainage and water supply plans. It might be necessary to increase the design criteria for the water and drainage systems. One solution to reduce damage to homes and infrastructure in densely populated areas could be to introduce local storm water systems involving surface runoff along natural depressions in the terrain or streams.

6.3.3 Civil protection and emergency planning

Prevention of and preparedness against climate change incidents are important for instilling a sense of safety among the public and to prevent major socio-economic costs. The principles of responsibility, equality and proximity which are at the very core of the civil protection and emergency planning work in Norway also apply to the ability to prevent and gradually handle stress, crises and accidents caused by climate change. Furthermore, each sector is responsible for ensuring that the necessary risk and vulnerability analyses are prepared and that sufficient emergency preparedness measures are in place in the event of a natural disaster, disruption of society's critical functions or other climate change incidents.

The expected increase in nature-triggered incidents and more extreme incidents will pose several challenges for rescue services and increase the need for coordination. More frequent instances of landslides and flooding will cause challenges for the Civil Defence and rescue services in terms of competence and use of resources. The projected climate changes will also bring challenges for the fire service and the civil defence's ability to handle the increased risk of forest fires, and for the power industry's ability to cope with an increase in damage to technical facilities. Furthermore, climate change will pose safety challenges for facilities handling hazardous substances, transportation of hazardous goods and consumer services.

An increase in traffic and accessibility in the Northern areas as a result of climate change could increase the accident potential and thus increase the rescue coordination centres' number of rescue missions. Moreover, an increase in maritime traffic in an ice-free but vulnerable Arctic region could also present more challenges in terms of oil spill preparedness than previously.

6.3.4 Health

The public's health is affected by changes in the ecosystem. Higher temperatures increase the risk of insect-born diseases from, for instance, mosquitoes, ticks or slugs. The risk of infection will increase as such species spread and multiply quicker at high temperatures. The risk of infection could also increase as new species appear, such as new species of bats which could increase the risk of rabies infection.

Global warming could cause tropical diseases such as malaria to become more widespread. This could be significant for Norway as the risk of being infected during travels abroad would increase. Higher temperatures would increase the risk of infection via food articles. Furthermore, the change in temperature would also directly affect the public's health. More frequent extreme weather events would mean that the public would be exposed to risk situations such as flooding and landslides more frequently. Climate change will also affect the composition of pollen and pollination levels, as well as dispersion patterns.

Public health measures consist of a combination of prevention and health service adaptation measures. Prevention could involve measures to limit the spread of disease-carrying species and information and hygiene-promoting initiatives within critical areas, such as food and drinking water. Health service adaptation measures would involve extensive monitoring and vaccination programme assessments, as well as adaptation of competence and capacity to changes in the clinical picture.

6.3.5 Insurance

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

6.3.6 The Arctic

The report from the Arctic Climate Impact Assessment (ACIA), which was initiated in 2001 by the Arctic Council, finalized in 2004 and printed in 2005, emphasizes that the Arctic now is experiencing some of the most rapid and severe climate change on earth. The Norwegian Ministry of the Environment initiated a national follow-up programme of the ACIA-report, Norwegian Arctic Climate Impact Assessment (NorACIA), with the aim to improve the knowledge relevant for adaptation strategies for the most vulnerable societal sectors and to fill the knowledge gaps as described in the ACIA report. The secretariat for this national programme is located at the Norwegian Polar Institute, and the programme will be finished early spring 2010.

6.4 Adaptation measures

In May 2008 the Ministry of the Environment presented a framework to enhance society's resilience to climate change, to reduce vulnerability and strengthen our ability to adapt. In this initial phase the framework sets out the following objectives:

- To identify vulnerabilities and incorporate climate change considerations into affected policy areas.
- Obtain more knowledge about climate change and climate adaptation.
- Promote coordination, information and competence development.

On 5 December 2008 the Norwegian Government appointed the Norwegian Commission on Vulnerability and Adaptation to Climate Change. The Commission is headed by the governor of the county of Sogn og Fjordane and gathers experts from government agencies, research institutes and civil society. The Commission has been tasked to prepare a comprehensive report on the challenges and opportunities caused by a changing climate, and should provide guidance on priorities and specific measures to reduce vulnerabilities. The Commission shall report to the Ministry of the Environment no later than 1 November 2010.

It is important today to focus on issues affected by climate change such as transport and energy infrastructure, where decisions today may have implications for several decades ahead. Such investments should take into consideration the risks posed by a changing climate, and adapt accordingly.

Obtain more knowledge about climate change and climate adaptation

The framework gives priority to develop the knowledge base. There is particular priority to climate change monitoring and to the effects of climate change in the northern areas. Topical subjects include research into climate change consequences and adaptation measures to enhance resilience of ecosystems, business and industry and society at large. Norwegian researchers participate actively in international research collaborations, and contribute to the work of IPCC.

Policy development relies on regional and local knowledge about the projected climate changes. The current climate scenarios for Norway give us a general picture of the projected developments for the country on a national level. They do not, however, provide sufficient information about regional and local conditions on the scale needed to implement adaptation measures. A national climate model is now being developed further as part of the research project NorClim, funded by the Research Council of Norway. The project's research findings will provide the basis for improved and more detailed climate change projections.

Our current knowledge on scientific causality in relation to climate developments is substantial. However, our knowledge about climate consequences is more limited and fragmented. We need a better understanding of what impact climate change will have on society. In order to develop good adaptation strategies, we need sound knowledge on what we are adapting to. There is, therefore, a close correlation between research on climate change consequences and research on adaptation.

A forum will be established for strategic cooperation on climate and environmental research. Climate is an interdisciplinary research field, and the forum will be responsible for identifying and implementing measures that will ensure that research on climate and the environment is carried out across disciplines, sectors and ministries. The forum will play a strategic role in following up research needs relating to climate adaptation.

The research must be followed by active knowledge-sharing and development of methods to be applied in social planning. It is important that the research is easily available and relevant to those who will be affected by climate change and will consequently make use of the results.

Promoting coordination, information and competence development

The very nature of the challenges calls for cooperation and knowledge-sharing across sectors and disciplines. In 2007, an inter-ministerial group was appointed to promote coordination and dialogue. The group meets on a regular basis to discuss common challenges encountered in the work on climate adaptation. The group will coordinate measures and ensure that the work on climate adaptation takes an interdisciplinary approach. The group is under the direction of the Ministry of the Environment and has been appointed for a period of five years.

A national secretariat has been set up to deal with the practical coordination of climate change adaptation. The secretariat is under the responsibility of the Directorate for Civil Protection and Emergency Planning. The role of the secretariat is to help coordinate adaptation activities across different segments of society and to promote implementation of common measures. Another important task is to provide information on government adaptation efforts and promote exchange of experience and network building.

The secretariat has initiated forums for competence development through courses, seminars and resource groups. This mainly takes place within the framework of existing initiatives, to forge closer links between climate adaptation efforts and affected disciplines. Measures to raise competence were introduced through as-

signing the County Governor with an official task to hold seminars on climate adaptation for municipalities. Follow-up and continuation will be maintained through the above-mentioned project relating to the coordination of the County Governor's tasks for 2009.

The office of the County Governor plays a central role in climate adaptation work, and through the official duties of the office, has specific tasks within this field. In 2009, the Directorate for Civil Protection and Emergency Planning, the Norwegian Water Resources and Energy Directorate and the Norwegian Pollution Control Authority developed guidelines and expectations on the regional adaptation work.

Adaptation to climate change is a relatively new concept. Valuable information and lessons learned from local adaptation efforts already exist, but such information is scattered and not readily available. Consequently, a clearing house mechanism entitled "Klimatilpasning i Norge" *(Climate Adaptation Norway)* was launched in 2009. The clearing house is run by the national secretariat for climate adaptation and is available on the government website www.klimatilpasning.no.

The clearing house has been developed to meet the specific needs of regional and local spatial planners, but should nevertheless be of value to a broader audience. It facilitates exchange of information and experience between researchers, administrative bodies and the business sector. The objective is to make relevant information available in one place. The portal provides an overview of topics and challenges, and provides users who need more detailed information with links to research institutions and government agencies.

6. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY, INCLUDING INFORMATION UNDER ARTICLES 10 AND 11 OF THE KYOTO PROTOCOL

7.1 Provision of 'new and additional' financial resources

There is no internationally agreed definition of what constitutes "new and additional" resources under Article 4.3 of the Convention. Norwegian official development assistance (ODA) has been increasing steadily over the period under review and is now at approximately 1 per cent of gross national income (GNI). Funding for climate change actions has been increased considerably over the last few years; by any definition these can therefore be classified as "new and additional".

GEF Trust Fund

The Norwegian government`s contribution to the Global Environment Facility for the period 2004-2008 was approximately NOK 57 million per year. Norway reported 77 per cent of the contributions to the GEF Trust Fund as ODA. Total commitment to GEF IV is approximately NOK 57 million per year. Approximately one third of total GEF Trust Fund funding is for the climate change focal area.

Funds under the UNFCCC

From the start in 2005 and as per November 2009, total Norwegian contributions to the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF) under the UNFCCC were NOK 53 million and NOK 121 million, respectively.

Adaptation Fund

Norway contributed NOK 1 million to the costs associated with starting up this fund.

UNFCCC Secretariat

Norway has contributed substantial voluntary funds to the Secretariat for activities not covered by the core budget and for developing country participation in the process. Over the last few years, Norway has been the biggest contributor in absolute figures. Actual contributions were as follows:

2005:	NOK	7.1	million
2006:	NOK	17.35	million
2007:	NOK	17.0	million
2008:	NOK	52.0	million
2009:	NOK	20.0	million

Prototype Carbon Fund (PCF, World Bank)

Norway was among the early movers in carbon finance and joined the PCF in 2000, with a commitment to pay in USD 10 million over the life-time of the fund (non ODA). As per November 2009, approximately one half of the capital has been called up. The PCF finances projects that reduce greenhouse gas emissions in developing countries for the purposes of the Kyoto Protocol.

Carbon Partnership Facility (CPF, World Bank)

As a contribution to incentivise both private and public sector engagement in clean energy and clean technology investment in developing countries, Norway supported the establishment of the World Bank`s new carbon fund for the post-2012 period, Carbon Partnership Facility. The partnership consists of future private and public buyers and sellers of carbon credits in developing countries. Norway supported the capacity building part of the CPF to the tune of EUR 18 million in 2008 (ODA), and is considering entering the buying part with EUR 35 million (non-ODA).

Climate Investment Funds (CIF, World Bank)

Norway was active in the design and consultation process leading up to the establishment in 2008 of the umbrella framework for climate funds, the Climate Investment Funds (CIF) in the World Bank. The CIF is governed through a new and innovative structure, by which the Board consists of equal representation from recipients and contributors, and observers from, amongst others the UN, NGOs and the private sector. Norway has so far joined the Pilot Program for Climate Resilience (PPCR) (NOK 45 million in 2009), the Forest Investment Program (Norway has pledged USD 150 million for 2010 - 2012) and the SREP (Scaling up Renewable Energy in Low Income Countries (NOK 150 million over 3 years, including NOK 50 million to Energy for the Poor).

Forest Carbon Partnership Facility (World Bank)

The Forest Carbon Partnership Facility (FCPF) is designed to assist developing countries to develop and carry out REDD programs. It consists of two funds: Readiness Fund and Carbon Fund. In 2009, Norway contributed NOK 169 million to the FCPF. For 2010, USD 10 million for the Readiness Fund and USD 10 million for the Carbon Fund are expected to be contributed.

Multi donor fund for sustainable development and environment (World Bank)
Theme 2009: Adaptation to climate change. Contribution NOK 80 million.
Theme 2010: Climate change impacts and responses and food insecurity, financial chocks and vulnerability. Contribution NOK 30 million.

Clean Energy Financing Partnership Facility (Asian Development Bank)
Clean energy and energy efficiency investment in projects in poor member countries. Norwegian contribution 2007 – 2009: NOK 30 million.

Renewable Energy and Energy Efficiency Partnership (REEEP)
Norway has supported the Renewable Energy and Energy Efficiency Partnership (REEEP) from 2006 to 2009 with NOK 30 million. This contribution made Norway the second biggest donor for this three year period. Norway intends to support REEEP for a new three year period – from 2010 to 2012. The support is planned to remain at the same level, NOK 30 million. Norway also intends to earmark extra support to strengthen REEEP`s regional secretariat in Johannesburg with one person, which would imply an additional EUR 175 000 of our support to REEEP. Norway's support will be subject to political approval.

REEEP's objectives largely coincide with the aims of the Norwegian Action Plan for Environment in Development Cooperation. The plan, which is operational until 2015, sets out ambitious goals for reducing poverty and promoting sustainable ecological, economic and social development.

The Global Energy Efficiency and Renewable Energy Fund (GEEREF)
Norway has contributed to the establishment of GEEREF together with the European Commission and Germany. Norway will support GEEREF with NOK 80 million during a four year period (2008-2011).

GEEREF represents a promising innovative mechanism for raising risk capital in developing countries and economies in transition. GEEREF will accelerate the transfer, development and deployment of environmentally sound technologies and thereby help to bring secure energy supplies to people in poorer regions in the world. The private sector has a vital role to play in efforts to address climate change and ensure access to clean energy. The transition to a low-emission world will not be possible without the involvement of the private sector. Norway sees the GEEREF as a promising model for this.

Carbon Capture and Storage Capacity Building Trust Fund (World Bank)
Norway will support carbon capture and storage capacity building activities through a CCS Capacity building Trust Fund in the World Bank with about NOK 35 million (approx. USD 6 million). The Kyoto Protocol encourages carbon capture and storage (CCS) projects. CCS is one of many mitigation technologies needed to cut global emissions of greenhouse gases. Both developed and developing countries must take part in the development and deployment of CCS. Developing countries cannot bear the costs of importing CCS technology. The World Bank has an important role to play in carbon capture and storage capacity building.
The Trust fund will run to 2013 and support strengthening of capacity and knowledge sharing, create opportunities for Member Countries to explore CCS potential, access carbon markets and realize benefits of domestic CCS technology development. Furthermore, it will facilitate inclusion of CCS options into low-carbon growth strategies and policies developed by national institutions and supported by WBG interventions.

NEFCO
In the period 2004 – 2008, Norway contributed NOK 3.2 million per annum to the Nordic Environment Finance Corporation, which is a risk capital institution financing environmentally beneficial projects in Central and Eastern Europe. Its purpose is to facilitate the implementation of such projects, including climate change related projects.

Global Gas Flaring Reduction Partnership
Global Gas Flaring Reduction Partnership is a partnership between oil companies, producing countries` authorities and donors, who cooperate in order to reduce gas flaring in connection with oil drilling. Norwegian contribution was USD 400,000 for 2004 – 2006, and for 2007 – 2009. A binding pledge of USD 390,000 has been given for 2010 – 2012.

Activities Implemented Jointly (AIJ)
All projects financed by Norway under this heading have been successfully completed.

OECD
Support has been provided to the OECD Annex I Expert group, including for seminars with non-Annex I countries.

IPCC
Norway has consistently supported the work of the IPCC and developing country participation therein. For 2009, NOK 3 million were transferred for this purpose.

Table 7.1 Norwegian Support to Multilateral Climate Fund/Programmes/Mechanisms

Name of Fund/ Programme/ Mechanism	Acronym	Purpose of Fund/Program/Mechanism	Norwegian Support
Global Crop Diversity Trust	GCDT	Development of food grains strong enough to handle climate change and extreme weather.	2008: NOK 100 mill.
Carbon Partnership Facility	CPF	Gives incentives for large, cleaner investments in energy and infrastructure that have long-term emission reduction potential by supporting their purchase over long periods after 2012.	2008: EUR 18 mill.
Adaptation Fund	AF	Established to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change	2008: NOK 1 mill for start up phase
The Special Climate Change Fund	SCCF	Adaptation and technology transfer	2005-2008: NOK 91 mill. 2009: NOK 30 mill.
The Least Developed Country Fund	LDCF	Adaptation	2005-2008: Ca. NOK 43 mill. 2009: NOK 10 mill.
Amazon Fund		Reduced deforestation in the Amazon	Pledged NOK 1 billion to 2015. Transfered NOK 123 mill in 2009. NOK 750 mill planned for 2010.
The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries	UNREDD	Reduced deforestation in pilot countries.	Agreed amount 2008/2009 ca USD 52 mill. Around NOK 285 mill transfered in 2009. NOK 175 mill planned for 2010.
Congo Basin Forest Fund	CBFF	Reduceas deforestation and forest degredation	Pledged NOK 500 mill over 3 years. 2008: NOK 80 mill. 2009: NOK 105 mill.
Scaling up renewable energy for low-income countries (Strategic Climate Funds)	SREP	Investment fund for increased access to clean energy in poor countries.	Pledged NOK150 mill over 3 years (incl. NOK 50 mill for Energy for the Poor)
Pilot Program for Climate Resilience (Strategic Climate Funds)	PPCR	Development and implementation of national adaptation plans in the most voulnerable countries.	2009: NOK 45 mill.
The Renewable Energy & Energy Efficiency Partnership	REEEP	Reduce climate emissions and promote development through renewable energy and energy efficiency in developing countries	Last 3 years: NOK 30 mill 10 per year), Next 3 yerars: NOK 32 mill.
The Global Energy Efficiency & Renewable Energy Fund	GEEEREF	Private and governmental investments in clean energy in developing countries	NOK 80 mill over 4 years. First transfer of NOK 20 mill in 2008.
World bank Trust Fund for CCS	WB CCS TF	CCS-capacity building in developing countries	2009: NOK 35 mill.

Forest Carbon Partnership Facility	FCPF	For future buying and selling of carbon quotas from reduced emmissions from deforestation and forest degredation (REDD). First phase is development of REDD-plans for the countries involved, to make them capable of implementing REDD programs. Consists of two funds: Readiness Fund and Carbon Fund.	Agreed USD 25,2 mill to Readiness Fund for 2009 and 2010. NOK 167,59 mill transfered in 2009. NOK 72 mill (USD 10 mill) transfered to Carbon Fund in 2008.
Prototype Carbon Fund	PCF	Development of and international carbon market and capasity development for developing countries for the samme.	USD 10 mill. for 2000-ca 2015. About half of this transfered so far.
United Nations Framework Convention on Climate Change - secretariat	UNFCCC	Activities, meetings etc under the UNFCCC.	2008: ca. USD 9,5 mill. 2009: NOK 20 mill.
Clean Energy Financing Partnership Facility - Asian Development Bank	CEFPF	Through financial and technical support for investments in clean energy- and energy efficiency-projects in poor member countries contribute to reduces climate emissions and increased access to modern sources of energy.	Agreement 2007-2009: NOK 30 mill.
The Trust Fund for Environmentally & Socially Sustainable Development	TFESSD	Promote sustainable development and environment in the WB's strategies operations. Annual themes. 2009: Adaptation to climate change, 2010: Climate change impacts and responses and food insecurity, financial shocks and vulnerability.	FY 2009 (2008-2009): NOK 80 mill. FY 2010: NOK 30 mill.
Consultative Group on International Agricultural Research	CGIAR	Development of food grains strong enough to resist climate change and extreme weather.	2009: NOK 88 mill.
TerrAfrica - Regional Sustainable Land Management		Fund for sustainable land management contributing to adaptation	2009: NOK 7,5 mill
Global Fund for Disaster Risk Reduction	GFDRR	Disaster reduction and recovery	2009: NOK 12,5 mill.
Global Gas Flaring Reduction Partnership	GGFR	GGFR supports the efforts of oil producing countries and companies to increase the use of associated natural gas and thus reduce flaring and venting, which wastes valuable resources and damages the environment.	USD 400 000 for 2004-2006. Same amount for 2007–2009. Agreement 2010-2012 stipulates USD 390 000.
Forest Investment Program (Strategic Climate Funds)	FIP	Reduce deforestation and forest degradation and to promote sustainable forest management, leading to emission reductions and the protection of carbon reservoirs.	Pledged USD 150 mill for 2010-2012.
Climate for Development in Africa	ClimDev Africa	Newly established fund in AfDB for climate change adapted development in Africa	2010: Planned NOK 30 mill.

Other

Norway has also supported international initiatives seeking to present models for the post-2012 climate change regime. This includes contributions to WWF International, Centre for Clean Air Policy (CCAP), International Institute for Sustainable Development (IIED), World Resources Institute (WRI) and support for the CRI Common Fund.

7.2 Assistance to developing country Parties that are particularly vulnerable to climate change

There is no internationally agreed definition of which developing country parties are "particularly vulnerable", nor is there any likelihood that such a definition will be agreed in the foreseeable future. In Article 4.8 of the Convention, few if any developing countries will fall outside the groups listed. Hence, the definition of which countries are most vulnerable is up to each country. In practice, this is not a major problem.

Adaptation

Development aid and climate change adaptation are interlinked in complicated manners. We have no clear criteria for when a specific development aid project should be accounted also as an adaptation project, although much effort is being put into work on this. Hence, it is difficult to provide a comprehensive overview on assistance for climate change adaptation. Statistically, there are still some gaps that make it difficult to provide correct data for support to adaptation.

Sustainable development that takes the environment, poverty reduction and economic development into account is also the best way to adapt to a changing climate. Hence, adaptation efforts should to the greatest extent possible be integrated into the development process.

As previously reported, Norway`s support for adaptation activities of developing countries is mainly channelled through the general contributions to multilateral development institutions, including through the UNDP and international financing institutions. Contributions to the two Convention adaptation funds have been among the highest on a per capita basis, cf. above.

A few examples of measures and programs that Norway supports and which are relevant to adaptation:

World Bank:
- Pilot Program for Climate Resilience: NOK 45 million/2009.
- Global Fund for Disaster Risk Reduction: NOK 12,5 million/2009.
- Trust Fund for Economic and Social Sustainable Development: NOK 45 million/2009. Increasing emphasis on adaptation.

Africa:
- African Development Bank: New fund for climate adjusted development in Africa (Clim-Dev-Africa): NOK 30 million/planned for 2010.
- African Climate Policy Centre: NOK 8 million/ planned for 2010.
- Increased support for conservation agriculture in Eastern Africa (COMESA): Up to NOK 165 million/ planned for 2010.

Consultative Group on International Agricultural Research (CGIAR):
- NOK 88 million/2009.

Global Crop Diversity Trust:
- NOK 100 million/2009.

Natural disasters: Total support 2009: NOK 335 million. Disaster risk reduction: NOK 100 million/planned 2010.

The Norwegian proposal in the climate negotiations for international auctioning of AAUs is mainly intended for creating revenue for adaptation purposes in developing countries. Depending on the percentage of AAUs auctioned, and other assumptions, we have estimated this could bring in USD 20-30 billion/year (corresponding to auctioning 2 per cent of the total AAUs).

Norway plans to use NOK 7 billion for purchasing UN certified emission quotas from CDM for the Kyoto period 2008-2012. With 2 per cent of the value of the CERs going to the KP Adaptation Fund, this would mean that a total of NOK 140 million could end up in this fund.

Norway has introduced a program for "climate proofing" of all bilateral development assistance. Through examination of development activities by Norwegian embassies, the aim is to make sure that all assistance takes account of climate change. These examinations are carried out on the basis of OECD`s recent guidelines for integration of climate change adaptation into development assistance.

Table 7.2 Support for selected environmentally related initiatives sorted by contracting party and title 2005-2008 (NOK 1000) 1

Initiativ	Agreement partner	Agreement title	2005	2006	2007	2008
CGIAR	CGIAR - Consultative Group on International Agricultural Research	Norwegian support 2008 Addition				314
		Norwegian support to CGIAR 2007			80 500	
		Norwegian support to CGIAR 2008				88 000
GEEREF	GEEREF – The Global Energy Efficiency and Renewable Energy Fund	Global Energy Efficiency and Renewable Energy Fund - GEEREF				20 000
NEFCO	NEFCO - Nordic Environment Finance Corporation	Capacity building program on energy auditing and final			1 600	
REEP	REEP - The Renewable Energy and Energy Efficiency Partnership	REEEP. Renewable energy & energy efficiency		5 000	10 000	15 000
UNFCCC	UNFCCC - United Nations Framework Convention on Climate Change	Christian Himmelhuber FN - UNFCCC				816
		UNFCCC & Kyoto Protocol. Contr various activities		7 000		
		UNFCCC voluntary contribution 2005	2 000			
		UNFCCC work CDM, dev.countries delegates, workshop	5 000			
		UNFCCC. Additional voluntary contribution		7 350		
		UNFCCC. Developing country part. Accra				13 000
		UNFCCC. Voluntary contrib. to activities in 2008				15 000
		UNFCCC. Voluntary contribution.			10 000	
SCCF and LDCF	GEF - Global Environment Facility	GEF. Climate Change. Least Devel. Countr. Fund			24 000	
		GEF. Spescial Climate Change Fund. Norw. contrib.				40 000
	IBRD - International Bank for Reconstruction and Development	GEF - Special Climate Change Fund (SCCF)		14 000		
		LDCF (Climate Change). Norwegian contribution 2006		20 162		

Initiativ	Agreement partner	Agreement title	2005	2006	2007	2008
GCDT	Biodiversity International (IPGRI)	GCDT 2006. (Global Crop Diversity Fund)		12 000		
		GCDT matching Gates Foundation			24 500	
		Global Crop Diversity Trust	19 000			
	WHO - World Health Organization	Global Crop Diversity Trust	8 000			
FCPF	World Bank	Forest Carbon Partnership Facility (FCPF)				32 260
UNREDD	UNDP - UN Development Programme	Support to UN´s Donor Fund for REDD				64 956
CBFF	AFDB - African Development Bank	Congo Basin Forest Fund				80 000
CEFPF	ASDB - Asian Development Bank	Asian Development Bank. Clean Energy co-financing. Chapter 171.72.			10 000	10 000
TFESSD	IBRD - International Bank for Reconstruction and Development	Trust Fund for Environment and Social Sustainable Development			68 284	66 566
TerrAfrica	World Bank	TerrAfrica Leveraging Fund		6 000		6 000
Totalt			**34 000**	**71 512**	**228 884**	**451 911**

[1] *The numbers in the table shows actual contributions. Contributions to the relevant funds/initiatives may also be categorized under other contracting parties and thus not be included in this overview. The genuine expenditures may therefore be larger than shown in the table. The table is based on filtering of "Agreement partner" in addition to text searches.*

Source: Norad.

7.3 Provision of financial resources, including financial resources under Article 11 of the Kyoto Protocol

On the bilateral side, environment and climate change have high priority in our cooperation with large developing countries like China and India.

China: A Memorandum of Understanding (MOU) on environment cooperation has been signed, and in 2008 a framework agreement on climate change was signed with the National Development and Reform Commission (NDRC). Under these two agreements, a number of projects have been launched in China that are relevant for climate change, including cooperation on development of climate change plans for the provinces. Annual expenditure has in the last few years been in the region of USD 5 – 6 million. In addition, Norway has for more than ten years supported Sino-Norwegian research into different climate change aspects, with annual allocations of approximately USD 0.5 million.

India: The focus in cooperation with India has since 2003 slowly shifted to institutional and technical co-operation.

In 2007, technical co-operation had a budget of NOK 24.5 million. India and Norway have a mutual interest in a number of areas related to sustainable development and climate change. India did also during the course of 2007-2008 start identifying areas where co-operation with Norway is desirable. In June 2008, India launched its National Action Plan for Climate Change (NAPCC). Although the NAPCC was a domestic initiative, the initiatives taken from the Indian side clearly also fall within the priorities of Norway and qualify for collaboration.

One of the lessons learned (ref. below) is that there is great potential for cooperation between government, research community and private sector. Research collaboration has therefore recently taken a prominent place in the cooperation between India and Norway. In 2008 and 2009 more than 80 per cent of the total budget of NOK 35 and 43 million, respectively, were for climate and environment.

In 2009, an MOU was signed on Co-operation in the field of Environment and Clean Development Mechanism (CDM).

Norway has also supported a number of research institutions in Norway, including CICERO, ECON, Fridtjof Nansen`s Institute, and international institutions like Chatham House and Wilton Park (UK) and Teri (India) on various issues relating to climate change. Likewise, considerable research and other climate change activities are being supported in the Arctic region.

Capacity building (bilateral)

Examples:
- Studies to improve CDM capacity in Africa (Angola, Mozambique, Uganda and Tanzania) and Bangladesh, Bhutan, Nepal and Sri Lanka.
- Supporting individual CDM projects. For example, in South Africa assistance has been given to a state owned company for investments in various carbon projects whose objective are to provide advisory, financial and operational services within CDM project management, in order to promote CDM in South Africa and Africa generally.

The European Economic Space Agreement:
The aim of the EEA and Norway Grants is to contribute to economic and social development in 15 beneficiary states in Central and Southern Europe. In the period 2004-2009, the contribution amounts to EUR 1.23 billion. Around one fourth of the funds contribute to environmental protection. More than EUR 86 million is allocated to 129 projects in the areas of renewable energy, energy efficiency, and greenhouse gas emission reduction.

An independent assessment report prepared in 2008 concluded that as a result of the energy efficiency projects in Poland, the average saving in 300 schools and health institutions was more than 50 per cent. In addition, the projects contribute to reduced air pollution, better indoor climate, and new jobs.

7.3.1 The Government of Norway´s International Climate and Forest Initiative

Emissions from deforestation and forest degradation in developing countries amount to about 17 per cent of the global greenhouse gas emissions and must be addressed in order to reach the 2 degree Celsius stabilization goal.

Reducing emissions from deforestation and forest degradation in developing countries (REDD) is currently being negotiated as a part of a post-2012 climate regime.

In addition to reduced emissions and enhanced removals, a global REDD mechanism should promote sustainable forest management, contribute to the protection of biodiversity, promote sustainable development and poverty reduction, and secure the rights, involvement and livelihood of local communities and indigenous peoples.

In order to promote early action on REDD, the Government of Norway has launched a comprehensive Climate and Forest Initiative. The initiative was launched by Prime Minister Stoltenberg at the Bali summit in 2007, and will have an annual budget of up to about 3 billion NOK (USD 500 million). In 2008, the initiative was allocated NOK 280 million to REDD activities, increasing to NOK 1.5 billion in 2009. For 2010, the Government of Norway has allocated NOK 2.1 billion to the initiative.

The allocations are mainly channelled through multilateral initiatives but also supporting bilateral cooperation with Brazil and Tanzania, as well as substantial support to analysis and policy development and civil society. With time, as allocations to partner countries become increasingly based on results in reduced emissions from deforestation and forest degradation, funding to some partner countries will be scaled up. In this way, annual allocations will eventually reach up to NOK 3 billion.

The initiative is financed by official development cooperation funds. Promoting sustainable development and poverty reduction is an overriding objective of Norwegian foreign development policy, and thus an inherent but also overriding goal for this effort. The overall responsibility for the initiative lies with the Ministry of Environment, where a project secretariat has been established. The Ministry of Foreign Affairs, supported by Norwegian missions abroad and the Norwegian Agency for Development Cooperation (Norad), is responsible for foreign and development policy related to the initiative, as well as management and disbursement of funds. An interministerial body is established for coordination and, when necessary, preparation of government discussions on issues of relevance to the initiative.

It is an implicit aim of the initiative to encourage rapid learning on approaches for achieving REDD. The objectives of the initiative are stated in the Proposition No. 1 to the Storting 2008-2009:

1. The inclusion of emissions from deforestation and forest degradation in a new international climate convention (post-Kyoto).
2. Early action to achieve cost-effective and verifiable reductions in green house gas emissions.
3. The conservation of natural forests to maintain their carbon storage capacity.

The challenges related to reducing emissions from deforestation and forest degradation in tropical forest countries are reasonably well known. Carbon leakage – which refers to a situation where emission reductions in one part of the world are counteracted by rising emissions elsewhere – is a concern at both national and global level. So is the need to ensure that emission reductions in one year are not counteracted by a rise in emissions the year after. There are major scientific and political challenges involved in measuring carbon emissions from deforestation and degradation, and in setting reference emission levels. Changing the patterns of deforestation and forest degradation in a country is an extremely challenging task for the national authorities in the countries.

In order to address these challenges, Norway´s Climate and Forest Initiative supports countries who engage in national, government-led strategies for REDD. Over time, the support would be based on results in form of measurable, reported and verifiable emissions reductions from the forest sector.

The principle of national ownership and preparation of strategies at national level will be of crucial importance for the success of REDD initiatives. A national level approach would be well positioned to safeguards against opportunities to exploit the system, and to hold governments accountable for both emission reductions and negative side-effects. It would also avoid national leakage. To avoid leakage internationally, the mechanism must provide sufficient incentives to motivate most tropical forest countries to join.

The support for reducing deforestation and forest degradation must be truly results based. Credible reference emission levels must be established as soon as possible, and payments must be calculated on the basis of the reductions achieved relative to the reference levels. In an interim period, countries may be rewarded for results based on proxies for emissions reductions. Proxies are simplified and conservative which may be used to measure country´s emissions reductions in a period before a solid system for measuring the carbon emissions is established in a country.

The development of national REDD strategies and implementation mechanisms will, in most countries, require substantial time and capacity. An important objective of NCFI is to support capacity development and necessary political reforms that can facilitate future cost effective REDD actions.

Support channelled through multilateral initiatives

UN organisations and the World Bank are major multilateral recipients of NCFI funds.

The initiative has supported the establishment of the UN REDD Programme, aimed at an enhanced and coordinated UN support to developing countries' REDD efforts. The programme comprises FAO, UNDP and UNEP, as its core constituent parts, but will involve other relevant parts of the UN as well. In addition to the support to developing countries strategies for reducing deforestation and forest degradation, the work to engage and raise awareness of REDD amongst national stakeholders, and the improvement of technical and analytical tools for maximizing the contribution of REDD to sustainable development, one main contribution of the UN-REDD Programme is the development of improved guidance on Measurement, Reporting and Verification (MRV) approaches, including consensus on principles and guidelines for MRV and training programmes.

Hosted by the World Bank, the Forest Carbon Partnership Facility (FCPF) has been established with funds from several donor countries to support developing countries' planning of reforms and actions to implement REDD. The Norwegian Government is one of the main donors to this facility.

Contributions have been pledged from the Norwegian Government to the Forest Investment Programme (FIP), a program within the World Bank's Strategic Climate Fund. The FIP's overall objective is to mobilize significantly increased funds to reduce deforestation and forest degradation and to promote sustainable forest management, leading to emission reductions and the protection of carbon reservoirs

Contributions have also been made to the Congo Basin Forest Fund (CBFF), managed by the African Development Bank. The CBFF will support activities to avoid deforestation and contribute to poverty alleviation in the Congo basin forests.

Support through country partnerships

The countries prioritised through direct partnerships in the early phase of the initiative are Brazil, Tanzania and recently Guyana. In Brazil, support to the Brazilian Amazon Fund has been established under an agreement with the Brazilian Development Bank (BNDES).

In Tanzania, a bilateral partnership agreement covers research, capacity building, and the development of a national REDD strategy. Substantial support is allocated to demonstrational projects and civil society organizations. Tanzania is also a participating country in the UN-REDD Programme and the FCPF and has officially launched the Tanzanian national REDD policy process.

In November 2009, Norway and Guyana engaged in a partnership where Norway will compensate Guyana for keeping their deforestation and forest degradation rate low, while strengthening institutions and practices to avoid increased deforestation in the future. Financial support from Norway will be channelled through a new fund, the Guyana REDD+ Investment Fund (GRIF). Guyana's Ministry of Finance will be responsible for the GRIF's operations, and a reputable international financial institution to be selected by Norway and Guyana will act as manager of the fund. This agreement is an important contribution to the REDD agenda, being an agreement to support a developing country for succeeding to maintain its good history of low deforestation rates. Supporting Guyana may prevent regional deforestation leakage. Finally, the efforts of Guyana provides an example of how a national strategy to reduce emissions from the forest sector can be an integral part of country´s overall low-carbon developing plan.

Norway´s Climate and Forest Initiative also supports non-governmental and research institutions under an application-based mechanism managed by Norad.

Through the Government of Norway´s International Climate and Forest Initiative, Norway is providing support to a number of developing countries and thus encouraging them to take early action to achieve cost-effective and verifiable reductions in green house gas emissions. Through its financial and intellectual contributions, the Government of Norway also contributes to the development of standards and guidelines on how REDD can be achieved in a manner that ensures the full and effective participation of all stakeholders in the REDD-processes and the establishment of social and environmental safeguards before large scale payments can be transferred to developing countries as results based compensation for reducing emissions from deforestation and forest degradation. Based on the insights gained from these early efforts of the Government of Norway´s International Climate and Forest Initiative, Norway has submitted, to the UNFCCC secretariat, views on the architecture of a future mechanism for reducing emissions from deforestation and forest degradation in developing countries.

8. RESEARCH AND SYSTEMATIC OBSERVATION

8.1 General policy on research and systematic observation

The most recent white paper on research in Norway, Climate for Research (Report No. 30 (2008 - 2009) to the Storting) puts global challenges high on the agenda. The white paper lists five thematic priority areas; climate, energy, the environment, aquaculture and food security in which Norwegian research must contribute to solve social challenges, not limited to Norway, but globally.

Norwegian public funding of research is mainly channelled through the Research Council of Norway, with a budget of approximately NOK 6.2 billion in 2009. The Research Council supports, basic research, strategic basic and applied research in addition to research for innovation and technology, and covers all disciplines. Unlike most other countries, Norway has only a single research council.

The Research Council's main strategy for the period 2009-2012 is entitled "In the Vanguard of Research". The strategy identifies four topical areas of priority among the challenges facing society and two of these are Processes of globalization and climate change. Within these topics the Council fund research programs, as well as Centres of excellence and Centres for Environment-friendly Energy Research. The objective of the latter is to establish time-limited research centres which conduct concentrated, focused and long-term research of high international calibre in order to solve specific challenges in the field.

Together these activities cover climate science, i.e. research on the climate system and how it changes as well as the effects of the changes on society and nature. Furthermore, research on the development of technology to reduce emissions of CO_2 and other greenhouse gases, and the development of new renewable or alternative energy sources, and more environmentally friendly and efficient use of energy, is also included with high priority. A new area which receives increased attention is research related to emergency preparedness and adaptation to climate change, and which involves information work and the development of expertise as well as research.

Carbon capture and storage (CCS) is broadly considered as one of the most important technologies for combating climate change. The technology is so far only used full scale in industrial processes such as gas processing (Snøhvit and Sleipner) and prototyped on small scale, but no commercial scale CCS from power plants has been built. The main challenges are to reduce the cost of capturing CO_2 and to prove that CO2 can be safely stored for thousands of years in geological formations. To meet these challenges it is necessary to demonstrate existing technology, as well as to support medium to long term R&D to develop safer and more cost effective solutions. Norway is playing a pioneering role in CCS, and as stated several years ago, all new gas fired power plants must be equipped with CCS. This will, of course, also include coal power plants. Thus, based on political decisions, R&D and demonstration of improved CCS technology have been prioritised, bringing Norway to a leading position in developing CCS worldwide.

Norwegian climate researchers are active in international research cooperation, e.g. under the EU Framework program and the Global Change programs (IGBP, WCRP, and others). Norwegian scientists take part in the EU 7th Framework Program projects and participate in one third of all EU projects under “Environment (including Climate Change)”. International collaboration outside these established frameworks is also important. For instance, a new program on the cooperation with China was launched in 2009 and climate change research is one of the key areas.

Norway does not have a national Global Climate Observing System (GCOS) program. Long time series of climate data are being collected by different Norwegian institutions. Continuation of these series requires sustained efforts. In order to prevent termination of important time series, an overview of time series of climate data that are important for climate research was made a few years ago. This overview, together with other background material, made the basis for the new national strategy for research infrastructure (2008-2017) entitled “Tools for research”. The goal for this strategy is to provide the scientists with the equipment they need to meet the research challenges. Also the needs of trade and industry for efficiency and high quality research and to make Norwegian research

groups attractive to the international community by offering outstanding infrastructure facilities is important.

The "Tools for Research" strategy issued the first call in 2009 with about NOK 180 million assigned to new projects on, or in need of, infrastructure. Hereby including several projects connected to time series relevant to climate change research, polar buoys and infrastructure for High-Precision Palaeoecological Analyses etc. Norway also takes an active part in the ESFRI-work (European Strategy Forum on Research Infrastructures), and is involved in 16 of the 44 projects on the ESFRI roadmap. Of particular importance to Norwegian climate research, is the Svalbard Integrated Arctic Earth Observing System (SIOS) and European Polar Research Icebreaker Consortium "Aurora Borealis".

As a follow-up of the Agreement on Norway's climate policy the Norwegian Government appointed a strategic committee for Climate Change Research (KLIMA21), in addition to the existing committee on energy (ENERGI21). The Agreement emphasizes the need for research and development in three areas; Renewable energy, CCS and Climate change. The two areas renewable energy and CCS have received budget increases as indicated in the Agreement. It is expected that the third area (Climate Change) also will receive increased funding in the future. The total funding through the Research Council related to Climate Change, including CCS (but excluding renewable energy technology), was NOK 330 million in 2008, compared to NOK 270 million in 2005. Also, there are considerable research efforts funded by the private sector, particularly related to carbon capture and storage, e.g. several petroleum companies fund this kind of research. The total amount, on the national level, was approx. 1070 million NOK in 2007.

8.2 Research

A major part of the national funding for research on climate change is channelled through the Research Council of Norway, with about NOK 268 million, more than 50 per cent of the total funding. These programs define the priority areas of research in Norway. Projects will often be co-funded from other sources, both public and private. In the following, the research priorities currently in progress under the Research Council of Norway are briefly outlined.

NORKLIMA, Climate change and its impacts in Norway, was launched in 2004 and the program will run until 2013. The main goals of NORKLIMA is to provide new knowledge related to, the climate system, the change in climate in the past, present, and future and direct and indirect effects of climate change on nature and society, as a basis for adaptation policies and measures.

An overall objective is to ensure that Norwegian climate research maintains the highest international standards and to enable Norwegian researchers to conduct research in prioritized areas. The total annual budget available to NORKLIMA is about NOK 90 millions, and in 2009 the program was funding around 90 projects.

NORKLIMA encourages international collaboration and coordination with international research programs. About 70 per cent of the NORKLIMA projects include international collaboration. Recently, collaboration with China has been given high priority, and in 2008 a special call dedicated to such collaboration was launched resulting in six new projects which started in 2009.

The International Polar Year (IPY 2007 – 2008) has now come to an end, and the activities are about to conclude. More than 90 per cent of the IPY projects where Norway is/was involved have climate relevant activities. The end-conference of the IPY in June 2010 will be arranged in Oslo, and more than 3000 scientists are expected to attend. The Norwegian contribution to IPY amounted to about NOK 300 million. Whether a corresponding amount will be upheld to similar issues in the future remains to be decided.

The large research programme RENERGI (Clean Energy) is one of a limited number of major research programmes in which the Research Council deploys a wide range of instruments and resources. The main focus of the programme is on renewable energy production, energy efficiency and end-use, energy systems, hydrogen, and social science related to energy and climate change. The programme period is 2004-2013, and the yearly budget is about NOK 280 million.

Eight Centres for Environment-friendly Energy Research were established in 2009:
- BIGCCS Centre – International CCS Research Centre
- Centre for Environmental Design of Renewable Energy (CEDREN)
- Bioenergy Innovation Centre (CenBio)
- Norwegian Centre for Offshore Wind Energy (NORCOWE)
- Norwegian Research Centre for Offshore Wind Technology (NOWITECH)
- The Norwegian Research Centre for Solar Cell Technology
- Subsurface CO2 storage – Critical Elements and Superior Strategy (SUCCESS)
- The Research Centre on Zero Emission Buildings – ZEB

The Research Council of Norway is also funding a national Centre of excellence for climate research, the Bjerknes Center for Climate Research (BCCR) in Ber-

gen. BCCR is a joint research venture between the University of Bergen, the Institute of Marine Research and the Nansen Environmental and Remote Sensing Centre. The scientific focus 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. More than a hundred scientists are now connected to the centre. The funding of the 10-year period as a Centre of Excellence was supposed to conclude in 2012, but in 2009, the Minister of Research and Higher Education announced that an annual basic funding of NOK 20 million will be provided from 2010 and onwards.

Another research centre conducting research on climate change is CICERO (Center for International Climate and Environmental Research - Oslo) which was founded by the Norwegian government in 1990. It is an independent research centre associated with the University of Oslo with a mandate to both conduct research and provide information about climate change related themes. With expertise in both the natural and the social sciences, CICERO conducts interdisciplinary research on four main areas: 1) The scientific basis of climate change, 2) Mitigation and costs, 3) Impacts, vulnerability and adaptation and 4) International agreements and policy instruments.

In 2009 the Norwegian Ministry of the Environment funded the establishment of the new Centre for Ice, Climate and Ecosystems (ICE) within the Norwegian Polar Institute. ICE shall be developed into a national competence centre with aspirations of becoming a world leading centre in close collaboration with other national and international research groups. The research focus of the centre is on understanding of polar climate processes to better parameterizations in climate models and hence improve the precision of climate projections. The main research topics are: (i) sea ice and snow, especially how these affect and are affected by climate; (ii) the effect of climate change on ice-associated species and high-latitude ecosystems; and (iii) high-latitude and high-altitude glaciers.

8.2.1 Climate processes and climate system studies, including paleoclimate studies

The largest coordinated project in the research program NORKLIMA is NorClim. NorClim have several objectives:

- Provide future climate scenarios with focus on 2030 – 2100 with uncertainties elucidated.
- Identify climate variability ranging from years up to a century.
- Establish a national Earth System Model (ESM).
- Better understanding of current climate models weaknesses, and try to amend these.
- Convey new knowledge about the climate system and climate change to the public, governmental bodies and NGOs.
- Be an arena for sustained build-up of climate research competence in Norway.

NorClim consists of researchers from the largest climate research natural science based communities in Norway, and coordinates the development of the Norwegian ESM. The scope of the NorClim project is very wide and also includes user's needs for sector specific information about future climate states.

8.2.2 Modelling and prediction, including general circulation models

Norway has strong research groups working on modelling, ocean and atmospheric both dynamical and physical processes. Of particular focus is the development of a Norwegian ESM, within the NorClim project, but also regional models (statistical and/or dynamical downscale models). ESM development is done to get a firmer understanding of the uncertainties in the compartments that comprise the earth system, both within each compartment but also in the flux between these. Particular emphasis is put on the carbon cycle.

Downscaling of climate models is necessary to be able to look at structures in climate variables in higher spatial and temporal resolution. In addition to study climate parameters these data are used by research groups in the study of societal and biological changes caused by changing climate. Of particular interest is extreme weather and on the co-variability of effect as e.g. sea level rise and heavy rain that tend to coincide.

8.2.3 Research on the impacts of climate change

Climate impact research constitutes a major component of NORKLIMA, and research is going on concerning: 1) Climate change and its impacts on abiotic systems and the built environment, 2) Climate change and its effects on ecosystems and 3) Impacts on society (see 8.2.4)

NORKLIMAs research on the impacts of climate change on the physical environment includes water resources, flooding, snow and ice conditions, landslides and avalanches, erosion, glaciers, fjords, water temperature and sea level. Such abiotic factors are a key part of the environment for ecological systems, agriculture, fisheries and society.

Research on impacts on the built environment has been a minor part in NORKLIMA, but a call dedicated to this was launched towards the end of 2009 and new projects will start in 2010.

Research on effects of climate change on ecosystems includes marine, limnic and terrestrial systems in terms of species distribution, interaction between species, relevant biogeochemical functions such as nutrient cycling, and productivity. With regard to terrestrial ecosystems, both natural and cultivated are included.

Included are also feedbacks to the climate system.

The Arctic is an area of particular concern, as climate changes are expected to be more pronounced and occur at a faster rate in this area compared to lower latitudes. This has also been a major part of the research within the International Polar Year (IPY). Research on impacts of climate change in the Arctic includes research on immigration of species, on population ecology at all trophic levels and particularly in marine ecosystems, and on population dynamics of interacting species. More general ecological research, e.g. on vertebrate population dynamics responses to climate change, is also done.

This research is closely linked to research described under Section 8.2.4, socio-economic analysis. Both NORKLIMA and the IPY have included quite a few interdisciplinary projects, often across the border between the natural and social sciences.

Following are examples of three NORKLIMA projects:

The *project Geohazards, Climatic Change, and Extreme Weather Events* has defined the relationships between meteorological conditions and geohazards based on historical records and numeric simulations. An assessment of the frequency and character of future geohazards events has been produced. The project also included an assessment of the socioeconomic consequences of geohazards in Norway.

Climate change will affect the distribution of warm Atlantic water and cold Arctic water masses of shelf and fjord regimes in West-Spitsbergen. The project *Marine ecosystem consequences of climate induced changes in water masses off West-Spitsbergen (MariClim)* has described how this alters the zooplankton composition and subsequently changes the energy transfer within the pelagic food web with consequences for upper trophic levels.

The project *Predicting consequences of climate change on population fluctuations of birds and mammals in time and space will:*
- Examine population consequences of expected changes in climate on the dynamics of bird and mammal populations using a set of stochastic population models.
- Develop general predictions whether effects of climate changes on bird and mammal populations can be predicted from life history characteristics or position along ecological gradients.
- Analyze how expected changes in climate are likely to affect the spatial-temporal variation in the yield from the harvest of commercially important game species such as grouse, moose and ducks.

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

Among other climate-related issues, NORKLIMA analyses the impacts of climate change and climate-driven change in ecosystems and the natural resource base on society. Moreover, NORKLIMA has given a higher priority to research on society's adaptation to climate change. One objective of the programme is to study the impacts of climate change on society and how adaptive capacity can be strengthened. NORKLIMA also analyses the links between emission trends and the development of society, and of international cooperation to mitigate climate change.

A main objective is to identify regions and sectors that may be particularly vulnerable to climate change in the next 30 to 50 years in order to strengthen adaptation strategies. An important concern for NORKLIMA is to gain a better understanding of what impacts climate change may have on Norwegian society and how we best can adapt to climate change. This includes building up the capacity needed to cope with necessary adaptations, and how governance systems and the institutional framework can be adapted to make society more robust to climate change.

Other relevant research questions are conflicts of interest which may arise, legal issues viewed in terms of the impacts of and adaptation to climate change, accountability and distributional effects, and how power relations may influence the other factors. The treatment of uncertainty and risk related to climate change in key areas of society are also of priority, including an understanding of uncertainty in climate scenarios and economic uncertainty. Moreover, NORKLIMA analyses the linkage between climate scenarios and socio-economic scenarios, with a view to obtaining better knowledge of future emission trends and their importance for the development of society and climate development.

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

The energy sector is a dominating economic sector in Norway. Oil and gas dominate exports, whereas domestic energy supply is dominated by renewable

energy (hydropower). Research and technology development are of priority in both these fields of energy production. There is also a considerable research effort into other technologies for renewable energy production.

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

Research on international climate agreements, the factors that affect the design of and support for different types of agreements, and the possible impacts on climate development, has been transferred from the RENERGI programme to the NORKLIMA programme. An important approach is to link research on international climate agreements to research on emission scenarios, the development of society, and compliance with climate agreements based on targets for the atmospheric concentration of CO_2.

Another thematic area that has been given priority is research on the carbon cycle and monitoring of the atmospheric concentration of CO_2 in compliance with international commitments relating to target concentrations. This includes research that can improve quality assurance of investments made by the Government to halt deforestation at the global level (through Norway's International Climate and Forest Initiative).

Following are some examples of NORKLIMA projects:

The aim of the project *Responding to Climate Change: the Potentials of and Limits to Adaptation in Norway (PLAN)* (University of Oslo) is to provide an empirical and theoretical understanding of adaptation as a social process, with an emphasis on its potential to reduce negative impacts and realize the potential benefits of climate change. It also contributes to a relatively new discourse on the societal limits to adaptation as an effective response to climate change. The PLAN project considers how Norway's potentially high capacity to adapt to climate change through infrastructural, technological, institutional and behavioural changes differs across communities that are embedded in different and dynamic biophysical and social contexts. It emphasizes the ways that competing interests, objectives and priorities, differing values, unequal power relations, and policy planning processes constrain or facilitate adaptation at national individual, and community levels.

The project *Managing risk in climate change – A dynamic perspective* (Frisch Centre) focuses on the deep uncertainty in climate policy pertaining to how greenhouse gases affect the global climate and how the global climate change will affect the human ecosystem. A main objective is to integrate scientific knowledge of climate change and economic understanding of policy and impacts on society. Further, the project aims to develop numerical models which should facilitate the analysis of the role of uncertainty in the formulation of climate policy.

The purpose of project *Insuring Future Climate Change (IFCC)* (Norwegian Computing Center) is to study the effects of climate changes on the insurance industry and adaptation to these changes. The project focuses on how projections of increased occurrence and intensity of extreme weather events caused by humanly induced climate change may amplify payouts and administrative costs for the insurance sector considerably. Not only the insurance companies themselves, but also their private and public clients, will be affected. Eventually, society as a whole must bear the costs of climate change, exemplified through higher insurance premiums or infrastructure repairs financed by taxes. A main goal for the project is to enhance knowledge of the effects of climate change on the insurance sector in order to enable adaptation and bring important economic opportunities.

One important aim for the RENERGI (Clean energy) programme is to improve the social science knowledge base of energy markets, energy policy and public instruments, and provide a framework for social scientific research on energy and the environment. The main focus of this post of the programme is on economics and political science, but the research also involves several other disciplines. The total budget for RENERGI is currently NOK 280 million/year, approximately 10 per cent of the budget is allocated to the social science part of the programme.

The social science part of RENERGI covers three main topics:
- Energy Markets.
- Energy Policy and instruments.
- Social and international analysis.

Energy markets:
- Market design, for example within environmental markets that secure a sustainable development, such as emission certificates, tradable quotas, etc.
- International harmonisation of rules and regulations in integrated energy markets to secure efficiency

and sustainability.
- Investment incentives, distributed generation and development of Norwegian energy.
- Public procurement and organisation of innovation processes such as Public Private Partnership models. Processes connected to efficient commercialisation of new energy technologies and industrial development.
- Economic cost analysis of new energy technologies.

Energy policy and instruments to reach energy policy goals:
- International energy policy.
- Frameworks and instruments for R&D and innovation.
- Development of models, instruments and tools that can help to realise energy policy goals.
- Governance of energy and environmental policy, including studies of interaction between different levels of governance and the relation to other areas of policy.

Social and international analysis:
- Consumer behaviour.
- Acceptance of policy instruments and acceptance related to the introduction of new technologies.
- Political and cultural comparative energy studies.
- Effects and influences on nature, the environment and local settlements as a result of new energy installations.

Following are three examples of RENERGI projects:

The aim of the project *Reforming The EU Emissions Trading System: Causes And Consequences* (Fridtjof Nansen Institute) is to analyse the reform of the EU Emissions Trading System and assess the revised system's prospects to deliver innovation and reductions in greenhouse gas emissions, combining insights in the policy process and implementation at the company level.

The aim of the project *Emission trading in Europe: The importance of allocation rules* (Statistics Norway) is to explore the implications of different allocation rules in emission trading schemes (ETS). Current allocation rules in the EU and Norwegian ETS are partly designed so that firms can influence on the number of allowances they get (especially for new entrants). The allocation rules will therefore affect firms' incentives, and the outcome of the emissions trading market. The project will examine how different allocation rules affect cost-efficiency of the ETS. Moreover, the project will analyse how permit prices are affected by different rules and the links between the emission trading market and the power market.

The project *Multiple instruments and the design and implementation of effective energy and climate policy* (Statistics Norway) analyses the economic consequences of using multiple instruments towards energy and climate policy targets. The project studies the main political causes for deviating from the simple cost efficient recommendations. A key objective of the project is to identify effective policy measures that also are politically feasible. The development of effective policy measures is a key focus in environmental social science research.

8.2.5 Mitigation and adaptation technologies

KLIMATEK, a government-funded Norwegian national technology programme, was initiated in 1997 as the result of a political initiative to promote the development and demonstration of technology that can reduce emissions of greenhouse gases in Norway. The programme was merged with other programs in 2002. From 2005 a new programme (CLIMIT) dedicated to gas fired power generation with CO2 capture and storage (CCS) has been established. The CLIMIT program is a national program run in collaboration between Gassnova and the Research Council. KLIMATEK covered all greenhouse gases, but projects were mainly focusing on CO_2 and methane. Initially, priority was given to projects in the offshore petroleum sector and in the process industry. At present, the CLIMIT programme is focusing on CO_2 capture and storage from power generation based on natural gas and other fossil sources.

There is an increasing interest in CCS both from coal and gas power plants internationally. Many Parties, inter alia the European Union, Australia, Canada and the USA, work towards developing new and improve existing technologies for CO_2 capture and geological storage of CO_2. Norwegian companies and research institutions are playing a major role in this international collaboration.

From the beginning of the programme in 1997, KLIMATEK, and now CLIMIT, have allocated around NOK 550 million from the Government. In addition, industry companies have participated with a similar amount. The annual budget from the Government is about NOK 150 million 2009.

Projects supported by CLIMIT include the following:
- BIG CO_2 is a large project at SINTEF Energy research, covering many aspects of capture and storage of CO_2. Post combustion capture, oxyfuel, and new technologies for capturing CO_2, including membranes etc. are covered. Integration, chain analysis, and storage aspects are also topics. Precombustion capture and chemical looping are covered by parallel projects.
- In collaboration between Aker Clean Carbon and SINTEF, a major project named SOLVit is run at the research facilities in Trondheim. The project is focusing on post combustion capture of CO_2 using amines, and is financed both by Gassnova and the

Research Council of Norway.
- The University of Bergen is running a project on mathematical modelling of CO_2 storage. Risk assessment and modelling of the behaviour of CO_2 stored are among the topics.
- The University of Oslo, in collaboration with the Institute for Energy Technology and other institutions is studying geological storage of CO_2, with focus on geochemical and geomechanical aspects of storage, including cap rocks, seal integrity, hydrates etc.
- Statoil (StatoilHydro until November 2009) runs several projects in CLIMIT. One project is looking at transport of CO_2 in pipelines, with emphasis on multi-phase flow, heat transfer, impurities, vertical well transport etc.
- Statoil is also looking at new ways of integrating capture of CO_2 in the power production, as well as more efficient desorber technologies.
- In the beginning of 2009, 8 centres for environmentally friendly energy technologies were established. Two of them are within capture and storage of CO_2. The BIG CCS centre at SINTEF in Trondheim is covering capture, transport and storage of CO_2, while the SUCCESS centre at Christian Michelsens Centre in Bergen – in collaboration with University of Bergen, University of Oslo and Institute for Energy Technology – is concentrating on storage.

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

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

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

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

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

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

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

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

8.3 Systematic observation

8.3.1 Meteorological and atmospheric observations.

The Norwegian Meteorological Institute (met.no) has included 10 existing meteorological surface observing stations and one upper air station (Jan Mayen) as part of GCOS. The stations report to the WMO international data exchange according to standard procedures. Norway does not have a separate national GCOS programme.

The Norwegian Meteorological Institute operates 6 upper air stations-, including two stations at the Arctic islands Jan Mayen and Bjørnøya, and a station at the Ekofisk oil field in the North Sea. These stations make soundings twice daily measuring temperature, humidi-

ty and wind every 2 sec up to a height of approximately 28 km. The institute also collects upper air data from a station operated at Ny-Ålesund, Spitsbergen by the Alfred Wegner Institute.

The surface based meteorological network for real time synoptic observations comprises approximately 230 stations, including the manned stations at Jan Mayen, Bjørnøya and Hopen. In addition the Norwegian Meteorological Institute operates a number of automatic meteorological stations at the northern part of Svalbard and has equipped approx 10 oil rigs and approx 20 ships in the Norwegian and Barents sea from which meteorological observations are collected. Many of these stations report on an hourly basis. One automatic station located on the ice in the Arctic is made available to the International Arctic Buoy Programme (IABP). A synoptic meteorological station has also been set up at the Troll station in the Antarctica.

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

The institute also operates a network of manual precipitation stations consisting of approximately 400 stations. 50 per cent of these stations report the data on a daily basis. The rest only report on a weekly basis.

The Norwegian Meteorological Institute has operated meteorological observing stations for more than 100 years at a number of locations. The climate data base of the Norwegian Meteorological Institute therefore includes very long records of climate data. This base is now made freely available on the web (www.eklima.no). This web site includes both real-time data as well as long historical climate series.

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

The Norwegian Institute for Air Research (NILU) has the main responsibility for greenhouse gas monitoring in Norway. A wide range of greenhouse gases is monitored at the Zeppelin station at Ny-Ålesund, Spitsbergen. They include a more than 20 halocarbons in a wide range of halogenated species (including CFC, HFC and HCFC gases), methane, CO, and tropospheric and stratospheric ozone. From 2010 the measurement programme also includes N_2O . The station is a part of the WMO Global Atmosphere Watch (GAW) system, and also a contribution to the international Network for the Detection of Atmospheric Composition Stratospheric Change (NDACCNDSC) and the Advanced Global Atmospheric Gases Experiment Network (AGAGE). NILU also hosts the European part of the NDACC-NDSC database and operates the European database for stratospheric ozone (NADIR), which contains data from several projects on stratospheric ozone founded by the European Commission. In addition, NILU also measure CO_2, methane, hydrogen tropospheric ozone and aerosol physical properties (including aerosol optical depth) at the site Birkenes in Southern Norway. NILU further operates a number of background sites with air and precipitation chemistry observations in support of Global Atmosphere Watch (EMEP-GAW joint sites). From 2010, NILU will host the WMO-GAW World Data Centre for Aerosols (previously hosted by EC-JRC Ispra).

The Zeppelin station is also basis for measurements of CO_2 and particles performed by Stockholm University, funded by the Swedish Environmental Protection Agency, and the Polar Institute.

Data on the halogenated greenhouse gases are now receiving particular attention and most of the components have declined the recent years except for HFCs. The Norwegian Institute for Air Research coordinates the EU-funded project entitled "System for observation of halogenated greenhouse gases in Europe" (SOGE). The project established involves careful calibration routines 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 international Network for the Detection of Atmospheric Composition Stratospheric Change (NDACCNDSC) and the Advanced Global Atmospheric Gases Experiment (AGAGE).

8.3.1 Oceanographic observations

The Institute of Marine Research (IMR) has an extensive monitoring programme on physical and biological oceanographic parameters. Temperature and salinity observations are made at nine fixed coastal stations from Skagerrak to the Barents Sea with vertical profiles occupied 2-4 times per month. The monitoring started in 1936. Together with the Russian sister organisation PINRO in Murmansk, IMR maintain the hydrographic section Kola in the eastern Barents Sea. The section is the most comprehensive oceanographic time series in the world, started by the Russians in year 1900, and taken monthly since then. IMR also occu-

pies fixed hydrographic sections along the Norwegian coast between 2-4 times per year. Most of these time series have been maintained since 1970s.

The Norwegian Polar Institute (NPI) maintains a monitoring programme in Framstrait, monitoring the oceanic output from the Arctic Ocean to sub polar seas. The programme is a collaborative effort with Alfred Wegener Institute for Polar and Marine Research (AWI). The latter institution is responsible for monitoring the input of heat and salt to the Arctic, while NPI monitors the export of freshwater. Since 1990, ice thicknesses have been continuously monitored with two to four upward looking sonars. The Norwegian Polar Institute also monitors the marine living environment and sea ice properties in Kongsfjorden, Svalbard.

The Joint Assessment and Monitoring Programme (JAMP) adopted by OSPAR 2005 (MASH 05/6/Info.2) is developed to provide the basis for a consideration of OSPAR's requirements for monitoring the species and habitats. Norway also contributes to a reporting and coordinating mechanism for WMO operational marine activities, the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM).
SEAPOP (Seabird Population Management and Petroleum Operations) is a national seabird mapping and monitoring programme. The programme which is developed in collaboration with research institutes, oil industry and management will provide improved data on seabirds, which, in addition to contribute to implementation of ecosystem management also will give valuable information on possible impact from climate change on biodiversity. The program do now cover the whole Norwegian cost.

A Working Group for marine biodiversity was appointed by the Directorate for Nature Management in 2002 and resulted in 2005 in a proposal, for a National Programme for monitoring biodiversity in coastal areas. The aim of the programme was to coordinate existing and planned monitoring activities on biodiversity to meet the demands of an ecosystem approach. This work continued in 2008 for the open seas with the same aim. None of the monitoring plans are implemented.

There is a serious need of data and mapping of species and habitat at a regional and local level and activity has now started as a part of the National Programme. A national program for mapping of costal habitat started in 2007 as a joint venture project between the Ministry of the Environment and the Ministry of Fisheries and Costal affairs. The aim towards year 2010 is that half of the Norwegian communities along the cost have been mapped regarding important habitats that are significant for biological diversity.

MAREANO is an integrated mapping programme for the Norwegian seas and coastal areas carried out by the Institute of Marine Research (IMR), the Geological Survey of Norway (NGU) and the Norwegian Hydrographic Service (SKSK). The programme initiates a detailed mapping of the physical, chemical, biological environment of the sea bottom areas. The program started in the Barents Sea in some areas which were given priority (due to the management plan for the Barents Sea and the Lofoten Island) like the sea area outside the Lofoten Islands. It is decided that the mapping program will continue to do mapping also in the Norwegian Sea.

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

8.3.2 Terrestrial observations

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

Ongoing monitoring programmes of special interest with respect to climate change:
- Terrestrial Monitoring Programme (TOV) (Directorate for Nature Management) in birch and coniferous forests
- Monitoring of palsa peatlands (Directorate for Nature Management)
- Forest monitoring programme (state/vitality of forest ecosystems) (ICP-forest) (Norwegian Institute for Forest and Landscape)
- National Forest Inventory (inventory on permanent plots all over the country at 5-year intervals) (Norwegian Institute for Forest and Landscape)
- Monitoring of cultural landscapes (3Q) (Norwegian Institute for Forest and Landscape)
- Environmental monitoring on Svalbard and Jan Mayen (MOSJ) (Norwegian Polar Institute).

Norway participated in ACIA (Arctic Climate Impact Assessment) under the Arctic Council. The final reports were published in 2004/2005 and include research and observations related to the climate system as well as marine and terrestrial systems. Since 2005 a national project has been established to follow up the ACIA-report on a national level. The main object of the project is to improve the knowledge on projected climate change and related consequences for the northern areas of Norway, identify particular vulnerable sec-

tors and ecosystems and identify relevant adaptation strategies. The final report will be published in spring 2010.

Existing national plans

A national plan for biodiversity monitoring was adopted in 1998. This plan includes different threats against biodiversity, including climate. Recommendations from this plan have been implemented in a varying degree in ongoing national programmes. An interministerial national programme dealing with surveying and monitoring including reporting biodiversity data has been going on since 2002. A national bird monitoring programme is under establishment (fully established network in 2010/11). This programme will give representative data on bird observations from a national network to a "common bird index" for Norway. In connection of implementation of the EU Water Framework Directive in Norway a biological monitoring programme for freshwater and coastal areas is under planning. That programme will include climate monitoring, where ecological effect of climate change will be emphasized.

Climate parameters monitored in Norway

The programmes described above are not, with the exception of ACIA and NORKLIMA and the palsa mire monitoring, 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 ground vegetation communities and epiphytic lichens in sub alpine birch forests and coniferous forests, changes in populations of passerine birds and small mammals in sub alpine birch forests, palsa mire changes, changes in forest growth and vitality in coniferous 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 in forests are reported to ICP Forest (ECE).
- Data from 2 stations are reported to Scantran (Scannet) (Finse, Ny-Ålesund).
- Data from 1 station is reported to Envinet (NyÅlesund) (within EU programme).
- Forest monitoring (state/vitality of forest ecosystems). Reporting to ICP Forests under the UNECE.
- Forest monitoring (forest resources, Pan-European Criteria & Indicators etc.) Reporting to UNECE/FAO.

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

9. EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1 Introduction

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

9.2 Education

Awareness of issues related to sustainable development and climate change has long been embedded in the Norwegian system of education. Norway takes part in the UN Decade for Education for Sustainable Development (2005 – 2014), and we cooperate with the other Nordic countries.

Primary and Secondary Education

In 2006, a new curriculum was introduced for primary and secondary schools. These curriculum guidelines represent a natural continuation regarding sustainable development and other issues related to e.g. energy-use and climate change. The following examples describe how these issues are embedded in the curriculums:

Social Studies Subject Curriculum

Competence aims after Year 10
Main Subject Area: Geography

The aims for the education are that the pupil shall be able to:

- Tell others about the basis in nature focusing on internal and external forces on earth, movement in air masses, circulation of water, weather, climate and vegetation, and discuss and elaborate on relations between nature and society.
- Describe and explain natural and cultural landscapes in the local community.
- Explain how people exploit resources in nature, other resources and technology in Norway and other countries in the world.
- Assess the use and misuse of resources, consequences this might have for the environment and society, and conflicts this can create locally and globally.

Natural Science Subject Curriculum

Competence aims after 1. Year, Upper secondary education
Main Subject Area: Sustainable Development

The aims for the education are that the pupil shall be able to:

- Describe succession processes in an ecosystem.
- Examine an ecosystem and assess where it is in the succession process.
- Elaborate on factors that influence the size of a population.
- Explain what is meant by the "look-before-you-leap" principle, uncertain knowledge and the concept of sustainable development, and give examples of these.
- Assess environmental principles for consumer choices and energy use.
- Select and describe some global conflicts of interest and assess the consequences these might have for the local population and the global community.
- Elaborate on how the international community is working on global environmental challenges.
- Provide examples of nature management and changes of natural environments that may have consequences for indigenous peoples in Norway and other countries.

On 9 December 2008 the Storting adopted a new object clause in Section 1-1 of the Norwegian Education Act. The new object clause, concerning the new objectives of education and training, includes the following sentence: "The pupils and apprentices are to learn to think critically and act ethically and with environmental awareness".

The work on providing teachers and schools with support materials has been continued. 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 Educa-

tion Network (http://sustain.no/). The Network is organized as a co-operation between schools at all levels, research institutions and environmental authorities.

Participating schools monitor a study site in their neighbourhood. The goal is to combine good environmental education with collecting data that can be useful to others. The results of the investigations are collected in a central database, searchable from the Networks web pages. The Network works as a meeting ground between students, teachers, environmental management, research institutions and voluntary organisations. The institutions offer professional support and ideas to the teacher on how to organise the environmental education.

Tertiary education (research)
Universities and colleges are important institutions for both research on climate issues and for climate related facts and knowledge. There are several general courses at higher and lower levels at universities and technical colleges, and within both the natural and the social sciences of relevance for climate change.

Research related to the environment in general is important for understanding the environment and how it develops; it provides an important requisite for a sound and rational policy in this field. In Report No. 20 to the Storting (2004-2005) Commitment to research the area energy and environment was singled out as one of the major areas for research. Report no. 30 to the Storting (2008-2009) Climate for research followed up on this, stating among others that "The Government's goal is that Norwegian research policy will contribute to:

– meeting global challenges, with a particular emphasis on the environment, climate change, oceans, food safety and energy research".

It is imperative that knowledge from environmental research is disseminated to both the public as well to other areas of the society. The Ministry of Education and Research aims at increased and improved imparting of research. Both universities and colleges and the Research Council of Norway convey results from environmental research in various ways, through publications, at conferences and by the use of Internet.

9.3 Information

9.3.1 Klimaløftet

The Norwegian Ministry of the Environment launched the public awareness campaign on climate change Klimaløftet in March 2007. It was initiated as a supplementary measure to help ensure the necessary reduction in Norwegian emissions in a long-term perspective. The purpose is to spread information on the climate issues, based on scientific research, with the ambition and aim to educate the people on the issues. To make an understanding of what is at stake, and that we all have to join efforts to succeed in solving the climate crisis.

The campaign is in a partnership with several stakeholders such as enterprises and businesses, NGO´s and the civil society, where all partners do public awareness-campaigns, some of them receive economic contributions from Klimaløftet. A lot of initiatives and efforts from these actors are included in Klimaløftet to emphasize that the campaign is a joint effort.

A special focus is to communicate what the individual can do as their contribution, by showcasing simple and reasonable measures for a climate-friendly lifestyle.
The target groups are the public in general and young people in particular, of age 15-25 years. Measures in the campaign: courses of lectures around the country, web-based campaigns, educational programmes, website, newsletters and magazines, mass media advertising, web-based competitions for youth etc.

9.3.2 The Environmental Information Act

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

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

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

An appeals board has been established to ensure that the Act is complied with and to consider complaints related to the follow up of this Act in private enterprises. Half of the members of the appeals board are people with an industry background, and the other half is people with a background in an environmental organisa-

tion, a consumer organisation or media. The existence of the appeals board ensures proper evaluation and control of whether requests for information are treated in accordance with the Act.

9.3.3 Public websites

An important website for information on environmental issues to the public is the State of the Environment Norway (www.environment.no). The Ministry of the Environment has assigned the production of State of the Environment Norway to the environmental authorities. The Norwegian Pollution Control Authority has the overall editorial responsibility. The State of the Environment Norway aims to provide you with the latest facts on the state and development of the environment. The service covers 14 main topics which are further divided into several subtopics. Each topic is presented in a simple and easy-to-follow way and provides access to more detailed scientific presentations. On most of the pages you will also find further information about legislation and international agreements, environmental targets, references and relevant links.

Norway wishes to encourage individuals and companies to reduce their greenhouse gas emissions. Offsetting through purchase of European Union Allowances (EUA) and Certified Emission Reduction units (CER), is a good option for emissions that cannot be avoided. The Norwegian Pollution Control Authority therefore established in 2008 a website (www.co2.sft..no) where businesses and members of the public can purchase carbon offsets. This voluntary scheme provides both EUAs and CER. EUAs and CERs purchased through this website will be cancelled in the Norwegian registry. This removes the emission allowance from the market. It cannot subsequently be reused by another party or company. Reducing the number of available EUAs and CERs is therefore a small, but concrete step towards lowering global greenhouse gas emissions.

The Norwegian Pollution Control Authority also has the editorial responsibility for the Norwegian Pollutant Release and Transfer Register (PRTR). The website www.sft.no/norskeutslipp provides the public with information on chemical substances and pollutants released to air, water and soil from industrial activities in Norway, in addition to waste generated from the industry. The data is searchable and can be presented by industry sectors, by facility, by a chemical substance or groups of substances.

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

9.3.4 Statistics Norway

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

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

9.3.5 CICERO Center for International Climate and Environmental Research - Oslo

CICERO (Center for International Climate and Environmental Research – Oslo) is an interdisciplinary research institute with a specific focus on climate change, and 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. CICERO's mission is to provide reliable and comprehensive knowledge about all aspects of the climate change problem. Its work is based on two main objectives:

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

Active involvement in the public debate on climate issues is of special importance for CICERO. Six times a year, CICERO publishes the popular climate science magazine Klima, which has a circulation of 10.000 main-

ly among ministries, directorates, local government, the business sector, research institutions, universities and schools. This magazine reports on developments in both science and policy related to climate change, and is written in popular scientific form to reach a wide audience. CICERO has also extensive publications related to the IPCC Fourth Assessment Report, and will be publishing a popularised book on the IPCC findings with financial support from the Norwegian Research Council ahead of the UN Climate Conference in Copenhagen. CICERO also provides regular updates on major events in the international climate negotiations. Twice a week CICERO issues a web-based climate news service in English and Norwegian.

CICERO is given a national role in the dissemination of climate research, and in this capacity, CICERO undertakes information projects for a large variety of research institutions, government and industry. The Ministry of the Environment contributes financially to the information activities of the research institute.

For several years CICERO has arranged the Climate Forum, which brings together representatives from industry and business as well as government and researchers. The Climate Forum is organised to provide information on development trends in international climate research and policies, and to improve the dialogue between the various parties involved. During 2009 CICERO had a series of meetings titled "Towards Copenhagen", targeted at business and government. The meetings have been open to the press. In addition, CICERO often organises press briefings, seminars and national and international conferences.

9.4 Consumer information

Providing information about the environmental effects of products throughout their life cycles is an essential part of efforts to promote sustainable consumption patterns. The Nordic environmental label (Nordic Swan Label) is the predominant official eco-label in Norway, Sweden, Denmark, Finland and Iceland. The label is awarded only to those products in a product range that fulfil strict criteria for environmental impact throughout their life cycles. The Swan Label has been developed through cooperation between governments and business, environmental and consumer organizations, and the overall aim of the label is to stimulate both the supply of and demand for products with a reduced environmental impact. The label is available for 71 product groups for which it is deemed that eco-labelling will be beneficial, and around 480 of the licenses awarded are valid (both figures as per November 2009). Everything from detergent to furniture and hotels can carry the Swan label. The Swan is a widely recognized eco-label in the Norwegian market. Polls have shown that as many as 90 per cent of adults know that the Swan is Norway's official eco-label, and about equally many express that they prefer Swan-labelled products to those without the label.

Figure 9.1 The EU Flower

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

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

Figure 9.2 The Nordic Swan Label

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

9.5 Environmental and Social Responsibility in Public Procurement

The public sector shall contribute to benefits to society by ensuring the most efficient use of resources in public procurement, based on good commercial practices and equitable treatment. These principles are laid down in the Norwegian Public Procurement Act. The Public Procurement Act from 2001 provides an important basis for work on environmental and social responsibility in public procurement. The Act requires public procurers, when planning purchases, to take into account the life cycle costs and environmental impact of each purchase (Section 6 in the Act).

The Government wants the public sector to lead the way as a responsible consumer and demand environmental sound products and services which have been manufactured in accordance with high ethical and social standards. The Norwegian action plan for Environmental and Social Responsibility in Public Procurement (2007 -2010) was launched June 2007 by three ministers: Environment, Government Administration and Children and Equality (social aspects).

The goal is to minimise the environmental impact of public procurement. Priority will be given to measures relating to climate and energy, hazardous chemicals and biodiversity.

An environmental policy for central government procurement has been specified and entered into force 1 January 2008 and shall be integrated into the environmental management systems and procurement routines of all national government institutions. The policy sets specific requirements for procurement of 15 priority products groups such as property management building, transport and vehicles, ICT equipment, textiles, health and hygiene consumer material, printed matter and paper, office furniture and supplies, cleaning and hotels. Indicative product criteria and capacity-building assistance has been made available for public procurement officers.

Implementation of the action plan has been delegated to the Agency for Public Management and eGovernment (Difi), which also has overall responsibility for improving the quality of public procurement in general. Difi will therefore have strong focus on integrating Environmental aspects with general activities directed at improving public procurement.

9.6 Green Government

The project Green Government started up in 2002 with the objective of having environmental management introduced as an integrated part of the management system of all national government institutions and operations by the end of 2005. The system is based on the principles formulated in ISO-14001 and EMAS, but adapted for easier use. The Government regards the use of environmental management systems as an important way to promoting environmental considerations in public procurement and of treating procurement related measures as part of an integrated environmental policy in the individual organisation. The Green Government project was evaluated in 2006 and as a result of the evaluation the systems has been strengthen with the environmental policy for government procurement (see over). The Environmental management system is now included in the action plan for Environmental and Social Responsibility in Public Procurement. Governmental institution with a significant impact on the environment to introduce third-party certified environmental management systems, like ISO 14001. Other government institutions will have a simpler environmental management system.

9.7 Networks and information centres

A network of focal points at the county level for providing advice, courses to local procurement officers and feedback to the Agency for Public Management and eGovernment (Difi) is being established. 6 are in place and the remaining 12 will be established during 2009. The target groups are local authorities and national government institutions with distributed organizations. An Internet based infrastructure is being built up for sharing templates, examples, presentations, as well as discussions and dialogue a) between Difi, b) support points and c) procurement officers at the local level.

The energy agency Enova is responsible for the public information in the field of energy efficiency. An open line providing energy efficiency advice for the households and commercial actors is one of the main instruments. The establishment of energy efficiency networks for specific sectors is an important part of Enova's energy efficiency strategy. During the last few years, information campaigns in media with nationwide coverage have helped to raise awareness of energy efficiency issues in private households and among other energy users. For more information on Enova, see section 4.3.3.

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APPENDIXES

A: Summary tables on emission trends

Table 3.1 Emissions of greenhouse gases in Norway during the period 1990-2007. Units: CO_2 and CO_2–eq. in Mtonnes (Mt), CH_4 and N_2O in ktonnes (kt) and other gases in tonnes (t).

Year	CO_2 Mt	CH_4 kt	N_2O kt	PFC t	SF_6 t	HFC[1] t	Total CO2 eq Mt
1990	34.8	219.7	15.2	503.6	92	0.1	49.7
1991	33.4	222	14.8	447.5	87	0.4	47.7
1992	34.2	225	12.9	343	29.5	0.9	45.9
1993	35.9	228.3	13.7	344.9	30.9	2.6	48
1994	37.9	231.8	14	305.2	36.7	6.9	50
1995	37.8	230.8	14.2	301.4	25.4	15.1	49.7
1996	40.9	231.8	14.4	274.7	24	27.6	52.7
1997	41	232.8	14.4	245	24.3	43.8	52.6
1998	41.1	226.9	14.7	223.1	30.4	67.1	52.8
1999	42	220.1	15.3	208.5	36.6	94.7	53.8
2000	41.6	226.6	14.6	198	39.1	124.8	53.4
2001	43	227.2	14.3	199.4	33.1	157.6	54.6
2002	42	219.2	14.9	215.3	10	188.9	53.3
2003	43.4	220.4	14.4	135.7	9.8	215.2	54
2004	43.9	218.8	14.9	131.5	11.5	240.7	54.7
2005	42.9	211.1	15.3	124.3	13.1	274.4	53.7
2006	43.3	202.8	14.2	110.7	8.9	303	53.5
2007	45	210.1	13.7	119	3.2	328.7	55.1
Changes 1990-2007	**29 %**	**-4 %**	**-10 %**	**-76 %**	**-97 %**	**-**	**11 %**

[1] *HFCs are given as actual emissions.*

Source: Statistics Norway/The Norwegian Pollution Control Authority

B: Summary tables for 1990, 2000 and 2007. From National Inventory Report as of April 15 2009.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2009 v1.1
NORWAY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**22 487.53**	**4 616.39**	**4 731.94**	**0.02**	**3 370.40**	**2 199.78**	**37 406.06**
1. Energy	**28 596.57**	**629.37**	**310.55**				**29 536.48**
A. Fuel Combustion (Sectoral Approach)	25 939.37	253.30	306.44				26 499.11
1. Energy Industries	6 647.60	48.17	26.88				6 722.65
2. Manufacturing Industries and Construction	3 597.24	10.98	44.15				3 652.37
3. Transport	11 108.73	71.90	145.42				11 326.05
4. Other Sectors	4 129.61	121.78	83.87				4 335.25
5. Other	456.19	0.48	6.12				462.79
B. Fugitive Emissions from Fuels	2 657.19	376.07	4.11				3 037.37
1. Solid Fuels	7.37	56.49	NA,NO				63.86
2. Oil and Natural Gas	2 649.82	319.58	4.11				2 973.52
2. Industrial Processes	**6 039.17**	**9.99**	**2 078.81**	**0.02**	**3 370.40**	**2 199.78**	**13 698.18**
A. Mineral Products	721.27	NA	NA				721.27
B. Chemical Industry	900.36	8.95	2 073.59	NO	NO	NO	2 982.90
C. Metal Production	4 334.00	1.04	5.22	NO	3 370.40	2 143.83	9 854.50
D. Other Production	77.30						77.30
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				0.02	NA,NO	55.95	55.97
G. Other	6.23	NA	NA	NO	NO	NO	6.23
3. Solvent and Other Product Use	**155.65**		**35.53**				**191.18**
4. Agriculture		**2 268.13**	**2 176.45**				**4 444.57**
A. Enteric Fermentation		1 946.11					1 946.11
B. Manure Management		298.17	133.36				431.53
C. Rice Cultivation		NO					NO
D. Agricultural Soils[3]		NA,NO	2 036.21				2 036.21
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		23.85	6.88				30.72
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[1]	**-12 304.04**	**1.77**	**13.45**				**-12 288.82**
A. Forest Land	-15 145.82	1.77	12.72				-15 131.33
B. Cropland	482.33	IE,NO	0.68				483.01
C. Grassland	1 887.15	NO	NO				1 887.15
D. Wetlands	3.37	NE,NO	0.05				3.43
E. Settlements	458.81	NE,NO	NE,NO				458.81
F. Other Land	NA,NE,NO	NO	NO				NA,NE,NO
G. Other	10.12	NO	NO				10.12
6. Waste	**0.19**	**1 707.13**	**117.14**				**1 824.46**
A. Solid Waste Disposal on Land	IE,NA	1 687.61					1 687.61
B. Waste-water Handling		19.51	117.07				136.58
C. Waste Incineration	0.19	0.01	0.07				0.27
D. Other	NA,NO	NA,NO	NA,NO				NA,NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	2 097.52	75.26	6 107.88				8 280.65
Aviation	619.47	73.01	6 096.37				6 788.85
Marine	1 478.05	2.24	11.51				1 491.80
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**4 474.82**						**4 474.82**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	49 694.88
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	37 406.06

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2000
Submission 2009 v1.1
NORWAY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**24 499.27**	**4 759.37**	**4 530.71**	**238.36**	**1 317.90**	**934.42**	**36 280.04**
1. Energy	**34 123.29**	**1 029.12**	**427.15**				**35 579.56**
A. Fuel Combustion (Sectoral Approach)	30 423.01	274.26	422.39				31 119.66
1. Energy Industries	10 099.23	63.72	35.84				10 198.79
2. Manufacturing Industries and Construction	3 887.32	10.92	38.42				3 936.66
3. Transport	13 025.12	62.40	273.04				13 360.56
4. Other Sectors	3 233.19	136.94	71.33				3 441.46
5. Other	178.16	0.27	3.76				182.20
B. Fugitive Emissions from Fuels	3 700.28	754.85	4.76				4 459.90
1. Solid Fuels	9.25	70.86	NA,NO				80.11
2. Oil and Natural Gas	3 691.04	683.99	4.76				4 379.79
2. Industrial Processes	**7 325.53**	**10.06**	**1 739.10**	**238.36**	**1 317.90**	**934.42**	**11 565.37**
A. Mineral Products	962.29	NA,NO	NA,NO				962.29
B. Chemical Industry	762.35	8.76	1 732.87	NO	NO	NO	2 503.97
C. Metal Production	5 348.37	1.30	6.24	NO	1 317.86	773.17	7 446.93
D. Other Production	232.01						232.01
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				238.36	0.04	161.26	399.65
G. Other	20.50	NA	NA	NO	NO	NO	20.50
3. Solvent and Other Product Use	**142.01**		**40.04**				**182.05**
4. Agriculture		**2 308.06**	**2 181.03**				**4 489.09**
A. Enteric Fermentation		1 978.99					1 978.99
B. Manure Management		319.17	144.91				464.08
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NA,NO	2 033.27				2 033.27
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		9.90	2.85				12.75
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry [1]	**-17 091.62**	**0.33**	**13.03**				**-17 078.27**
A. Forest Land	-20 093.32	0.33	12.69				-20 080.30
B. Cropland	145.80	IE,NO	0.28				146.08
C. Grassland	2 042.71	NO	NO				2 042.71
D. Wetlands	3.37	NE,NO	0.05				3.43
E. Settlements	783.38	NE,NO	NE,NO				783.38
F. Other Land	NA,NE,NO	NO	NO				NA,NE,NO
G. Other	26.43	NO	NO				26.43
6. Waste	**0.07**	**1 411.81**	**130.36**				**1 542.25**
A. Solid Waste Disposal on Land	IE,NA	1 400.97					1 400.97
B. Waste-water Handling		10.74	130.29				141.03
C. Waste Incineration	0.07	0.10	0.07				0.25
D. Other	NA,NO	NA,NO	NA,NO				NA,NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	3 514.91	231.94	9 004.13				12 750.99
Aviation	912.88	228.00	8 983.86				10 124.73
Marine	2 602.03	3.95	20.27				2 626.25
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**4 681.09**						**4 681.09**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	53 358.31
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	36 280.04

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

[4] See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2007
Submission 2009 v1.1
NORWAY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**19 066.76**	**4 411.72**	**4 245.92**	**565.51**	**801.41**	**76.24**	**29 167.55**
1. Energy	**38 448.53**	**1 022.29**	**559.69**				**40 030.51**
A. Fuel Combustion (Sectoral Approach)	34 777.96	315.41	552.79				35 646.16
1. Energy Industries	12 683.31	81.38	42.29				12 806.99
2. Manufacturing Industries and Construction	3 519.73	11.36	40.33				3 571.42
3. Transport	15 441.81	84.65	390.39				15 916.85
4. Other Sectors	2 923.74	137.82	77.57				3 139.14
5. Other	209.37	0.19	2.21				211.77
B. Fugitive Emissions from Fuels	3 670.57	706.88	6.90				4 384.35
1. Solid Fuels	8.59	65.85	NA,NO				74.44
2. Oil and Natural Gas	3 661.98	641.04	6.90				4 309.92
2. Industrial Processes	**6 367.91**	**6.32**	**1 380.23**	**565.51**	**801.41**	**76.24**	**9 197.61**
A. Mineral Products	1 005.06	NA,NO	NA,NO				1 005.06
B. Chemical Industry	412.12	5.60	1 377.43	NO	NO	NO	1 795.15
C. Metal Production	4 785.44	0.72	2.80	NO	801.37	NO	5 590.33
D. Other Production	165.23						165.23
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				565.51	0.04	76.24	641.78
G. Other	0.06	NA	NA	NA,NO	NO	NO	0.06
3. Solvent and Other Product Use	**145.71**		**42.15**				**187.86**
4. Agriculture		**2 190.03**	**2 107.26**				**4 297.29**
A. Enteric Fermentation		1 871.27					1 871.27
B. Manure Management		313.97	122.99				436.96
C. Rice Cultivation		NO					NO
D. Agricultural Soils[3]		NA,NO	1 982.90				1 982.90
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		4.79	1.38				6.17
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[1]	**-25 895.43**	**0.24**	**12.62**				**-25 882.57**
A. Forest Land	-28 023.62	0.24	12.42				-28 010.96
B. Cropland	116.86	IE,NO	0.15				117.01
C. Grassland	1 875.17	NO	NO				1 875.17
D. Wetlands	3.37	NE,NO	0.05				3.43
E. Settlements	116.24	NE,NO	NE,NO				116.24
F. Other Land	NA,NE,NO	NO	NO				NA,NE,NO
G. Other	16.54	NO	NO				16.54
6. Waste	**0.04**	**1 192.84**	**143.97**				**1 336.84**
A. Solid Waste Disposal on Land	0.04	1 183.19					1 183.22
B. Waste-water Handling		9.58	143.90				153.47
C. Waste Incineration	NA,NO	0.07	0.07				0.14
D. Other	NA,NO	NA,NO	NA,NO				NA,NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	3 269.95	314.72	12 296.10				15 880.77
Aviation	1 247.84	311.65	12 280.34				13 839.84
Marine	2 022.11	3.07	15.76				2 040.94
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**5 198.39**						**5 198.39**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	55 050.12
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	29 167.55

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

C: Methodologies and key macroeconomic assumption

This annex describes the methodology, macroeconomic model and key assumptions behind the forecast presented in Chapter 5. A summary of the main changes in emissions since the last communication is also given.

Methodology and key assumptions

The emission forecasts are based on the macroeconomic projections presented in table 5.2 (Chapter 5) and table C1 below. The macroeconomic model MSG (Multi-Sectoral Growth) covers both the macroeconomic development and CO_2 emissions. CO_2 emission forecasts are mainly calculated using this model. In addition, model results are adjusted on the basis of available micro studies of CO_2 emission from the petroleum extraction sector, some of the most emission intensive manufacturing sectors and road transportation. Building on this information the Norwegian Pollution Control Authority projects emissions of all greenhouse gases except CO_2. In the projections, the macroeconomic development and the predicted emissions are based on the technical assumption that no new measures will be implemented either in Norway or in other countries.

Assumptions about energy prices and energy productions are central in the projections. Petroleum extraction is assumed to peak at about 258 Sm3 oil equivalents in 2015, before gradually falling to about 232 million Sm3 oil equivalents in 2020. The producer price of crude oil is assumed to fall from NOK 617 in 2008 to NOK 400 in 2010, measured in 2009 prices, before stabilizing at this level thereafter. The wholesale price on electricity is assumed to increase from NOK 0.23 per KWh in 2007 to NOK 0.29 per KWh in 2010 measured in 2009 prices and increase to NOK 0.45 per KWh in 2020. Projected supply and demand of electricity is expected to balance in 2020. Projected supply and demand of electricity is expected to balance in 2020.

The estimated supply and demand of the different petroleum products in the calculations are shown in table C2 and C3. The combined effect of production factor substitution, changes in relative growth between different production and consumption sectors and autonomous energy efficiency improvements are shown in tables A4 to A6. The effect of substitution between production factors, e.g. energy and capital, due to differences in the development in relative prices, is captured by the dynamics of MSG. The rate of autonomous improvement in energy efficiency differs between sectors but is roughly 1 per cent a year after the base year for the model, which is 2004.

Table C1 Key macroeconomic assumptions

	Billion NOK	Percentage annual growth	
	2007	2010	2020
Gross domestic product	2277.1	2.2	2.1
Petroleum activities and ocean transport	553.0	3.9	-0.9
Mainland Norway	1724.1	1.8	2.7
Manufacturing	215.4	3.7	2.3
of which energy intensive manufacturing	65.9	14.6	2.1
Other goods production[1)]	172.8	1.4	1.8
Private services	756.6	1.2	2.9
General government	320.6	2.9	1.5
Correction items	258.7	0.9	4.0
Consumption (private and government)	1388.7	1.7	3.4
Gross fixed capital formation	484.6	1.3	0.8
Mainland Norway	354.3	-0.3	2.3
Petroleum activities and ocean transport	130.3	5.4	-3.7

[1)] *Including electricity production*

Table C2 Net domestic use of transport and heating oil. 1000 tonnes[1)]

	2004	2010	2020
Transport oil	6431	7198	7559
Heating oil[2)]	2640	2893	3025

[1)] Including energy-sectors and excluding sea transport in international waters. The classification in MSG may differ from energy accounts. This is why no account figures for 2007 are supplied.
[2)] The figures for heating oil are especially uncertain.

Table C3 Supply and use of petrol and autodiesel[1)]. 1000 tonnes

	2004	2010	2020
Total supply	18 730	20 974	22 058
Production	17 274	18 441	19 381
Import	1 456	2 534	2 677
Export	11 793	13 272	13 993
Statistical differences/ changes in inventories	505	505	506
Net domestic use	6 431	7 197	7 559

[1)] Technical model simulation results.

Table C4 Electricity per unit of production[1)]. MWh/million 2004 NOK

	2004	2010	2020
Total	63	59	49
Mainland Norway	80	69	54

[1)] The figures are based on model simulations and are highly uncertain.

Table C5 Heating oil per unit of production. Tonnes per million 2004 NOK

	2004	2010	2020
Total	1.5	1.4	1.2
Mainland Norway	1.8	1.6	1.3

Table C6 Petrol and autodiesel per unit of production[1)]. Tonnes per million 2004 NOK

	2004	2010	2020
Total	3.7	3.6	3.0
Mainland Norway	4.6	4.2	3.4

[1)] The figures are based on model simulations and are highly uncertain.

The MSG model

Various versions of the MSG model have been used by the Ministry of Finance since the 1960s. MSG is a general equilibrium model developed by Statistics Norway. The main determinants of growth are capital accumulation, labour supply, availability of natural resources and the rate of technological change. As all resources are fully utilised, the model is unsuitable for analysing short-term adjustments problems like unemployment or extensive downscaling of specific industries due to changes in policy or international prices.

The model is quite disaggregated and contains over 60 commodities. Over 30 private production sectors 8 government sectors. It includes 19 consumption goods with detailed description of use of energy and transport. The main production factors are material inputs, labour, three types of real capital, two types of energy sources and various types of polluting and non-polluting transport services. A certain degree of substitution between production factors is assumed in the model depending on changes in their relative prices and the exogenous assumptions about factor productivity developments. Producers enjoy some market power at home which is, a feature supported by empirical analyses of the Norwegian economy.

Producer behaviour at home is therefore characterized by monopolistic competition. On the world market, however, prices are fixed, suggesting that producers are exposed to free competition and act as price takers in export markets. In each sector, real capital formation is determined so that expected return on capital equals an exogenously given return on capital.

The model provides a relatively detailed description of the markets for energy and transport. A detailed emission model is incorporated into the MSG, turning it into an effective tool for assessing environmental consequences of changes in economic activity. Twelve pollutants (6 GHG and 6 air pollutants) disaggregated by source and sector are specified in the model. The disaggregated approach in MSG with emphasis on environmentally important sectors is a clear advantage when studying environmental issues.

CO_2 sequestration

Net annual CO_2 sequestration in Norwegian forests is calculated according to the 2003 IPCC Good Practice Guidance for LULUCF, employing the stock change method. The figures for annual uptake and emissions of CO_2 in Norwegian forests are calculated based on data obtained from the National Forest Inventory (NFI). The Norwegian Forest and Landscape Institute 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 net annual CO_2 sequestration in Norwegian forests cover biomass above and below ground, including tops and branches, bark, stumps and coarse roots.

The projections of CO_2 uptake in Norwegian forests are based on data from the Norwegian Forest and Landscape Institute. The projections on productive forests are developed by using the projection program Avvirk 2000 (Eid and Hobbelstad 1999), and by doing the following modifications:

- increased productivity due to an increase in the temperature of 2°C,
- inclusion of calculations on biomass and on dead organic material,
- a modified mortality rate on old forest and
- a direct link to the dynamic soil carbon model YASSO.

Projections on annual growth in unproductive forests are calculated by assuming annual biomass increment which is independent of age, but based on historical observations. The projections on both short and long term are sensitive to fluctuations and their effect on forestry. In the long run, the projections are dependent on climate change development and the effects on forest health and growth. The projections in Chapter 5 are based on the assumption that the current level of harvesting will continue.

Main differences between current and previous projections

The projections have been revised downwards since the fourth national communication under the Framework Convention on Climate Change published December 2005. Table C7 summarises the main changes.

The adjustment from 4NC report and to the White Paper on Long-term Perspectives is mainly due to:

- No further expansion of gas fired power and cleaning of existing plants, in line with new policies (most of the downward adjustment in 2020)
- Higher emissions from petroleum extraction as production has been revised upwards
- Lower emissions from industry production (both ordinary and energy intensive). The downward revision of emissions from energy intensive industries is partly due to new policy measures
- Lower emissions from transport (both due to new policies (see below) and to improvements in the method for projecting road transport)
- New measures introduced to reduce greenhouse gas emissions, including:
  i) New building regulations
  ii) Changes to the taxation of cars
  iii) New funds to Enova (Enova promotes environmentally friendly restructuring of energy consumption and generation in Norway)
  iv) Increased use of bio fuels and introduction of E85-cars
- Higher oil prices (reduces emissions from road transport and use of heating oil)

The list is not completely exhaustive.

C7 Changes in emissions compared to the 4th National Communication. Million tonnes

	1990	2010	2020
Total Energy	0.2	-1.9	-8.9
- Oil and gas production	0.9	1.2	3.4
- Petroleum refining	-0.7	0.2	-0.2
- Public electricity and heat production	0.0	0.2	-8.8
- Manufacturing industry and construction	0.1	-1.4	-1.2
- Transport	0.0	-1.8	-1.6
- Other sectors	0.0	-0.3	-0.6
Industrial processes	0.2	-1.8	-2.5
Agriculture	-0.2	-0.2	-0.2
Waste	-0.8	-0.5	-0.6
Total	-0.5	-4.5	-12.2

12. DEFINITON OF ACRONYMS

AAU	Assigned Amount Unit
ASAP	Automated Shipboard Aerological Programme
BAT	Best Available Techniques
CCAP	Center for Clean Air Policy
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CICERO	Centre for International Climate and Environmental Research
EEA	European Economic Area
ERU	Emission Reduction Unit
EU	European Union
GAW	Global Atmosphere Watch of WMO
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gases
GIS	Gas-insulated switchgear
GTOS	Global Terrestrial Observation System
GWP	Global Warming Potential
ICSU	International Council for Science
IEA	International Energy Agency
IGBP	International Geosphere-Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JI	Joint Implementation
NEFCO	Nordic Environment Finance Corporation
NILU	Norwegian Institute for Air Research
NIR	National Inventory Report
NMVOC	Non-methane Volatile Organic Compound
NOK	Norwegian Kroner
NORAD	Norwegian Agency for Development Cooperation
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
PCF	Prototype Carbon Fund
QA/QC	Quality Assurance/Quality Control
RegClim	Regional Climate Development under Global Warming
RMU	Removal Unit
SWDS	Solid Waste Disposal Sites
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollar
VAT	Value Added Tax
WCRP	World Climate Research Programme
WMO	World Meteorological Organization
WRI	World Resources Institute

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