Natural Resources and the Environment 2006. Norway

Statistisk sentralbyrå • Statistics Norway
Oslo–Kongsvinger

Statistiske analyser

I denne serien publiseres analyser av statistikk om sosiale, demografiske og økonomiske forhold til en bredere leserkrets. Fremstillingsformen er slik at publikasjonene kan leses også av personer uten spesialkunnskaper om statistikk eller bearbeidingsmetoder.

Statistical Analyses

In this series, Statistics Norway publishes analyses of social, demographic and economic statistics, aimed at a wider circle of readers. These publications can be read without any special knowledge of statistics and statistical methods.

ISBN 978-82-537-7205-9 Printed version
IISBN 978-82-537-7206-6 Electronic version
ISSN 0804-3221

Emnegruppe
01 Naturressurser og naturmiljø

Design: Siri Boquist
Printed: PDC Tangen / 425

Standard symbols in the tables	Symbol
Category not applicable	.
Data not available	..
Data not yet available	...
Not for publication	:
Nil	-
Less than 0.5 of the unit employed	0
Less than 0.05 of the unit employed	0.0
Provisional or preliminary figure	*
Break in the homogeneity of a vertical series	—
Break in the homogeneity of a horizontal series	|
Revised since the previous issue	r

Preface

Statistics Norway compiles statistics on important natural resources and environmental issues, and develops methods and models for analysing trends in the extraction and use of natural resources and changes in the state of the environment, focusing particularly on relationships between these factors and other socio-economic developments. The annual publication *Natural Resources and the Environment* gives an overview of this work.

An important objective is to ensure that this publication presents the environmental situation so that it can be readily understood while at the same time including considerable detail. *Natural Resources and the Environment 2006* starts with a summary of status and important trends for Norway's natural resources and environment. Updated national indicators for sustainable development are presented in a separate section. This is followed by detailed descriptions of various topics, including both statistics and analyses. This year a separate section presenting resource and environment-related research projects has been included. Finally, the appendix provides more detailed statistics in the form of tables.

Statistics Norway would like to thank the people and institutions who have supplied data for *Natural Resources and the Environment 2006*.

The publication was produced by the Division for Environmental Statistics, Department of Economic Statistics, with contributions from the Unit for Energy and Environmental Economics, the Unit for Petroleum and Environmental Economics, the Unit for Taxation, Inequality and Consumer Behaviour, and the Unit for Economic Growth and Efficiency, Research Department, and the Division for Primary Industry Statistics, Department of Industry Statistics. The 2006 edition was edited by Frode Brunvoll, Henning Høie and Svein Erik Stave. Alison Coulthard and Veronica Harrington have translated the Norwegian version into English.

Natural Resources and the Environment 2006 is also available at http://www.ssb.no/english/subjects/01/sa_nrm/.

More detailed information on the topics covered may also be found at http://www.ssb.no/english/subjects/ and in StatBank Norway at http://www.ssb.no/english

Statistics Norway
Oslo/Kongsvinger 15 May 2007

Øystein Olsen

Contents

List of figures

1. Introduction and summary

2. Indicators of sustainable development

3. Energy

List of tables

List of boxes

Part 1

Status and important trends. Aspects of sustainable development

1. Introduction and summary

The state of the environment depends on a complex variety of biological and physical processes. Human pressures such as various types of pollution and the use of natural resources are having substantial adverse impacts on the environment in general and on our own surroundings. Even though technological advances have improved our ability to limit many of the negative effects of economic activity, economic growth and rising consumption are putting increasing pressure on natural resources and the environment. The management and use of the environment and natural resources occupies an important place in the public debate and frequently makes the headlines in the media.

A set of indicators for sustainable development in Norway has been established as a tool for monitoring whether development is sustainable. It is hoped that such analyses of sustainability will result in political responses and practical measures. In a description of sustainability, important economic and social factors are included as well as the state of the environment. This illustrates the importance of natural resource and environmental issues, and the need to consider them in conjunction with economic and social developments.

An important task in the field of environmental statistics is thus to compile statistics that describe the state of the environment and environmental trends in a way that clearly illustrates the most important linkages between them.

1.1. Structure and content of the report

This book starts with a presentation of Norway's national core set of indicators for sustainable development, which include indicators or key figures (see box 1.1) for the environment, the economy and important social conditions. Part 2 describes the supply and use of natural resources, while Part 3 focuses on pollution and environmental problems. Part 4 presents Statistics Norway's environmental accounts, describing links between economy and environment. It also describes environmental protection expenditure in industry and environmental taxes in Norway. Part 5 presents results from selected environmental and resource-related projects in the Research Department of Statistics Norway.

The statistics presented in this publication are mainly from Statistics Norway (an overview will be found on our website: http://www.ssb.no/english/subjects/01/miljo_en/), but in some cases we have also used figures from other institutions to give a more complete picture. Much of the information has been taken from the white papers on the government's environmental policy and the state of the environment in Norway and the Norwegian Pollution Control Authority's website State of the Environment Norway (http://www.environment.no/).

Some of the text is in boxes. This includes information on special topics and lists of definitions, classifications and acts of legislation. Information on projects run by Statistics Norway that are still at the development stage, so that the results presented are preliminary and not yet official statistics, is also given in boxes.

Box 1.1. Indicators

Information on the environment includes a variety of topics, and it can be difficult to interpret overall trends. Indicators or key figures have therefore been developed that give simplified descriptions of phenomena and problems. Because they are simplified, they may illustrate some aspects of a phenomenon clearly, whereas others are not well described, and the indicators are not independent of each other. Often, several indicators are therefore used to describe a phenomenon.

Environmental policy focuses mainly on environmental problems that are caused by human activity. For environmental indicators to be adequate and function as effective tools, they must be linked to socio-economic factors. One generally-recognised way of structuring environmental indicators is the PSR model (Pressure-State-Response), which was developed by the OECD (e.g. OECD 1994, 1998, 2001a, 2004 and 2005). This has been further developed as the DPSIR framework, which includes the driving forces behind environmental pressures and the impacts of environmental change. This is used for example by the European Environment Agency (EEA). Environmental problems are analysed by looking at:

- *Driving forces*. These include population growth, economic activity, etc., which lead to
- *environmental Pressure* such as emissions to air and water and extraction of natural resources. These in turn result in changes in
- *the State of the environment,* for example changes in water quality or air quality, which cause
- *environmental Impacts* such as fish mortality, adverse effects on human health, reduction in crop yields or species extinction. At some point, society can react by making a
- *Response* to environmental problems, e.g. a CO_2 tax, protection of areas, treatment of emissions. The response in turn results in changes in economic driving forces, environmental pressures and various aspects of the state of the environment.

The figures compiled by Statistics Norway mainly provide a basis for indicators related to driving forces and environmental pressures. It is important that such indicators also show which types of activities exert pressures on the environment. Indicators are also important in the context of linking environmental statistics to economic models, analyses and projections. Indicators for responses are being developed.

In addition to the five OECD reports mentioned above, important international reports on environmental indicators and reports on environmental indicators for important sectors include the following: the European Environment Agency's *EEA Signals 2004* (EEA 2004), *Transport and environment: facing a dilemma - TERM 2005* (EEA 2006), *Environmental pressure indicators for the EU* (Eurostat 2001), *A selection of environmental pressure indicators for the EU and acceding countries* (Eurostat 2004) and *Environmental indicators for agriculture* (OECD 2001b).

A set of indicators for transport was presented in the report *Samferdsel og miljø - Utvalgte indikatorer for samferdselssektoren* (Transport and environment - Selected indicators for the transport and communication sector) (Brunvoll et al. 2005).

A general overview is provided by *Overview of sustainable development indicators used by national and international agencies* (Hass et al. 2002)

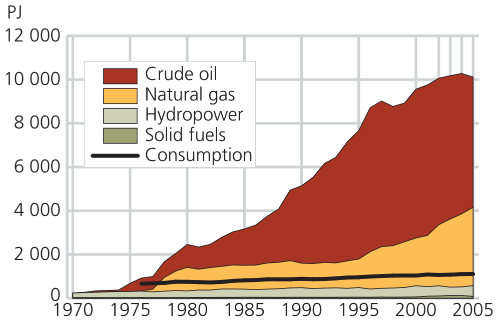
1.2. Summary

This section summarises three parts of the publication: Supply and use of natural resources (Chapters 2-8), Pollution and environmental problems (Chapters 9-13) and Links between environment and economy (Chapter 14). The summary does not include Chapter 2 (Indicators of sustainable development) or the last part of the book (Chapter 15), which presents selected environmental and resource-related research projects.

Supply and use of natural resources

Norway's economy is closely linked to the utilisation of natural resources. Extraction of oil and natural gas is clearly Norway's most important industry, measured in terms of export revenue and value added. In 2005, petroleum extraction accounted for about 23 per cent of GDP and 50 per cent of Norway's export revenues. Hydropower accounts for almost 100 per cent of electricity production in Norway, as compared with 19 per cent for the world as a whole. In 2005, there was an export surplus of 12 TWh. The traditional industries based on natural resources - agriculture, forestry and fisheries - together only account for about 1.5 per cent of GDP today, but in addition to their economic role, they are important for the maintenance of many communities and local culture. Sustainable management of natural resources is of crucial importance for Norway's economy and prosperity. Given the current rate of extraction, non-renewable resources such as oil and gas will only last for a limited period of time, and will in the foreseeable future have to be replaced by other sources of revenue. Renewable resources such as fish stocks and forests must be used and managed in accordance with their carrying capacity. At present, the pressure on several fish stocks in Norwegian waters is too high. However, direct harvesting is not the only important factor. Climate change and rising sea temperatures also affect species and ecosystems.

Figure 1.1. Extraction and consumption[1] of energy commodities in Norway. 1970-2005*

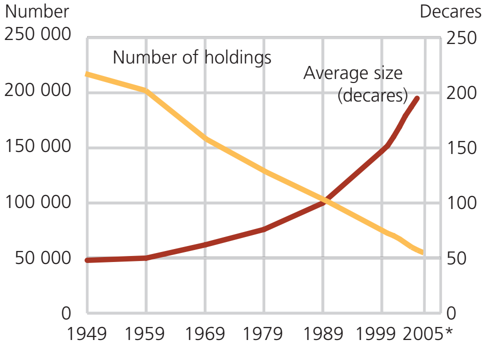


[1] Including the energy sectors, excluding international maritime transport.
Source: Energy statistics, Statistics Norway, Norwegian Petroleum Directorate and Norwegian Water Resources and Energy Directorate.

Energy

- The Norwegian oil and gas reserves are being exhausted more rapidly than those in the rest of the world. Given the current rate of extraction, the calculated crude oil reserves on the Norwegian continental shelf will be exhausted in 9 years' time and the gas reserves in 26 years' time. The corresponding figures for the world as a whole are 41 years and 65 years respectively.
- Hydropower production increased by 25 per cent from 2004 to 2005, and was the second highest ever recorded. However, it should be noted that production was unusually low in 2004 and unusually high in 2005, as a result of high rainfall.
- Annual consumption of bioenergy resources in Norway is about 15 TWh, and the utilisable potential is calculated to be about 35 TWh.
- In 2005, Norway's total energy use, excluding international maritime transport, was 1 109 PJ. This was a modest rise since the year before.
- Energy-intensive manufacturing and the category "other industry" are the consumer groups where energy use has risen most in the period 1976-2004.
- Transport now accounts for 87 per cent of total oil consumption, as compared with 47 per cent in 1976. Consumption of transport oils is increasing.

Figure 1.2 Number of holdings and average size of agricultural area in use (decares[1]). 1949-2005*

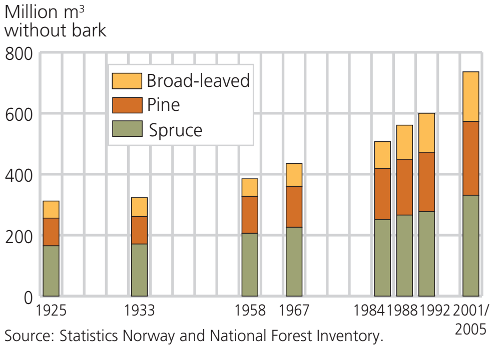


[1] 1 decare = 0.1 hectare.
Source: Agricultural statistics, Statistics Norway.

Agriculture

- In 2005, the agricultural area in use was about 10 400 km². The available land resources (cultivated and cultivable land) total 18 600 km².
- From 1949 to 2005, the available land resources have decreased by over 1 000 km² or 5.2 per cent as a result of the conversion of land for purposes that prevent future agricultural production.
- The number of holdings in Norway has been reduced to about a fourth since 1949; this is equivalent to a loss of 8 holdings a day. Figures for the last few years indicate a rising rate of farm closures. Since 1949, the average size of holdings has almost quadrupled.
- Agricultural production has increased by about 36 per cent from 1970 to 2005. However, production volume has not increased since 1990.
- Agriculture's share of GDP fell from 3.1 per cent in 1970 to 0.5 per cent in 2005.
- Ecological farming increased in all the Nordic countries in the 1990s. Norway, with 4 per cent in 2005, has the lowest percentage, as against 6-7 per cent in the other Nordic countries. In the last two to three years, the area ecologically farmed has remained stable or dropped slightly in Sweden, Denmark and Finland.

Figure 1.3. Volume of the growing stock. 1925-2001/2005

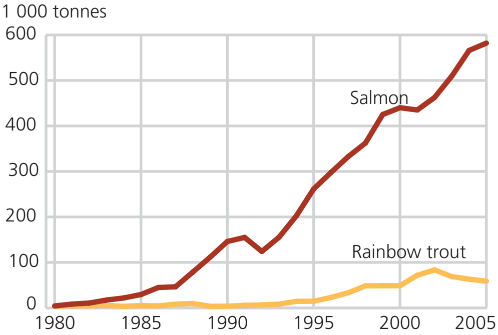


Source: Statistics Norway and National Forest Inventory.

Forest and uncultivated land

- About 125 000 km² (38 per cent) of Norway's area is forested. Of, this, about 75 000 km² is productive forest.
- In 2005, the gross increment in Norwegian forests was almost 26 million m³.
- The increase in the biomass (branches and roots included) of forests in 2004 resulted in an uptake of carbon by forest that corresponded to 24 million tonnes of CO_2 or about 55 per cent of the total anthropogenic CO_2 emissions in Norway.
- Forestry's share of Norway's GDP dropped from 0.78 per cent in 1970 to 0.33 per cent in 2005.
- Crown density is an indicator of the forest's state of health. Decreasing crown density was the trend from the first survey in 1989 until 1997. Since then, crown density of both spruce and pine has improved, with the exception of a small setback for both species in 2005.

Figure 1.4. Fish farming. Volume of salmon and rainbow trout sold. 1980-2005

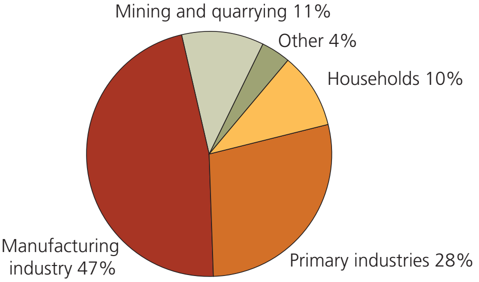


Source: Fisheries statistics, Statistics Norway.

Fisheries and fish farming

- Stocks of several important demersal fish species in the North Sea are still at very low levels. The current fishing pressure is high, but changes are also occurring in the physical environment. At the beginning of 2006, temperatures in the North Sea were very high, about 2 °C above normal.
- Although the size of the spawning stock of Northeast Arctic cod is reasonably satisfactory, fishing mortality (i.e. the proportion of total mortality that is due to fishing) is considered to be too high. Illegal fishing is a serious problem.
- In 2005, salmon production (sold quantity) increased to 582 000 tonnes. Production of trout was about 60 000 tonnes.
- In 2004, Norwegian production of Atlantic salmon accounted for about half the total global production of this species (1.1 million tonnes).
- Over 80 per cent of farmed salmon is exported.
- In 2005, Norway exported fish and fish products to a value of NOK 32 billion. Salmon exports totalled NOK 13.5 billion.
- Fishing, sealing, whaling and fish farming accounted for 0.6 per cent of Norway's gross domestic product (GDP) in 2005.
- At the end of 2005, 14 785 fishermen were registered in Norway. The number of fishermen has dropped by about 88 per cent since the late 1930s.

Figure 1.5. Total water consumption by sector[1]. 2003 or latest year for which figures are available

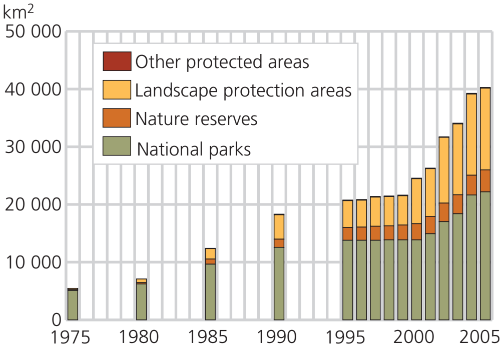


[1] Leakages not included.
Source: Provisional figures from Statistics Norway.

Water resources and water supply

- Only 0.7 per cent of the water resources available each year in Norway is utilised.
- A total of about 3 400 million m^3 of water is used annually in Norway. The largest share, just under 1 600 million m^3, is used in manufacturing. The sectors that utilise most are the metal industry, the chemical industry, refineries and the oil and gas industry.
- In 2004, water production at Norwegian water works was calculated to be 755 million m^3, with households using 41 per cent of this total. About a third of the water produced was lost due to leakages from pipelines and joints.
- Average household water consumption in 2004 is estimated at 205 litres per person per day.

Figure 1.6. Areas protected under the Nature Conservation Act. Whole country. 1975-2005. km²



Source: Directorate for Nature Management (2006).

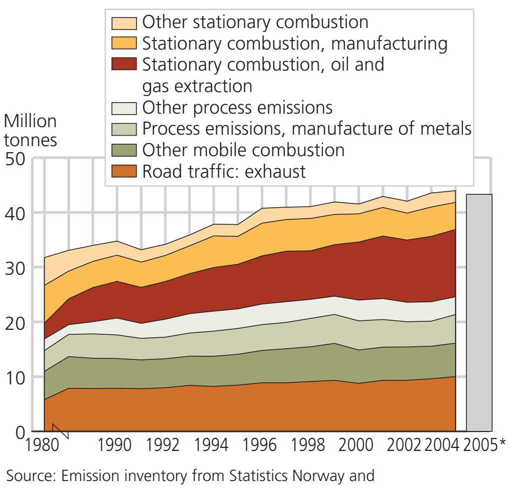
Land and land use

- As of 1 January 2006, protected areas included 25 national parks, 1 753 nature reserves, 159 protected landscapes and 98 other types of protected area. Areas protected under the Nature Conservation Act account for 40 288 km² or about 12 per cent of Norway's total area. The total area protected has risen by 2.6 per cent over the last year.
- As of 1 January 2006, a total of 994 km² of productive forest was protected. This is equivalent to 1.3 per cent of the total area of productive forest.
- 1.4 per cent of Norway's total area is covered by buildings and physical infrastructure.
- Norway has the second lowest population density in Europe after Iceland, with 15 inhabitants per km².
- In 2005, the population living in urban settlements increased by 1.3 per cent. A total of 78 per cent of the Norwegian population now lives in urban settlements.
- As of 1 January 2006, the average population density in Norwegian urban settlements was 1 594 inhabitants per km².
- In the four largest urban settlements, Oslo, Bergen, Stavanger/Sandnes and Trondheim, the population increased by about 25 000 persons, or about 2 per cent, in 2005.

Pollution and environmental problems

The use of natural resources and other economic activity puts pressure on the environment, for example in the form of releases of pollution to air, water and soils. In 2005, oil and gas extraction on the continental shelf accounted for almost one third of Norway's aggregate greenhouse gas emissions. These emissions are currently eight percentage points above its Kyoto commitment level (the maximum average level of emissions for the Kyoto period 2008-2012). If Norway's emissions exceed this level, the country must either take part in emissions trading to acquire emission units or make use of the other Kyoto mechanisms. The total quantities of waste generated in Norway are rising, and household waste generation is increasing most. Strict emission standards and new technology have resulted in large reductions in many of the emissions associated with waste management, and an increasing proportion of the waste is being recovered to provide new raw materials and energy. There has been more focus on water quality in Norwegian inland and coastal waters since the first North Sea Agreement was signed in 1990, and more recently because of the implementation of the EU Water Framework Directive, which lays down standards for water quality that also apply to Norwegian water bodies. In recent years, both Norway and other countries that drain to the Skagerrak and the North Sea basin have invested substantial resources in waste water treatment. The main reason has been that the pollution load in these waters has resulted in eutrophication and periodical algal blooms. These measures have resulted in substantial reductions of the Norwegian discharges of phosphorus and nitrogen to the North Sea since 1985. Since the 1930s, global production of chemicals has risen from 1 million tonnes a year to more than 400 million tonnes. More than 100 000 new substances have been synthesised, in addition to all those that occur naturally. Some chemicals are known to cause serious damage to health and the environment, but our knowledge of the vast majority of substances is incomplete. Ensuring safe handling and use of chemicals has therefore become one of the most important challenges for society.

Figure 1.7. Emissions of CO_2 by source. 1980-2005*

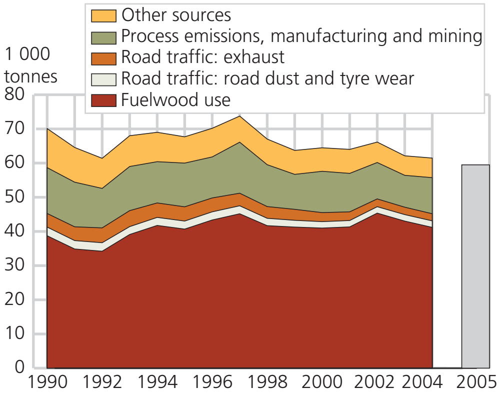


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Air pollution and climate change

- Greenhouse gas emissions in Norway dropped by 1 per cent from 2004 to 2005. The overall rise since 1990, the base year for the Kyoto Protocol, is 9 per cent.
- The increase in emissions after 1990 is mainly due to the growth in emissions from oil and gas-related activities and road traffic. There were several reasons for the decrease in emissions in 2005, but the most important was probably that higher oil prices resulted in lower consumption of heating kerosene and fuel oil. Another important factor was that emissions from industrial processes dropped, partly because of lower production, but also as a result of measures to control pollution.

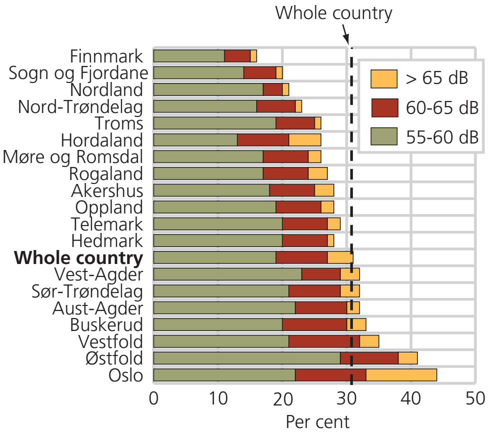
Figure 1.8. Emissions of particulate matter (PM_{10}) to air by source in Norway. 1990-2005*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

- Emissions of greenhouse gases totalled 54.2 million tonnes CO_2 equivalents in 2005. According to Norway's commitment under the Kyoto Protocol, Norway's emissions must not exceed 50.3 million tonnes CO_2 equivalents on average in the period 2008-2012. As a supplement to national emission reduction measures, Norway can make use of the Kyoto mechanisms, for example emissions trading, to acquire further emission units.
- In 2005, CO_2 emissions totalled 43.3 million tonnes. The overall rise since 1990 is 25 per cent. The main reason is a rise in emissions from oil and gas extraction and road traffic.
- In 2005, CH_4 emissions totalled 221 000 tonnes, 3.5 per cent less than the year before, and accounted for 9 per cent of Norway's aggregate greenhouse gas emissions. There has been a 2.7 per cent decrease in emissions since 1990.
- In 2005, N_2O emissions totalled 15 200 tonnes, an increase of 3 per cent from 2004, and accounted for 9 per cent of Norway's aggregate greenhouse gas emissions.
- Total deposition of acidifying substances has decreased by about 60 per cent since 1990. The main reason is a reduction in sulphur emissions in Europe.
- Although total deposition has been reduced, critical loads are still being exceeded in large parts of the southern half of Norway.
- Measured in ODP tonnes, Norway's consumption of ozone-depleting substances has been reduced by more than 99 per cent since 1986. Norway has met all its commitments under the Montreal Protocol and EU targets for ozone-depleting substances.
- Emissions of hazardous substances (heavy metals and several persistent organic pollutants) to air were substantially lower in 2004 than in 1990. The decrease is particularly marked for lead and dioxins.
- Fuelwood use has risen, resulting in higher emissions of several heavy metals and organic pollutants from this source, and also in an overall rise in emissions of certain of these substances in recent years. In addition, fuelwood use accounts for about two thirds of total emissions of particulate matter (PM_{10}) in Norway.

Figure 1.9. Proportion of the population exposed to road traffic noise levels exceeding 55 dBA, by county. 2003*

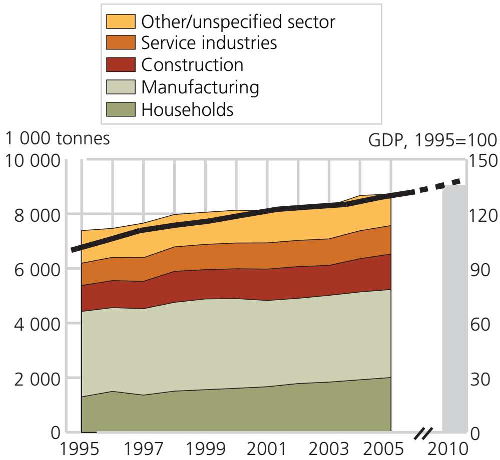


Source: Statistics Norway's noise model and Directorate of Public Roads.

Noise

- About 1.7 million Norwegians are exposed to noise levels exceeding 50 dBA outside their homes, and about half a million of them are annoyed or highly annoyed by noise.
- Five per cent of the population, or well over 200 000 people, have sleeping problems due to noise.
- Road traffic accounted for 78 per cent of noise annoyance in 2003.
- Despite a marked drop in noise annoyance from railways and air traffic, total noise annoyance in Norway rose by two per cent from 1999 to 2003. Noise annoyance caused by road traffic increased during this period because of a rise in the volume of traffic and in the number of people living in areas where there is heavy traffic.

Figure 1.10. Waste quantities in Norway, by source. 1995-2005* and projection 2010. 1 000 tonnes. GDP 1995-2010, index 1995=100



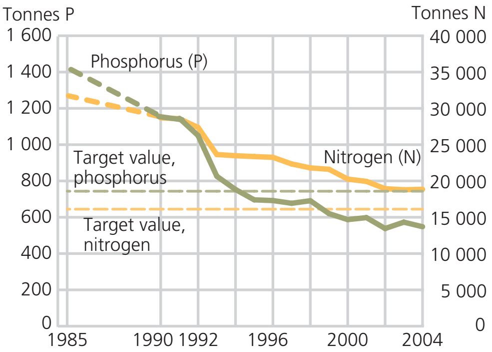
See: http://www.ssb.no/english/subjects/01/05/40/avfregno_en/
Source: Waste accounts and national accounts, Statistics Norway.

Waste[1]

- Preliminary figures from the waste accounts show that about 8.7 million tonnes of waste was generated in Norway in 2005. This is an increase of 18 per cent since 1995.
- In 2005, per capita generation of household waste was 402 kg, 167 kg more than in 1992 and 24 kg more than in 2004.
- Manufacturing waste accounted for 37 per cent of the total in 2005, and construction and demolition waste for 14 per cent.
- The most rapidly-growing fractions are plastics, wet organic waste and textiles, which are largely found in household waste.
- In 2005, 32 per cent of all waste generated was recycled, 14 per cent was incinerated with energy recovery and 19 per cent was landfilled. Treatment/disposal was unknown for 28 per cent of all waste generated.
- In 2005, 69 per cent of all waste for which information on treatment/disposal is available was recovered. In 1995, the recovery rate was 50 per cent.
- In 2004, the total quantity of hazardous waste was at least 900 000 tonnes. Most of the hazardous waste delivered for final disposal is deposited at special landfills for hazardous waste, generally after being stabilised by means of chemical reactions. Some hazardous waste is exported either for final disposal or for material recovery.

[1] New revised figures for the waste accounts have been published since the editing of this publication was completed. There are some substantial changes in the figures for both total waste quantities and certain waste fractions. See: http://www.ssb.no/english/subjects/01/05/40/avfregno_en/

Figure 1.11. Inputs of phosphorus and nitrogen to the North Sea region. 1985-2004

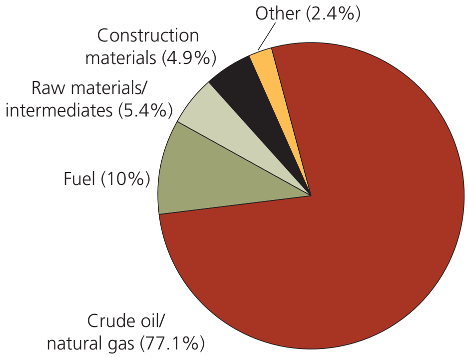


Source: Selvik et al. (2005).

Waste water and water pollution

- In the period 2000-2004, total anthropogenic inputs of phosphorus to the Norwegian coast increased by 10 per cent.
- In 2004, fish farming accounted for 73 per cent of the total inputs of phosphorus and 37 per cent of the nitrogen inputs to Norwegian coastal areas. Agriculture accounted for 39 per cent of the nitrogen inputs.
- Phosphorus and nitrogen inputs to the sensitive North Sea region (from the border with Sweden to Lindesnes) have been reduced by 66 and 42 per cent respectively from 1985 to 2004. This means that the target set for phosphorus in the North Sea Agreements has already been achieved, but that the nitrogen target has not yet been reached.
- Phosphorus inputs from municipal waste water treatment plants (mainly from households) have been reduced by 82 per cent since 1985 and nitrogen inputs by 44 per cent. Phosphorus inputs from agriculture have been reduced by around 38 per cent and nitrogen inputs by 27 per cent. Phosphorus and nitrogen inputs from manufacturing industry have been reduced by 15 and 74 per cent respectively.
- In 2004, waste water treatment plants in the North Sea counties removed on average 93 per cent of the phosphorus and 44 per cent of the nitrogen load processed by the plants. In the rest of the country, treatment efficiency for these nutrients was 39 and 14 per cent respectively.

Figure 1.12. Consumption of hazardous products, by product type. 2004



Source: Product Register 2005.

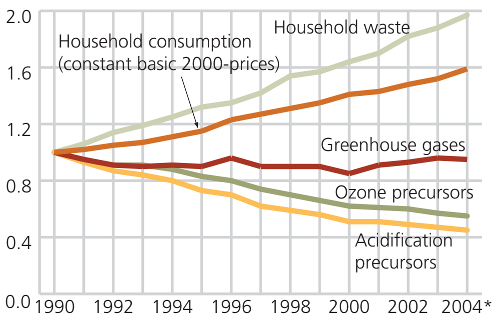
Hazardous chemicals

- Chemicals have become an essential part of modern life. They are used to give products the desired properties - soft or hard, washable or biodegradable, transparent or colourful. They are used in clothes, furniture, electronic equipment and a range of other products. They are also needed in many different industrial processes.
- More than 43 000 different products containing hazardous chemicals were declared to the Product Register in 2004. This is an increase of more than 10 000 products from 2000. However, the increase is partly explained by the introduction of stricter requirements for declaration.
- Consumption of products containing hazardous chemicals totalled more than 100 million tonnes in 2004. Petroleum products such as crude oil, natural gas, fuel oil and autodiesel make up by far the largest category by volume.

Links between environment and economy

The Norwegian Government wishes to maintain economic growth and at the same time reduce the associated environmental pressures. Emission intensity can be reduced either by improving the eco-efficiency of individual industries so that they generate less pollution per unit of value added, or through structural changes in the economy, so that less polluting industries grow at the expense of those that are more polluting. For Norway as a whole, emission intensity for greenhouse gases, acidifying gases and ozone precursors has decreased steadily since 1990. This does not necessarily mean that all industries have become more emission-efficient, but that economic growth has taken place particularly in industries that are less emission-intensive. It is a basic principle of international environmental law that producers should pay for the adverse impacts of their economic activity on the environment (the polluter-pays principle). In Norway, there are currently relatively large discrepancies between how much different industries contribute to the country's total emissions to air and the proportion of environmental taxes they pay.

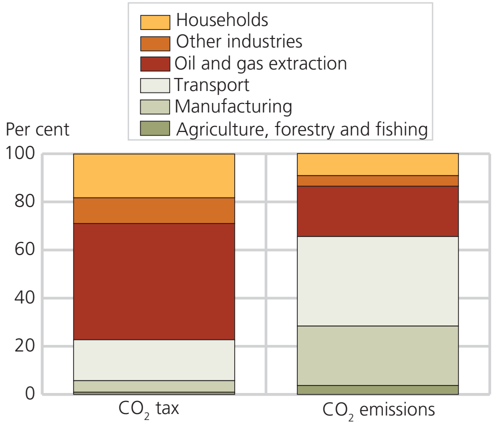
Figure 1.13. Consumption (constant basic prices), solid waste and air emissions. Households. Index: 1990=1



Source: National Accounts and Environment, 1990-2004, Statistics Norway (2006).

- In the early 1990s, the oil and gas extraction industry was becoming more emission-efficient with respect to greenhouse gases, but calculations for the last few years show that this trend is changing. This is primarily because value added has been fairly stable, while emissions of greenhouse gases have continued to rise. Since 2000, there has been a relatively rapid increase in greenhouse gas emissions, which is explained by a rise in energy-intensive production of natural gas relative to oil production.
- Although manufacturing accounts for a large proportion of total greenhouse gas emissions and a relatively low proportion of total value added, calculations show these industries have become more emission-efficient since 1996.
- Household consumption has risen sharply since 1990, while emissions of greenhouse gases, acidifying gases and ozone precursors have decreased. However, generation of household waste has risen faster than consumption throughout the period.

Figure 1.14. CO_2 tax and CO_2 emissions, by sectors. 2001. Per cent



Source: National Accounts and Environment Statistics, Statistics Norway.

- Norwegian firms reported total environmental protection expenditure of NOK 1.57 billion in 2003. This was split between NOK 1.1 billion in environment-related current expenditure, NOK 309 million in investments in end-of-pipe equipment and NOK 165 million in investments in process-integrated technologies such as energy and material recovery.
- In 2004, revenues from environmental taxes amounted to NOK 52 billion and accounted for 6.9 per cent of total tax revenues.
- Energy and transport taxes are the most important environmental taxes in terms of revenue. In 2004, each of these two tax categories accounted for almost 49 per cent of total environmental taxes.
- There are large discrepancies between how much different industries contribute to total pollution levels and the proportion of environmental taxes they pay. For example, the transport industry accounted for 37 per cent of total emissions in 2001, but paid only 17 per cent of the CO_2 tax.

References

Brunvoll, F., J. Monsrud, M. Steinnes and A.W. Wethal (2005): *Samferdsel og miljø – Utvalgte indikatorer for samferdselssektoren* (Transport and environment - Selected indicators for the transport and communication sector). Reports 2005/26, Statistics Norway.

Directorate for Nature Management (2006): http://www.dirnat.no

EEA (2004): *EEA Signals 2004. A European Environment Agency updateon selected issues*. European Environment Agency, Copenhagen.

EEA (2006): *Transport and environment: facing a dilemma - TERM 2005.* European Environment Agency, Copenhagen.

Eurostat (2001): *Environmental pressure indicators for the EU*. European Commission/ Eurostat.

Eurostat (2004): *A selection of environmental pressure indicators for the EU and acceding countries.* European Commission/Eurostat.

Hass, J.L., F. Brunvoll and H. Høie (2002): *Overview of sustainable development indicators used by national and international agencies.* OECD Statistics Working Paper 2002/1, STD/DOC (2002)2, Paris: Organisation for Economic Co-operation and Development.

OECD (1994): *Environmental indicators. OECD core set*, Paris: Organisation for Economic Co-operation and Development.

OECD (1998): *Towards sustainable development. Environmental indicators*, Paris: Organisation for Economic Co-operation and Development.

OECD (2001a): *Environmental indicators. Towards sustainable development*, Paris: Organisation for Economic Co-operation and Development.

OECD (2001b): *Environmental indicators for agriculture.* Volume 3 – Methods and Results, Paris: Organisation for Economic Co-operation and Development.

OECD (2004): *OECD Key Environmental Indicators 2004,* Paris: Organisation for Economic Co-operation and Development.

OECD (2005): *Environment at a Glance. OECD Environmental Indicators 2005,* Paris: Organisation for Economic Co-operation and Development.

Selvik, J.R., T. Tjomsland, S.A. Borgvang and H.O. Eggestad (Norwegian Centre for Soil and Environmental Research) (2005): *Tilførsler av næringssalter til Norges kystområder, beregnet ved tilførselsmodellen TEOTIL2* (Inputs of nutrients to Norwegian coastal areas, calculated using the input-model TEOTIL2). Report No. 5103-2005*,* Norwegian Institute for Water Research.

Statistics Norway (2006): National Accounts and Environment, 1990-2004. Economy grew again more than air emissions. Dagens statistikk (Today's statistics), 22 August 2006. http://www.ssb.no/english/subjects/09/01/nrmiljo_en/

2. Indicators of sustainable development

The Norwegian set of indicators of sustainable development shows that if current trends continue, Norway will face particular challenges related to greenhouse gas emissions, public sector finances and exclusion from the labour market. Norway makes little contribution to global income equalisation through increased trade with the least developed countries.

The indicators also show the importance of managing human resources satisfactorily in order to maintain national welfare. The labour force and its expertise will be the most important source of income in the future.

In December 2003, the Norwegian Government appointed an expert committee that was given the task of developing a set of indicators of sustainable development for Norway. The original set consisted of 16 indicators. The main purpose of the indicators is to provide information that can be used in evaluating and implementing the Government's action plan for sustainable development, its National Agenda 21. The indicator set focuses on the most important economic, environmental and social issues and the links between them. In 2005, the Ministry of Finance (the body responsible for coordinating the sustainable development effort in Norway) conducted a public consultation on the indicator set, and as a result a revised set of indicators was presented in the 2006 National Budget. There were relatively few changes: two new indicators were proposed and one of the original indicators was replaced by another, so that the set now consists of 18 indicators. At the same time, the Ministry pointed to the need for further development and improvement of the indicators, and particularly of the underlying data for some of them.

2.1. The set of indicators

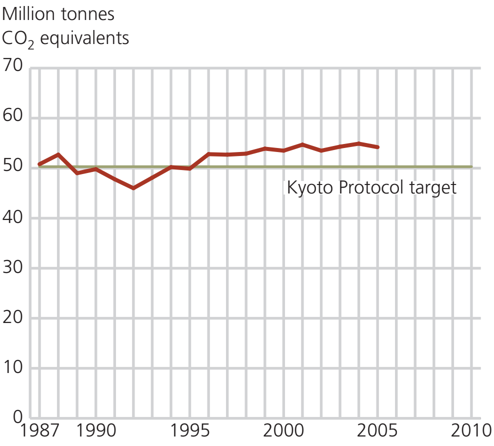
Climate change

Indicator 1: Norwegian emissions of greenhouse gases compared with the Kyoto target
Concentrations of greenhouse gases in the atmosphere are rising as a result of human activity. The most important reason for this is emissions of carbon dioxide (CO_2) from combustion of fossil fuels, which have already resulted in the highest CO_2 concentrations in the atmosphere for at least 650 000 years (Brook 2005), maybe for several million years. As concentrations of greenhouse gases rise, the atmosphere retains more of the thermal radiation from the earth, which causes the global mean temperature to rise and result in climate change. This phenomenon is called the anthropogenic greenhouse effect.

The report *Impacts of a Warming Arctic* (ACIA 2004) drew attention to the fact that in the past few decades, the temperature increase in the Arctic has been nearly twice as fast as in the rest of the world. Climate change will have far-reaching effects on the environment, resources, society and economy. Not all the effects will be negative, but dealing with them may nevertheless pose major challenges.

Seen on a global scale, 1998 was the warmest year registered since records began in 1850, while 2005 was the next warmest with an average temperature 0.46 °C above normal. The annual mean temperature in Norway in 2005 was 1.5 °C above average, making it the sixth warmest year since the Norwegian Meteorological Institute started measurements in 1867. The warmest year recorded in Norway is 1990, with an average temperature 1.8 °C above normal (Norwegian Meteorological Institute 2006).

Figure 2.1. Norwegian emissions of greenhouse gases compared with the Kyoto Protocol target. 1987-2005. Million tonnes CO_2 equivalents



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

- In 2005, Norwegian greenhouse gas emissions decreased by 700 000 tonnes, or 1 per cent. Nevertheless, the overall rise since 1990, the base year for the Kyoto Protocol, is 9 per cent (4.5 million tonnes CO_2 equivalents).
- There were several reasons why emissions decreased in 2005, but two in particular stand out. *Firstly*, the consumption of fuel oils and heating kerosene was considerably lower than the year before. Sales of fuel oils dropped by 25 per cent in 2005. This was probably because many users in the manufacturing industries, households and other sectors switched from oil to electricity for heating purposes in response to higher oil prices. The preliminary energy balance for Norway shows that electricity consumption rose by 2 per cent in 2005 and reached the highest level ever recorded.

Secondly, there was a drop in emissions from industrial processes. This was mainly because of lower production in several branches of industry that generate large greenhouse gas emissions. In addition, a parts of the process industry have introduced measures to reduce emissions that have had an effect over the past 10 years, and from 2004 to 2005. Although there has been an overall reduction in emissions from industrial processes, both production and emissions have increased in certain industries. The preliminary figures indicate for example that aggregate greenhouse gas emissions from aluminium production rose in 2005, but that emissions per unit produced were reduced.

Although greenhouse gas emissions from certain sources decreased somewhat in 2005, there is no evidence that this is the beginning of a downward trend. Emissions from road traffic have risen almost every year since 1990, and the increase is expected to continue. Emissions from the oil and gas industry are also expected to rise considerably in the years ahead, since gas production has not yet reached its peak. In fact, in *Facts 2006 – The Norwegian petroleum sector*, published in April 2006, the Norwegian Petroleum Directorate and the Ministry of Petroleum and Energy predict a marked rise in CO_2 emissions from the petroleum sector in 2006.

As of 18 April 2006, 163 countries had ratified the Kyoto Protocol. Of these, 36 industrialised countries including Norway have an assigned amount of emissions for the period 2008-2012. If their emissions exceed their assigned amounts, they must make use of the Kyoto mechanisms, which include emissions trading with other industrialised countries and financing approved projects to reduce emissions in developing countries (this is called the Clean Development Mechanism, CDM).

In 2006, Norway is required to submit its initial report under the Kyoto Protocol. The report will provide the final figures for calculating Norway's assigned amount for the commitment period 2008-2012, based on the emission inventory compiled by Statistics Norway and the Norwegian Pollution Control Authority. The assigned amounts are to be calculated using emission figures for 1990 as a basis, and Norway's aggregate greenhouse gas emissions in 1990 were 49.8 million tonnes CO_2 equivalents. This means that Norway's emissions for the whole commitment period must be limited to 251.5 million tonnes CO_2 equivalents (49.8 million tonnes * 1.01 * 5), and Norway can comply with this either by reducing its own emissions or by making use of the Kyoto mechanisms.

Norway has established a national emissions trading system. The Act relating to greenhouse gas emission allowance trading and the duty to surrender emission allowances (Greenhouse Gas Emission Trading Act) entered into force on 1 January 2005. According to the Norwegian Pollution Control Authority, all the 32 installations to which the scheme applied in 2005 complied with their obligations. Emissions from these installations totalled 5.66 million tonnes CO_2. This was four per cent less than the CO_2 emission allowances allocated to these installations (Norwegian Pollution Control Authority 2006b).

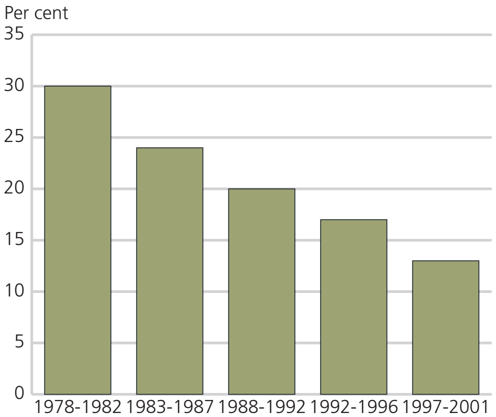
Long-range air pollution: Acidification

Indicator 2: Percentage of Norway's land area where critical loads for acidification have been exceeded

Acid rain is still a serious environmental problem in Norway, even though reductions in emissions have reduced the extent of acidification. Acid rain is caused by emissions of sulphur and nitrogen compounds to air. These compounds can be transported over long distances, and emissions from other countries in Europe account for about 90 per cent of acid deposition in Norway. The southern half of the country is particularly seriously affected by acid rain, because inputs of acidifying compounds are highest here, soils are thin and the bedrock consists of acidic rock types such as gneiss and granite, so that critical loads for acidification are low. Parts of eastern Finnmark also show the impacts of acid rain.

The Gothenburg Protocol, which entered into force in 2005, sets emission ceilings for four gases, to be achieved by 2010. Three of these, NO_X, SO_2 and NH_3, are acidifying substances. Norway has not succeeded in reducing emissions of nitrogen oxides to any great extent since 1990, and these emissions must be reduced by 60 000 tonnes, or on average 12 000 tonnes per year from 2006 to 2010, to reach the target in the Gothenburg Protocol. Norwegian SO_2 emissions have been more than halved since 1990, but some further reduction is needed to reach the 2010 target. Norway's ammonia emissions are just below the emission ceiling.

Figure 2.2. Percentage of Norway's land area where critical loads for acidification are exceeded



Source: Norwegian Institute for Water Research

- At the beginning of the 1980s, critical loads were exceeded across 30 per cent of the total area of Norway. Since then, the pollution load has been reduced, and in 2000, this figure was down to 13 per cent of the total area of Norway. If all countries meet their commitments under the Gothenburg Protocol, it will drop further to about 7 per cent. Thus, there is still expected to be some fish mortality and damage to fish stocks. However, liming programmes can help fish stocks to become re-established in rivers and lakes where critical loads are exceeded.
- No newer data are available for this indicator at present.

Inputs of sulphur and nitrogen to Norway have dropped with the emission cuts that have been achieved elsewhere in Europe. In 1980, sulphur deposition in Norway totalled 191 000 tonnes, while in 2003 the figure had dropped to 62 000 tonnes. This is a reduction of just over 65 per cent. Total nitrogen deposition (the sum of oxidised and reduced nitrogen) has dropped from 173 400 tonnes in 1980 to 104 000 tonnes in 2003, which corresponds to a 40 per cent reduction (Norwegian Pollution Control Authority 2006a).

In its annual report for 2004 on monitoring of long-range transport of pollutants, the Norwegian Institute for Air Research (2005) noted that the concentration of sulphur in air has never been lower since measurements started in 1973. According to the 2005 report (Norwegian Institute for Air Research 2006), concentrations of strong acid, sulphate, nitrate and ammonium in precipitation in 2005 were somewhat higher than in 2004, but the same as or lower than in 2003.

The Norwegian Pollution Control Authority's report summarising the results of all the monitoring programmes for long-range transport of pollutants (Norwegian Pollution Control Authority 2006c) confirms the impression of the past few years that concentrations of acidifying substances are beginning to level off. Although concentrations of these substances in fresh water are lower than they have ever been since the monitoring programmes were started in 1980, there is less improvement from one year to the next than before.

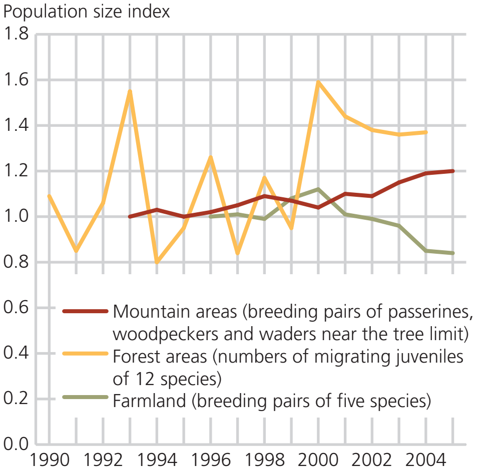
In conclusion, acidification has been considerably reduced, but it should be remembered that this is easier to deal with than a problem such as climate change. It is a relatively straightforward matter to reduce acidifying emissions, for example by introducing equipment to control emissions, but large cuts in greenhouse gas emissions will require much more far-reaching changes.

Biodiversity: Terrestrial ecosystems

Indicator 3: Bird population index - Population trends of nesting wild birds

Trends in bird populations are considered to give a good indication of the state of their habitats. Birds represent different levels in the food chain, they are known to respond to relevant threat factors, and they are widely found in all habitats.

Figure 2.3. Population trends of nesting wild birds. Index



Source: Directorate for Nature Management. Based on preliminary and incomplete data.

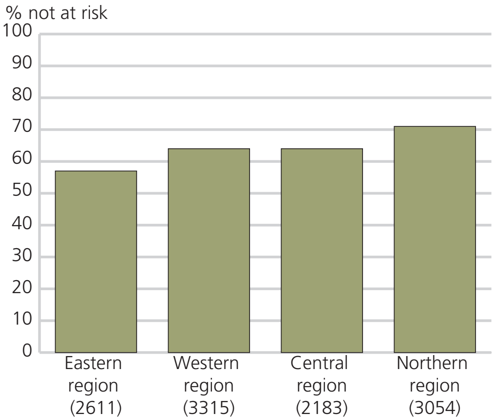
- In mountain areas, populations of nesting birds have increased. This trend is expected, given a warmer climate and a denser mountain forest. The figures for forest birds show large variations from year to year and no clear trend. The variations may reflect real fluctuations in populations, but could also be a result of the data collection method. Population trends are also uncertain in agricultural areas.
- The three data series shown are all based on incomplete data and are not representative of the country as a whole. This indicator needs further development to obtain better and more representative data. A monitoring system that is intended to provide representative data from the whole country is being developed.

Biodiversity: Fresh-water and coastal ecosystems

Indicators 4 and 5: Inland water bodies and coastal waters classified as «clearly not at risk»

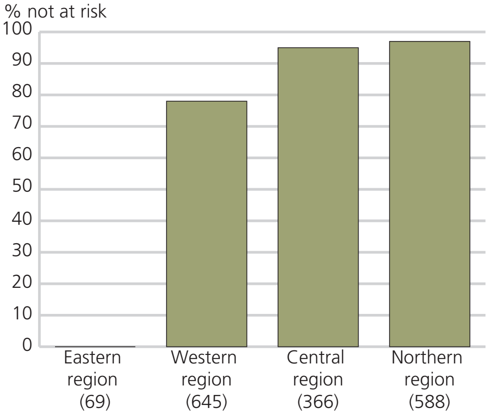
The choice of indicators for aquatic ecosystems is based on recommendations from the Directorate for Nature Management. These indicators are clearly policy-relevant, as they are related to the EU water framework directive. According to the directive, inland water bodies and coastal waters are to be classified by ecological status in five categories: high, good, moderate, poor and bad. Each member country must develop classification methods and monitoring systems.

Figure 2.4. Percentage of inland water bodies in Norway classified as «clearly not at risk». By region[1]. 2004



[1] Number of localities investigated is given in parentheses.
Source: Directorate for Nature Management and Norwegian Pollution Control Authority.

Figure 2.5. Percentage of coastal waters classified as «clearly not at risk». By region[1]. 2004



[1] Number of localities investigated is given in parentheses.
Source: Directorate for Nature Management and Norwegian Pollution Control Authority.

- Most inland water bodies and coastal waters in Norway are considered to be “clearly not at risk”. This is particularly clear in the more sparsely populated northern, central and western parts of the country.
- The situation is less satisfactory in the eastern part of the country, especially in coastal waters. Here, none of the water bodies have been categorised as “clearly not at risk”. However, these are preliminary results, and a number of the water bodies whose ecological status is uncertain will probably be classified as “good” after further assessment.

Cultural heritage

Indicator 6: Standards of maintenance of protected buildings

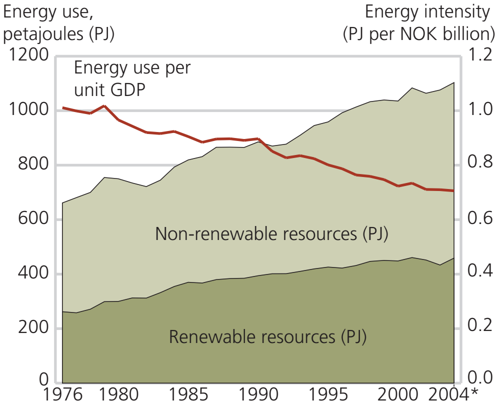
This indicator is intended to measure how well Norway is looking after its heritage. Data on standards of maintenance of protected buildings are being compiled. As of July 2006, complete data were available for privately-owned protected buildings in the counties of Akershus and Nordland. Surveys of a further 10 counties are to be completed by the end of 2006. From 2007, it will be possible to start reporting on trends in standards of maintenance of protected buildings. The Directorate for Cultural Heritage plans to obtain complete data for the whole of Norway by 2008.

Natural resources: Efficiency in resource use

Indicator 7: Energy use per unit GDP

In a modern society, energy is an essential input factor, and regardless of the energy source used, energy production and use have some kind of impact. Efficient use of energy is therefore particularly important in the context of sustainability.

Figure 2.6. Energy use per unit GDP[1] and total energy use (PJ) for renewable and non-renewable energy sources. 1976-2004



[1] GDP at constant 2002 prices.
Source: Statistics Norway.

- Except for brief periods around 1980 and 1990, value added (measured as GDP) in the Norwegian economy has grown more strongly than domestic energy use, although energy use has also increased substantially. Thus, energy intensity has decreased. International statistics show a similar trend in other OECD countries. A reduction in energy intensity is not necessarily a result of greater energy efficiency in the form of energy savings, since energy efficiency also depends on other factors, including the country's industrial structure. Structural changes are an important factor behind the observed reduction in energy intensity, together with market conditions, greater productivity and technological progress (Bøeng and Spilde 2006).
- From 1976 to 2004, energy use increased by 67 per cent. For the period as a whole, renewable energy use has risen slightly more than non-renewable energy use. However, GDP grew by 139 per cent in the same period, so that energy use has become considerably more efficient relative to value added in this period.

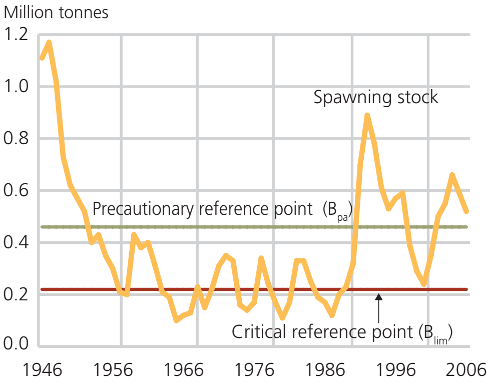
Despite the improvement in energy efficiency, energy use is continuing to rise. Given that a substantial proportion of energy use is based on fossil fuels, this is a problem, particularly in the context of global climate change.

Natural resources: Management of renewable resources

Indicator 8: Spawning stock biomass and precautionary (B_{pa}) reference point for Northeast Arctic cod.

Fishing has been an important basis for settlement and economic activity throughout Norway's history. Sustainable management of fish resources means that they must not be so heavily exploited that there is a danger of poor recruitment to the stocks. Without sufficient recruitment, there is no basis for long-term, sustainable harvesting of these resources.

Figure 2.7. Spawning stock biomass and critical (B_{lim}) and precautionary (B_{pa}) reference points for Northeast Arctic cod. 1946-2006



Source: Institute of Marine Research and ICES.

- The stock of Northeast Arctic cod is managed jointly by Norway and Russia. The TACs (total allowable catch) are now set according to new rules. Briefly, a three-year horizon has been adopted for the TAC levels, there are rules for how much the TAC can vary in this period, and rules for how the TAC is to be set in relation to spawning stock size and fishing mortality.
- The spawning stock of Northeast Arctic cod was about 520 000 tonnes in 2006, which is slightly above the precautionary level. Earlier maturation is an important reason for the rise in spawning stock biomass since 2000.

The critical reference point (B_{lim}) for the spawning stock is considered to be a danger level below which there is a high probability of poor recruitment. The level is defined on the basis of historical stock data and current theories on the dynamics of fish stocks. The precautionary reference point (B_{pa}) is somewhat higher, and can be interpreted as a warning level: if a spawning stock falls below this level, the authorities should consider taking steps to allow the stock to recover to a higher and safer level in order to ensure that the fishery is sustainable.

Although the size of the spawning stock is reasonably satisfactory, fishing mortality (i.e. the proportion of total mortality that is due to fishing) is higher than intended. The Advisory Committee on Fishery Management under ICES has therefore recommended a TAC of 309 000 tonnes for 2007 (162 000 tonnes lower than the TAC adopted for 2006). If this TAC is accepted, the harvesting level will not exceed the precautionary level. According to the ACFM, the TAC calculated using the new management rules is 366 000 tonnes, but given that there is considerable illegal fishing, this level is too high to protect the stock and provide a sustainable yield. Measures to halt illegal and unreported fishing are needed.

It is estimated that unreported catches in 2005 totalled 166 000 tonnes, after remaining at about 100 000 tonnes for several years.

Natural resources: Management of land resources

Indicator 9: Irreversible losses of biologically productive areas

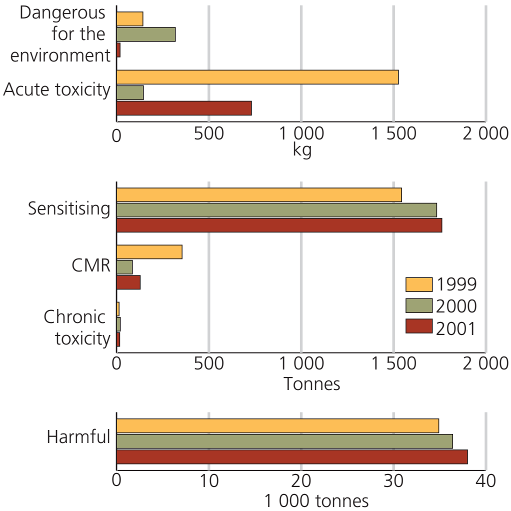
The committee appointed to develop the set of indicators identified productive areas as a critical resource (Official Norwegian Report 2005:5), but found that the data available was insufficient to provide a satisfactory indicator of irreversible losses of biologically productive areas. The 2006 National Budget included a proposal for Statistics Norway and the Norwegian Forest and Landscape Institute to cooperate on the development of this indicator, using studies currently in progress as a basis. However, as of August 2006, the necessary data for this indicator was still not available.

Hazardous substances

Indicator 10: Household consumption of hazardous substances

In recent years, there has been growing awareness of the links between exposure to hazardous substances and injury to human health. Since the discovery in the mid-1960s of the damage that was being caused to bird populations by DDT pollution, research has shown that releases of many chemicals cause environmental damage. From a sustainable development perspective, this knowledge should have clear consequences for the way society responds to the emissions and use of hazardous substances.

Figure 2.8. Household consumption of hazardous chemicals, by danger categories[1,2,3]. 1999-2001



[1] Some products are classified in several danger categories, but are only included in one category in the statistics.
[2] CMR = Carcinogenic, mutagenic or reprotoxic.
[3] Household products are defined as products registered for private use, and in addition some products used in building and construction and other personal services.
Source: Finstad and Rypdal 2003.

- Consumption of products containing carcinogenic, mutagenic and reprotoxic substances dropped by more than 60 per cent from 1999 to 2001. The main reason for this was a cut in consumption by the textile industry due to new technology and the introduction of a tax on perchloroethylene in cleaning products. On the other hand, the consumption of products containing sensitising substances rose by 14 per cent in the same period. This was mainly because of a rise in the consumption of paints and varnishes and of cleaning products that are classified as sensitising.
- Consumption of products that can have chronic effects or are classified as acutely toxic or as dangerous for the environment is low, and there are few products in these groups.
- The largest quantities of hazardous substances that households are exposed to are classified as "Harmful". This group includes products that may cause damage because they contain solvents, substances that are corrosive or irritant, etc. Total consumption of such products in 2001 was 38 000 tonnes, an increase of 9 per cent in the three-year period from 1999.

It was emphasised both by the expert committee that developed the original set of indicators and during the public consultation process that more indicators should be developed for this priority area, especially indicators of levels of environmentally hazardous substances in living organisms and of the impacts on human health and the environment. Statistics Norway, in cooperation with the working environment and environmental authorities, is developing an indicator based on the quantities of hazardous substances sold in the period 2002-2004. Later in 2006, this indicator will be updated using figures for quantities sold in 2005. To increase the relevance of this new indicator, the effect of applying correction factors to the sales figures is being tested. These are intended to provide an estimate of the exposure of people and the environment to different hazardous substances.

Sustainable economy: Sources of income

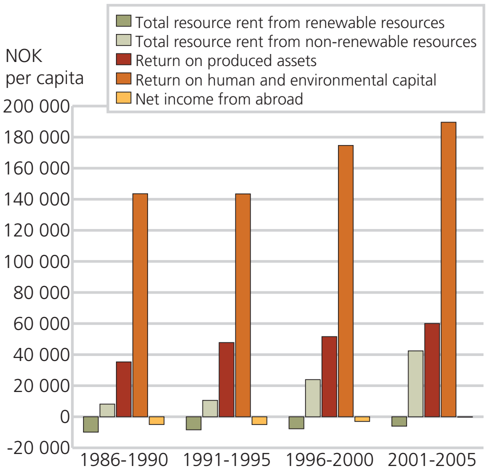
Indicator 11: Net national income per capita, by sources of income

Norway's national wealth is an expression of the total value of national resources, and consists of human capital, natural capital, real capital and net foreign assets. Maintenance of Norway's national wealth is an essential but not a sufficient basis for sustainable development. However, if national wealth is stable and increasing, this is an indication that the country is following a sustainable path of development, whereas the opposite would be an indication that sustainable development is in jeopardy.

Norway's net national income (NNI) may be regarded as the market-based return on our national wealth. The return on produced assets, net income from abroad and the resource rent from market-priced renewable and non-renewable natural resources are calculated on the basis of figures from the national accounts.

Variations in NNI over time may be an indication of changes in national wealth, although more short-term fluctuations in income are often a result of changes in capacity utilisation.

Figure 2.9. Net national income per capita, by sources of income



Source: Statistics Norway.

Methodology and results of national wealth calculations were documented in Greaker et al. 2005.

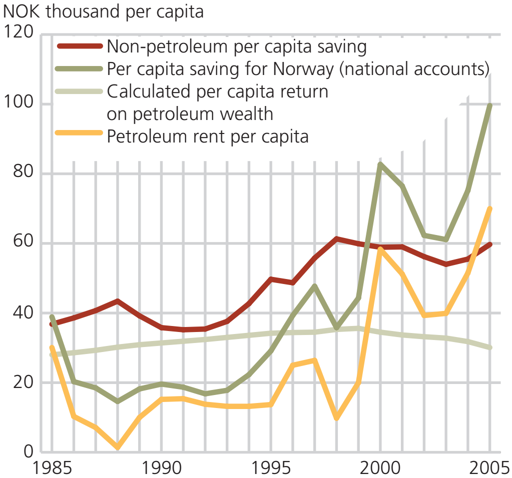
- The indicator shows that human capital and environmental capital are of the utmost importance for our economic welfare, and their importance has been increasing since 1986. Human capital should be understood as the entire contribution from the labour force: this includes actual labour provided, i.e. hours actually worked, and the educational level of the workforce, i.e. the quality of the labour provided (Løkkevik and Greaker 2005). Environmental capital includes, in principle, all non-market-based functions of the environment, such as the provision of clean water and air, recipient functions, biodiversity, etc.
- The exploitation of non-renewable resources, mainly oil and gas, has become increasingly important since 1985, and is now approaching the return on produced assets.
- The resource rent from the primary industries agriculture, forestry and fisheries, has been negative, mainly as a result of subsidies to agriculture. However, the size of the deficit has decreased during the period from the mid 1980s.

Sustainable consumption

Indicator 12: Non-petroleum saving

Are we consuming too much? Or to be more precise: has the Norwegian population consumed more during one year than we had reason to believe could be sustained over time? If the answer is yes, the level of consumption can in a sense be defined as unsustainable. The indicator "Non-petroleum saving" is intended to answer this question, even though several important aspects of consumption are not included. Non-petroleum saving is calculated as Norway's disposable income minus consumption and the resource rent from petroleum activities, plus the calculated return on the remaining petroleum wealth.

Figure 2.10. Non-petroleum saving. 1985-2005. NOK 1 000 per capita at constant prices (2005 NOK)



Source: Ministry of Finance and Statistics Norway.

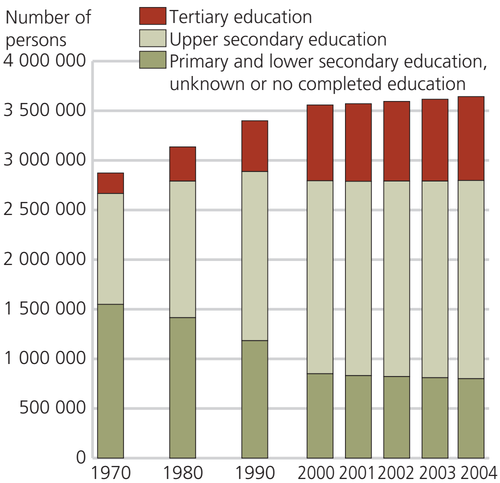
- Non-petroleum saving has been positive in the whole period under consideration. In economic terms, consumption in Norway seems therefore to have remained at a sustainable level. Per capita non-petroleum saving is estimated at close to NOK 60 000 in 2005.
- Figures for the return on our remaining petroleum wealth are based on expectations and are therefore uncertain. However, it should be noted that saving would have been positive throughout the period even if this return had been disregarded, i.e. if non-petroleum saving had been defined simply as saving minus the resource rent from petroleum activities.

Level of education

Indicator 13: Population by highest level of education completed

The level of education in the population may be regarded as an indicator of the supply of qualified labour for the public and private sectors. The OECD report The Well-being of Nations states that “Education, training and learning can play important roles in providing the basis for economic growth, social cohesion and personal development.”

Figure 2.11. Population (age 16 years and more) by highest level of education completed. 1970-2004



Source: Statistics Norway.

- The level of education of the Norwegian population has increased considerably over the last 30 years. In 1970 about 7 per cent of the population had a university-level qualification (tertiary education). By 2004, this had increased to 24 per cent - an increase of 17 percentage points during the last 34 years. During the last 21 years of the period (1983-2004), the number of people with a doctorate has almost quadrupled (from 3 569 to 14 401 persons).
- At the other end of the scale, the share of people with only primary and lower secondary education has decreased by over 30 percentage points since 1970.
- Today we find the highest level of education among young women. More than 40 per cent of women aged 25-39 years have completed a tertiary education. The corresponding figure for males is a little over 30 per cent.

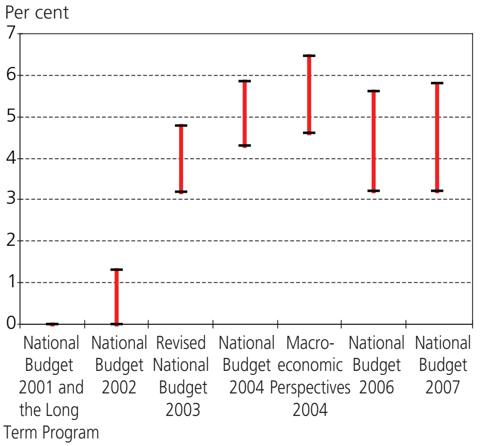
Sustainable public finances

Indicator 14: Generational accounts: Need to reduce public sector finances as a share of GDP

In Norway, the public sector plays an important role for total welfare, by facilitating economic activity in the private sector, providing basic educational health and social welfare services, and by maintaining an extensive social security system. The expenses for these systems must, over time, be financed within the limits of total public revenues.

The generational accounts are an indicator of whether today's financial policy is sustainable in the long term. For this to be the case, the current value of public sector revenues must correspond to the current value of public sector expenditure.

Figure 2.12. Generational accounts: need to reduce public finances as a share of GDP



[1] The need to reduce public sector finances is given as an interval, since calculations have been made on the basis of various assumptions concerning real wage growth.
Source: Ministry of Finance.

- The need to tighten public finances, as estimated in the generational accounts, has increased over time, partly as a result of altered assumptions concerning future developments in life expectancy. In addition, petroleum revenue spending has increased considerably, and expenditure on the national insurance scheme and on health and social services has risen more sharply than other expenditure. The substantial rise in the numbers of elderly people in the years ahead will have an adverse impact on generational balance. On the hand, the increase in the government's net cash flow from petroleum activities in the past few years has helped to restore the balance.
- The latest estimates in the 2007 National Budget (Report No. 1 (2006-2007) to the Storting) indicate a reduction in the order of NOK 50-90 billion. This is between 3 ¼ and 5 ¾ per cent of GDP for Mainland Norway.

It should be noted that the generational accounts are only one indicator or method of analysing the sustainability of public finances. Long-term macroeconomic projections (using the MSG model) of key variables in the Norwegian economy can also be used to illustrate future budgetary challenges.

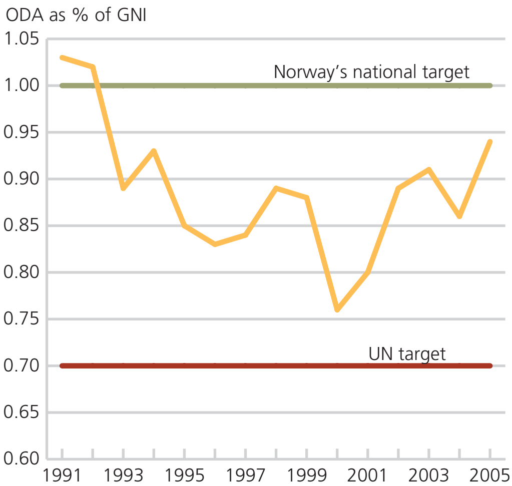
Global poverty reduction: Development assistance

Indicator 15: Norwegian official development assistance as percentage of gross national income

Norway is one of the world's richest countries. The quality of life in Norway and the other Nordic countries is higher than almost anywhere else in the world, as reflected by the Human Development Index published by the UN. However, in today's globalised world, there are strong arguments that the quality of a society should not be judged independently of the contribution it makes to solving global environmental and poverty problems (Barstad 2006).

The effect of development assistance on poverty reduction and economic development is much disputed. The dominant view seems to be that development assistance is effective, but only under certain conditions. It appears to have a poverty-reducing effect in countries with a high level of poverty, but only if a stable economic policy and well-functioning institutions are also in place.

Figure 2.13. Norwegian development assistance as a percentage of gross national income. 1991-2005



Source: Norwegian Agency for Development Cooperation (Norad) and Statistics Norway.

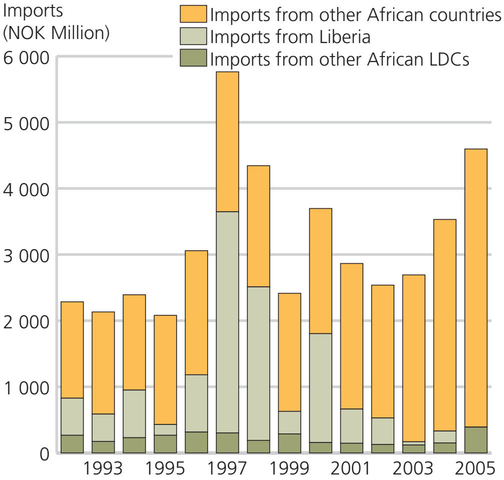
- The UN target is for donor countries to provide 0.7 per cent of gross national income (GNI) as official development assistance (ODA). Norway's national target is to reach 1 per cent of GNI.
- In 2005, Norway contributed over 0.9 per cent of GNI as official development assistance. Thus, Norway has not quite achieved its target, but ODA as a proportion of GNI is higher than in most other OECD countries. Norway's net development assistance rose from NOK 14.8 billion in 2004 to NOK 17.9 billion in 2005. In the same period, GNI rose from NOK 1 724 billion to NOK 1 913 billion.

Global poverty reduction: Trade with least developed countries (LDCs)

Indicator 16: Imports from LDCs and other countries in Africa

If we are to succeed in advancing global sustainable development, the most important tasks will be to resolve environmental problems and reduce poverty. The overriding objective of the UN Millennium Development Goals, adopted in 2000, is the reduction of global poverty. Calculations by the World Bank show that economic growth is vital for poverty reduction. One of the most important means of promoting economic development in developing countries is to give them the opportunity to sell their goods and services to industrialised countries on equal terms with other countries. Other important measures are economic and technical assistance to improve education systems and health services.

Figure 2.14. Imports from LDCs[1] and other countries in Africa. 1992-2005. NOK million



[1] LDCs stands for least developed countries.
[2] Imports for the whole period for the 50 countries defined as LDCs in 2006.
Source: Statistics Norway.

- Although total imports to Norway from developing countries rose from 2004 to 2005 (Statistics Norway 2006c), there has been little change in trade with least developed countries (LDCs) as defined by the Norwegian Agency for Development Cooperation (Norad).
- Imports from Africa make up only a small percentage of total imports to Norway, accounting for 2 per cent of the total in the mid-1990s. Since then, imports from Africa have fallen to below 1 per cent of total Norwegian imports. Imports from LDCs in Africa other than Liberia have been very modest and fairly stable throughout the period 1992-2003, and accounted for only 0.01 per cent of Norway's total imports in 2005.

Liberia is classified as an LDC. Norwegian imports from African LDCs have been dominated by imports of second-hand ships from Liberia, which must be seen in the context of Norwegian shipowners' use of the international ship register in Liberia. In 2005, imports from Liberia were very modest, and imports from African LDCs were dominated by the import of crude oil from Equatorial Guinea valued at close to NOK 200 million.

In 2005, Norway's imports from LDCs totalled NOK 890 million, or 0.2 per cent of its total imports. Of this, NOK 390 million, or 44 per cent, came from LDCs in Africa (34 countries). Imports from LDCs outside Africa (16 countries) are dominated by imports from Bangladesh. In 2005, these totalled NOK 414 million, more than the value of imports from all African LDCs, and 47 per cent of all imports to Norway from LDCs.

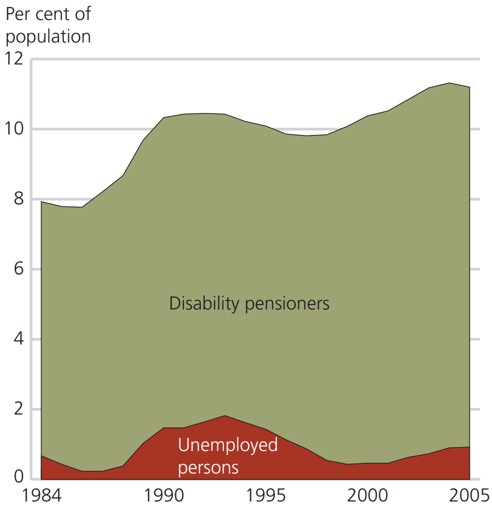
Exclusion from the labour market

Indicator 17: Long-term unemployed persons and disability pensioners as percentage of population

For most people, employment is an important basis for their income and a key to social inclusion. Although unemployment is low in Norway by international standards, the proportion of the population who receive a disability pension is high and rising.

If a large proportion of the working age population is outside the labour market, this may be a serious threat to the maintenance of human capital. In the long term, this may affect the productive capacity of the economy and social stability, and thus the sustainability of society.

Figure 2.15. Long-term unemployed persons and disability pensioners as percentage of population. Age group 18-66 years. 1984-2005



Source: Statistics Norway.

- During the economic downturn at the beginning of the 1990s, a relatively high percentage of adults were excluded from the labour market. This applied both to the long-term unemployed and to disability pensioners.
- There was a temporary decrease in exclusion from the labour market until 1998, but since then the percentage has increased again and reached 11 per cent of the population in 2005. Most people excluded from the labour market are disability pensioners, and they also accounted for most of the rise in total numbers. In 2005, 27 000 people were registered as long-term unemployed and more than 300 000 as disability pensioners. Far more women (172 000) than men (129 000) were registered as disability pensioners. In contrast, more men (16 000) than women (11 000) are registered as long-term unemployed.

Labour force participation, i.e. the proportion of the population aged between 16 and 74 who are in the labour force, rose by 0.2 percentage points from the first quarter of 2005 to the first quarter of 2006. There was a rise for both women and men, and for all age groups except those below the age of 20.

According to the Labour Force Survey, the number of unemployed people was on average 12 000 lower in the first quarter of 2006 than in the first quarter of 2005. The decrease was greatest for men in the age groups 16-24 and 25-54. Unemployed people accounted for 3.8 per cent of the labour force (4.1 per cent for men and 3.8 per cent for women).

The seasonally-adjusted unemployment rate was 4.0 per cent in February 2006, as compared with 4.5 per cent in November 2005. In the same period, the rate in the EU15 area remained unchanged at 7.7 per cent, and the rate in the OECD countries decreased from 6.5 to 6.3 per cent.

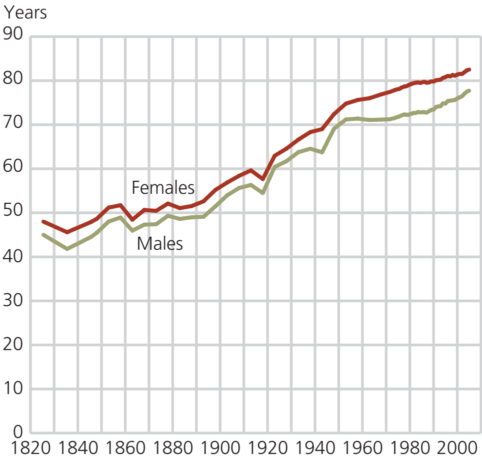
Long-term unemployed people made up 33 per cent of all unemployed in the first quarter of 2006, which is a rise of 9 percentage points from the first quarter of 2005 (Statistics Norway 2006b).

Health and welfare

Indicator 18: Life expectancy at birth

Life expectancy is an indicator that captures a number of factors related to health and social welfare.
Changes in the indicator can indirectly illustrate for example the quality of health services, changes in lifestyle, the quality of people's lives, diet, alcohol and drug abuse, accidents, etc.

Figure 2.16. Life expectancy at birth. 1825-2005



Source: Statistics Norway (2006a) and Brunborg (2004).

- Life expectancy in Norway has been increasing for nearly two hundred years and there is every indication that this trend will continue. In recent years, male life expectancy has been increasing particularly quickly, after levelling off in the 1950s and 1960s. Life expectancy increased by 0.2 years for both sexes from 2004 to 2005, and was the highest ever estimated. Male life expectancy at birth is now 77.7 years, and female life expectancy is 82.5 years. An important cause of this is declining infant and child mortality, but lower mortality in older age groups has also contributed to the increasing life expectancy.
- According to new population forecasts, life expectancy at birth will increase by about 8 years from 2004 to 2060, to 86.0 years for men and 90.1 years for women (Keilman and Pham 2005).
- Thus, population projections from Statistics Norway indicate that the Norwegian population will continue to age, almost regardless of what assumptions are made. Norway will therefore have a permanently higher share of older people in the population and higher pension and social security expenditure than today. This cannot be avoided by, for example, an increase in fertility or net immigration within realistic limits (Brunborg 2004).

2.2. Background and perspectives

In December 2003, the Norwegian Government appointed an expert committee that was given the task of developing a set of indicators of sustainable development for Norway. The main purpose of the indicators is to provide information that can be used in evaluating and implementing the government's action plan for sustainable development, its National Agenda 21. In its report (Official Norwegian Report 2005:5), the committee proposed a set of 16 indicators.

In 2005, the Ministry of Finance, which is responsible for coordinating the sustainable development effort in Norway, conducted a public consultation on the indicator set, and as a result a revised set of indicators was presented in the 2006 National Budget. There were relatively few changes: two new indicators were proposed and one of the original indicators was replaced by another, so that the set now consists of 18 indicators (table 2.1). At the same time, the Ministry pointed to the need for further development and improvement of the indicators, and particularly of the underlying data for some of them.

The set of indicators includes state and pressure indicators for several priority areas defined by the Government and indicators of the state of different components of Norway's national wealth. The policy areas are as follows:

1. Climate, ozone and long-range air-pollution
2. Biodiversity and cultural heritage
3. Natural resources
4. Hazardous substances
5. Sustainable economy
6. Social conditions of direct significance for sustainable development

Table 2.1 shows the relationship between the set of indicators and the policy areas. It should be noted that some indicators may be important explanatory variables for trends in several policy areas. For example, climate change will have considerable impacts on biodiversity, if the climate change has major impacts, this will have far-reaching consequences for economic and social conditions.

In spring 2006, the Ministry of Finance conducted a public consultation in connection with the development of a new national strategy for sustainable development. The results of this process may in the long run have consequences for the set of indicators.

It is a difficult task to determine whether or not development is sustainable, since sustainability is about what will or may happen in the long term, and involves environmental, economic and social issues. Norway has chosen to take the "capital approach" to the development of the indicator set. The reason for this is that our welfare today and in the future may be considered as the return on our total national wealth. This wealth consists of fixed assets such as machinery, tools and buildings, natural resources such as oil, gas, fish, forests and soil, environmental goods such as clean air and water, and last but not least, the labour force, knowledge and expertise that constitute human capital. If we are to succeed in maintaining and preferably improving our welfare in the long term, the national wealth must be conserved or preferably increased. Policies that ensure sound management of the total national wealth are therefore an essential basis for sustainable development.

The national wealth consists of many different components that cannot necessarily be substituted for each other. It is therefore necessary to develop several indicators that can show trends in different components of the national wealth. For example, life expectancy, level of education and exclusion from the labour market are three indicators that illustrate important aspects of the human capital.

A number of serious obstacles to sustainable development are primarily of an international nature. The UN Millennium Development Goals, adopted in 2000, set a number of clear targets including the reduction of global poverty. Norway also has commitments under a number of global and regional environmental agreements. The proposed national indicator set for Norway therefore also includes indicators of Norwegian efforts and pressures exerted by Norway that are related to global challenges.

The indicator set focuses on the most important economic, environmental and social issues and the links between them, so that it can be of direct practical use in policy development.

Table 2.1. Norway's national set of indicators for sustainable development

	Indicators	Policy areas
1	Norwegian emissions of greenhouse gases compared with the Kyoto target	Climate, ozone and long-range air pollution
2	Percentage of Norway's land area where critical loads for acidification have been exceeded	
3	Bird population index - Population trends of nesting wild birds	Biodiversity and cultural heritage
4	Inland water bodies classified as "clearly not at risk"	
5	Coastal waters classified as "clearly not at risk"	
6	Standards of maintenance of protected buildings	
7	Energy use per unit GDP	Natural resources
8	Spawning stock biomass and precautionary (Bpa) reference point for Northeast Arctic cod	
9	Irreversible losses of biologically productive areas	
10	Household consumption of hazardous substances	Hazardous substances
11	Net national income per capita, by sources of income	Sustainable economy
12	Non-petroleum saving	
13	Population by highest level of education completed	
14	Generational accounts: Need to reduce public sector finances as a share of GDP	
15	Norwegian official development assistance as percentage of gross national income	Social conditions of direct significance for sustainable development
16	Imports from LDCs and other countries in Africa	
17	Long-term unemployed persons and disability pensioners as percentage of population	
18	Life expectancy at birth	

Source: National Budget 2006.

More information: frode.brunvoll@ssb.no, phone: +47 21 09 49 35 and julie.hass@ssb.no, phone: +47 21 09 45 15

Useful websites

Norwegian Ministry of Finance: http://www.odin.dep.no/fin/norsk/tema/norsk_okonomi/21/bn.html
UN: http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm
http://unstats.un.org/unsd/mi/mi_goals.asp
EU: http://ec.europa.eu/sustainable/welcome/idea_en.htm
OECD: http://www.oecd.org/topic/0,2686,en_2649_37425_1_1_1_1_37425,00.html
Nordic Council of Ministers: http://www.norden.org/baeredygtig_udvikling/sk/index.asp?lang=3
Denmark: http://www.mst.dk/default.asp?Sub=http://www.mst.dk/tvær/07000000.htm
Finland: http://www.miljo.fi/default.asp?contentid=60941&lan=sv
Sweden: http://www.scb.se/templates/Product____21309.asp
http://www.regeringen.se/sb/d/1591
Switzerland: http://www.monet.admin.ch
UK: http://www.sustainable-development.gov.uk/ http://www.defra.gov.uk/environment/sustainable/index.htm

References

ACIA (2004): *Impacts of a Warming Arctic: Arctic Climate Change Impact Assessment.* Cambridge University Press, 2004. http://www.acia.uaf.edu/

Barstad, A. (2006): *"Verdens beste" også til å redusere global fattigdom.*(*Is Norway a world leader in global poverty reduction as well?*) I: Samfunnsspeilet no. 3/2006, Statistics Norway. http://www.ssb.no/samfunnsspeilet/

Brook, E.J. (2005): Tiny bubbles tell all, *Science,* vol. 310, p. 1285-1287, 25 Nov. 2005.

Brunborg, H. (2004): Befolkningen blir eldre (The population is ageing). *Economic analyses* 5/2004, Statistics Norway.
http://www.ssb.no/emner/08/05/10/oa/200405/brunborg.pdf

Bøeng, A.C. and D. Spilde (2006): Energiindikatorer 1990-2004. Gir økt verdiskapning mer effektiv energibruk? (Energy indicators 1990-2004. Does an increase in value added give more efficient energy use?) *Økonomiske analyser* 3/2006, Statistics Norway.
http://www.ssb.no/emner/08/05/10/oa/200603/boeng.pdf

Finstad, A. and K. Rypdal (2003): Bruk av helse- og miljøfarlige produkter i husholdningene - et forprosjekt (Use of products containing hazardous chemicals in households). Notater 2003/29, Statistics Norway. http://www.ssb.no/emner/01/04/10/notat_200329/notat_200329.pdf

Greaker, M., P. Løkkevik and M. Aasgaard Walle (2005): Utviklingen i den norske nasjonalformuen fra 1985 til 2004. Et eksempel på bærekraftig utvikling? (Norway's national wealth 1985-2004. An example of sustainable development?) Reports 05/13, Statistics Norway. http://www.ssb.no/emner/09/01/rapp_200513/rapp_200513.pdf

Keilman, N. and Pham, D. Q. (2005): Hvor lenge kommer vi til å leve? Levealder og aldersmønster for dødeligheten i Norge, 1900–2060 (How long will we live for? Life expectancy and patterns of mortality in Norway, 1900-2060), *Economic Analyses* 6/2005 (43-49). Statistics Norway.
http://www.ssb.no/emner/08/05/10/oa/200506/folkfram05.pdf

Løkkevik, P. and M. Greaker (2005): Utviklingen i den norske nasjonalformuen fra 1985 til 2004. Menneskelige ressurser gjør Norge rikt.(The Norwegian national wealth 1985-2004. Human resources make Norway a rich country) Magazine, 26 May 2005, Statistics Norway. http://www.ssb.no/vis/magasinet/analyse/art-2005-05-26-01.html

Norwegian Institute for Air Research (2005): Overvåking av langtransportert forurenset luft og nedbør. Atmosfærisk tilførsel, 2004 (Monitoring of long-range transport of polluted air and precipitation, atmospheric inputs, 2004). Report 929/2005 (TA-2102/2005).

Norwegian Institute for Air Research (2006): Overvåking av langtransportert forurenset luft og nedbør. Atmosfærisk tilførsel, 2005 (Monitoring of long-range transport of polluted air and precipitation, atmospheric inputs, 2005). Report 955/2006 (TA-2180/2006).

Norwegian Meteorological Institute (2006): Været i Norge. Klimatologisk månedsoversikt - året 2005. (The weather in Norway. Monthly climatological overview, 2005) Norwegian Meteorological Institute.
http://met.no/observasjoner/maned/2005/2005-aar.html

Norwegian Pollution Control Authority (2006a): http://www.miljostatus.no/.

Norwegian Pollution Control Authority (2006b): http://www.sft.no/kvoteregister/, Norwegian Pollution Control Authority. (http://www.sft.no/english/news/dbafile15082.html)

Norwegian Pollution Control Authority (2006c): Overvåking av langtransporterte forurensninger 2005 - Sammendragsrapport (Monitoring of long-range transport of pollutants 2005. Summary). TA-2183/2006.

OECD (2001): *The Well-being of nations. The role of human and social capital.* Centre for Educational Research and Innovation. Paris: Organisation for Economic Co-operation and Development.

Official Norwegian Report (2005:5): *Enkle signaler i en kompleks verden. Forslag til et nasjonalt indikatorsett for bærekraftig utvikling* (Simple signals in a complex world. Proposal for a national set of indicators for sustainable development). Statens forvaltningstjeneste, Oslo.

Report No. 1 (2003-2004) to the Storting: *Nasjonalbudsjettet 2004.* Kapittel 6: Nasjonal handlingsplan for bærekraftig utvikling (National Budget 2004, Chapter 6: Norway's Action Plan for Sustainable Development). Ministry of Finance. http://odin.dep.no/filarkiv/206402/nat_action.pdf

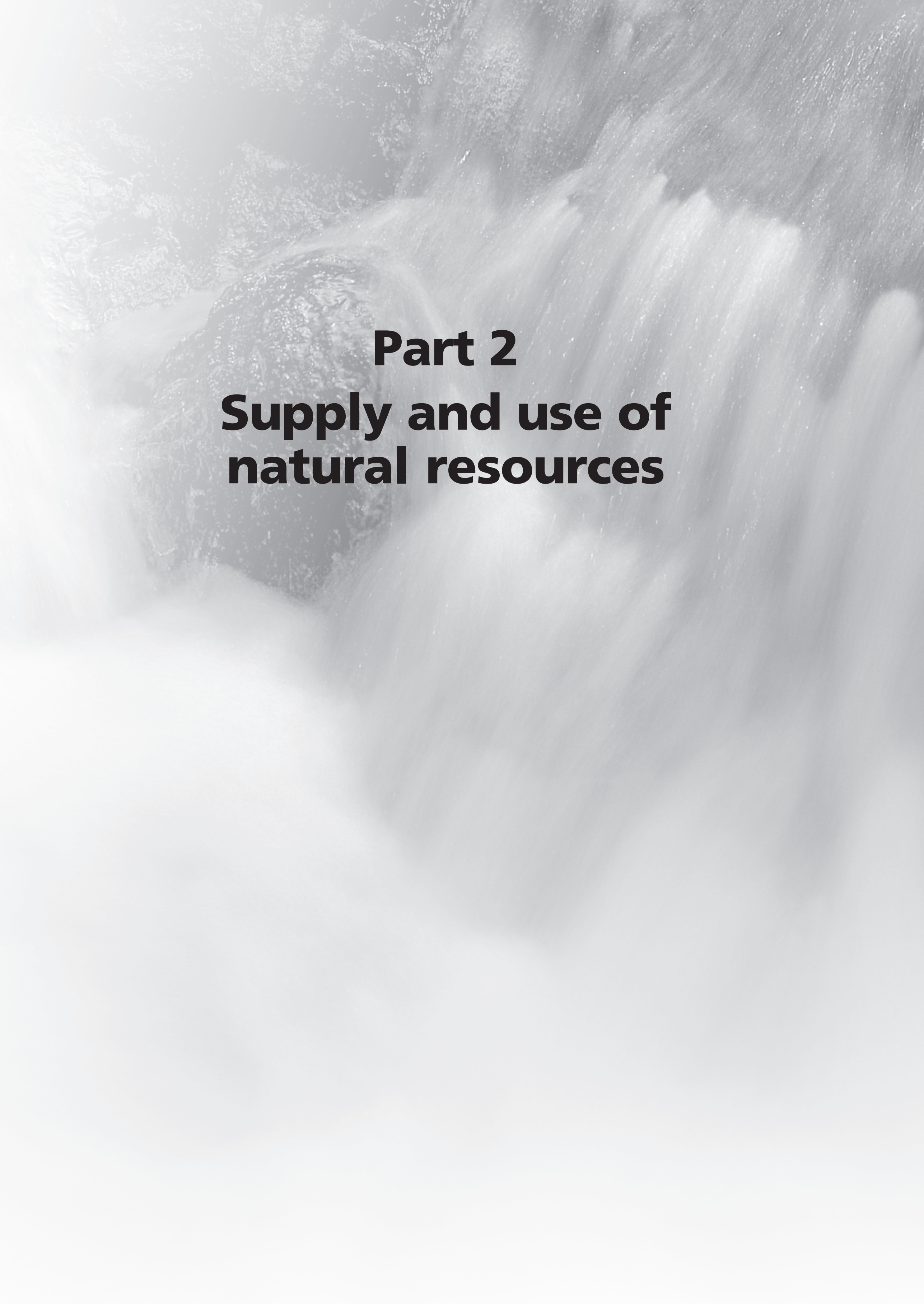
Report No. 8 (2004-2005) to the Storting: *Perspektivmeldingen 2004 – Utfordringer og valgmuligheter for norsk økonomi* (Long-term perspectives for the Norwegian economy). Ministry of Finance.

Report No. 1 (2005-2006) to the Storting: *Nasjonalbudsjettet 2006* (National Budget 2006). Ministry of Finance.

Report No. 1 (2006-2007) to the Storting: *Nasjonalbudsjettet 2007* (National Budget 2007). Ministry of Finance.

Statistics Norway (2006a): Befolkningsstatistikk. Døde, 2005. Levealderen øker fortsatt. (Population statistics. Deaths 2005. Life expectancy still increasing) Dagens statistikk (Today's statistics) 27 April 2006, http://www.ssb.no/english/subjects/02/02/10/dode_en/

Statistics Norway (2006b): Arbeidskraftundersøkelsen, 1. kvartal 2006. 22 000 flere midlertidig ansatte. (Labour Force Survey, 1st quarter 2006. A further 22 000 in temporary employment) Dagens statistikk (Today's statistics) 12 May 2006, http://www.ssb.no/english/subjects/06/01/aku_en/



Part 2
Supply and use of natural resources

3. Energy

Norway has rich energy resources, particularly in the form of oil, gas and hydropower, and energy extraction is far higher than the country's energy consumption. In addition, coal is extracted in Svalbard and Norway has a very high wind power potential. The production, transmission and use of energy cause various pressures on the environment. A large proportion of global air pollution is generated by the combustion of coal, oil and gas.

In 2005, extraction of energy commodities in Norway was about nine times higher than domestic consumption. Most of this is extraction of oil and gas, which accounted for 93 per cent of the total. Given the current rate of extraction, the calculated crude oil reserves on the Norwegian continental shelf will be exhausted in 9 years' time and the gas reserves in 26 years' time. In practice, production will continue for longer than this, since annual production will drop from the current high level. The ratio between reserves and production, called the R/P ratio, changes every year since the lifetime of the remaining resources depends on the rate of extraction, on new finds, on decisions concerning the development of proven fields, and, for fields that are on stream, on improvements in the recovery factor and on the production profile. Norway has 0.8 per cent of the world's oil reserves, but accounted for 3.5 per cent of world oil production in 2005; the corresponding figures for natural gas are 1.3 and 3.1 per cent. The Norwegian reserves are thus being exhausted more rapidly than those in the rest of the world. However, at the end of 2005 only 33 per cent of Norway's total oil and gas resources (which include all estimated volumes of oil and gas), had been recovered, or 50 and 17 per cent respectively of the oil and gas resources.

The high rate of extraction has made oil and gas Norway's largest export commodities. According to the national accounts, petroleum extraction accounted for about 23 per cent of GDP and 50 per cent of Norway's export revenues in 2005, as against 20 per cent of GDP and 46 per cent of export revenues the year before. The increase is explained by rising oil and gas prices. Oil and gas are to a large extent being converted from wealth in the form of natural resource assets to financial assets abroad through the Government Pension Fund.

Hydropower is Norway's other major energy resource, although electricity production from this source corresponded to only about 6 per cent of petroleum extraction in 2005, expressed as energy content. However, hydropower is a renewable energy source, unlike petroleum resources, which are depleted as they are extracted. In 2005, Norway produced 138 TWh of electricity, as against 111 TWh the year before. After having been a net importer of electricity for two years, Norway exported 12.0 TWh more than it imported in 2005. Mean annual production capability when water inflow to the reservoirs is normal is 120 TWh. For most of the period since autumn 2002, the degree of filling of the reservoirs has been below the median level, but it rose during autumn 2005, and reached a maximum of 9 per cent above the median. However, since late winter 2006 reservoir levels have generally been below the median again, and were considerably below this in summer 2006, as a result of a long period of dry weather. In early November 2006, the degree of filling was still 27 per cent below the median level for the period 1990-2005.

Consumption of energy commodities (the energy sector included) increased by 0.5 per cent in 2005. In the last 20-30 years, energy use has grown considerably more slowly than general economic growth (see Chapter 14 on the relationship between environmental pressures and economy).

Energy production and use has major environmental impacts. In 2004, extraction of oil and gas generated 26 per cent of Norway's total greenhouse gas emissions, while consumption of fossil energy commodities in the household, transport and other sectors generated about 57 per cent of these emissions (see Chapter 9 Air pollution and climate change). Hydropower developments in watercourses have a significant impact on biological diversity, the cultural landscape and outdoor recreation. About 58 per cent of Norway's hydropower potential has now been developed or is under construction or licensing. Recently, increasing attention has also been focused on the environmental problems associated with wind power.

3.1. Resource base and reserves

World fossil energy reserves

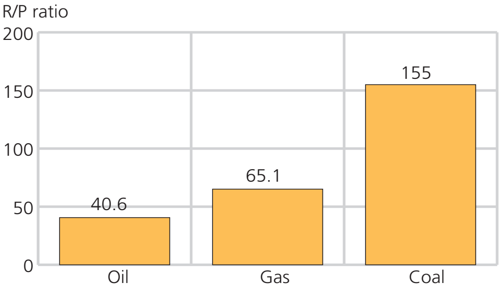
- Reserves are defined here as resources that are fairly certainly recoverable given the current economic and technological framework. There is always some uncertainty associated with estimates of reserves, and there is reason to believe that the quality of the data varies a great deal from country to country. Moreover, assumptions about prices and technology may change over time.
- According to BP (2006), coal reserves can be expected to last for considerably longer than oil and gas reserves at the current rate of extraction (figure 3.1). The Middle East has 62 per cent of the world's oil reserves, and about one third of this is in Saudi Arabia (table 3.1). The Middle East also has 40 per cent of the world's gas reserves, while only about 5 and 4 per cent respectively of the total oil and gas reserves are in North America. However, the US has the largest coal reserves, 27 per cent of the world total. Russia, China, India and Australia also have large coal reserves, and together with the US, these countries have three quarters of the world's total reserves.
- The estimated reserves of oil and gas are higher than at the beginning of 2005. The estimates of coal reserves have not been updated (BP 2006).

Table 3.1. World reserves of fossil energy commodities as of 1 January 2006

	Oil		Gas		Coal	
	Billion tonnes	Per cent	Billion tonnes o.e.	Per cent	Billion tonnes	Per cent
World	**163.6**	**100**	**161.8**	**100**	**909.1**	**100**
North America[1]	7.8	4.8	6.7	4.1	254.4	28.0
Latin America	14.8	9.0	6.3	3.9	19.9	2.2
Europe incl. former Soviet Union	19.2	11.7	57.6	35.6	287.1	31.6
Middle East	101.2	61.9	64.9	40.1	0.4	0.0
Africa	15.2	9.3	13.0	8.0	50.3	5.5
Asia og Oceania	5.4	3.3	13.4	8.3	296.9	32.7
OPEC	123.2	75.3	..	..	..	..
OECD	10.6	6.5	13.5	8.3	373.2	41.1
Norway	1.3	0.8	2.2	1.3	..	..

[1] Including Mexico.
Source: BP 2006.

Figure 3.1. R/P ratio[1] for world reserves of fossil energy commodities as of 1 January 2006

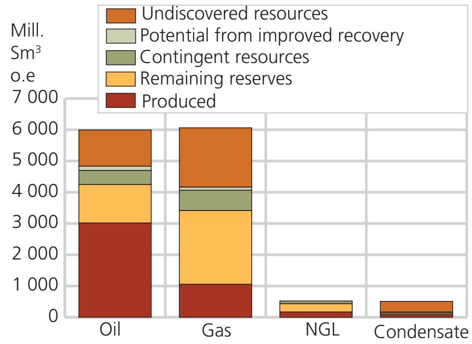


[1] The R/P ratio, or the ratio between reserves and the current annual rate of production, indicates how many years it will take before the reserves are exhausted.
Source: BP 2006.

Norwegian petroleum reserves

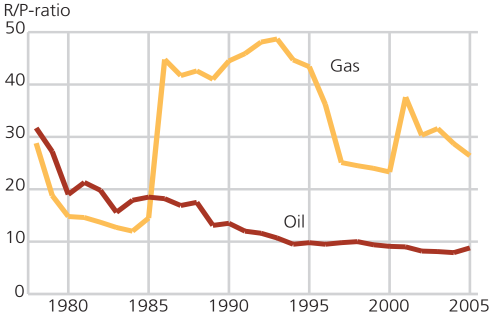
- The Norwegian Petroleum Directorate draws up annual resource accounts for oil and gas. In these, the term *resources* means, in addition to oil and gas that has already been produced, all estimated petroleum deposits - those that are marketable now, those that are not marketable given current technology, and those that have not been evaluated. *Reserves* are defined as the remaining marketable recoverable resources in fields that are already developed or where development has been approved. *Contingent resources* are those for which no decision has been taken on production, and *undiscovered resources* are believed to be present, but have not yet been discovered by drilling. In addition, it is expected that future technological developments will make it possible to recover more oil and gas than is the case today. Rising prices may also result in a rise in estimates of reserves.

Figure 3.2. Norway's oil and gas resources, 31 December 2005. Million Sm³ o.e.



Source: Ministry of Petroleum and Energy and Norwegian Petroleum Directorate (2006).

Figure 3.3. R/P ratio[1,2] for Norwegian oil and gas reserves. 1978-2005



[1] The R/P ratio, or the ratio between reserves and the current annual rate of production, indicates how many years it will take before the reserves are exhausted.
[2] Because of a change in the classification system for petroleum resources, there is a break in the time series between 2000 and 2001.
Source: Energy statistics from Statistics Norway and Norwegian Petroleum Directorate.

- As of 31 December 2005, Norway's total oil and gas reserves were estimated at 13 billion Sm³ oil equivalents (o.e.) (OED/OD 2006). Of this, 4 324 million Sm³ o.e., or 33 per cent, had already been produced. Thus, there are remaining resources of 8 676 million Sm³, of which 3 906 million Sm³ o.e., or 30 per cent of the total, is classified as reserves (figure 3.2). On the same date, 50 per cent of the oil resources but only 17 per cent of the gas resources had been extracted. Oil and gas each made up 46 per cent of the total resources expressed in Sm³ o.e., while NGL (natural gas liquids) and natural gas condensate made up 4 per cent each.

- The estimates of reserves in producing fields are revised annually, and new fields are included in the estimates almost every year (see Appendix, tables A1 and A2). According to the Petroleum Directorate's figures, the R/P ratios for Norway's reserves were 8.8 years (oil) and 26.4 years (gas). The R/P ratios change as new fields are approved for development and the quantities in already developed fields are re-evaluated.

Box 3.1. Energy content and energy units

Average energy content, density and efficiency of energy commodities[1]

Energy commodity	Theoretical energy content	Density	Fuel efficiency: Manufacturing and mining	Fuel efficiency: Transport	Fuel efficiency: Other consumption
Coal	28.1 GJ/tonne	..	0.80	0.10	0.60
Coal coke	28.5 GJ/tonne	..	0.80	-	0.60
Petrol coke	35.0 GJ/tonne	..	0.80	-	-
Crude oil	42.3 GJ/tonn e= 36.0 GJ/m^3	0.85 tonne/m^3	..	..	..
Refinery gas	48.6 GJ/tonne	..	0.95	..	0.95
Natural gas (2005)[2]	40.0 GJ/1000 Sm^3	0.85 kg/Sm^3	0.95	..	0.95
Liquefied propane and butane (LPG)	46.1 GJ/tonne = 24.4 GJ/m^3	0.53 tonne/m^3	0.95	..	0.95
Fuel gas	50.0 GJ/tonne	..	..	..	..
Petrol	43.9 GJ/tonn e= 32.5 GJ/m^3	0.74 tonne/m^3	0.20	0.20	0.20
Kerosene	43.1 GJ/tonne = 34.9 GJ/m^3	0.81 tonne/m^3	0.80	0.30	0.75
Diesel oil, gas oil and light fuel oil	43.1 GJ/tonne = 36.2 GJ/m^3	0.84 tonne/m^3	0.80	0.30	0.70
Heavy distillate	43.1 GJ/tonne = 37.9 GJ/m^3	0.88 tonne/m^3	0.80	0.30	0.70
Heavy fuel oil	40.6 GJ/tonne = 39.8 GJ/m^3	0.98 tonne/m^3	0.90	0.30	0.75
Methane	50.2 GJ/tonne	..	..	..	..
Wood	16.8 GJ/tonne = 8.4 GJ/fast m^3	0.5 tonne/fm^3	0.65	-	0.65
Wood waste (dry wt)	16.25-18GJ/tonne=6.5-7.2GJ/fm^3 ..	0.4 tonne/fm^3	..	..	
Waste	10.5 GJ/tonne	..	..	..	..
Electricity	3.6 GJ/MWh	..	1.00	1.00	1.00
Uranium	430-688 TJ/tonne	..	..	..	..

[1] The theoretical energy content of a particular energy commodity may vary. The figures therefore indicate mean values.
[2] Sm^3 = standard cubic metre (at 15 °C and 1 atmospheric pressure).
Source: Energy statistics, Statistics Norway, Norwegian Petroleum Industry Association, Norwegian Association of Energy Users and Suppliers, Norwegian Building Research Institute.

Energy units

	PJ	TWh	Mtoe	Mbarrels	MSm^3 o.e. oil	MSm^3 o.e. gas	quad
1 PJ	1	0.278	0.024	0.18	0.028	0.025	0.00095
1 TWh	3.6	1	0.085	0.64	0.100	0.090	0.0034
1 Mtoe	42.3	11.75	1	7.49	1.18	1.058	0.040
1 Mbarrels	5.65	1.57	0.13	1	0.16	0.141	0.0054
1 MSm^3 o.e. oil	36.0	10.0	0.9	6.4	1	0.90	0.034
1 MSm^3 o.e. gas	40.0	11.1	0.9	7.1	1.18	1	0.038
1 quad	1053	292.5	24.9	186.4	29.29	26.33	1

1 Mtoe = 1 million tonnes (crude) oil equivalents

1 Mbarrels = 1 million barrels crude oil (1 barrel = 0.159 m^3)

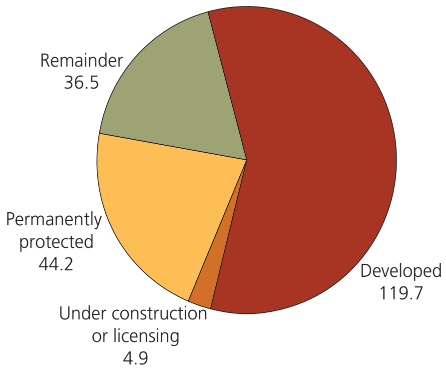
1 MSm^3 o.e. oil = 1 million Sm^3 oil

1 MSm^3 o.e. gas = 1 billion Sm^3 natural gas

1 quad = 10^{15} Btu (British thermal units)

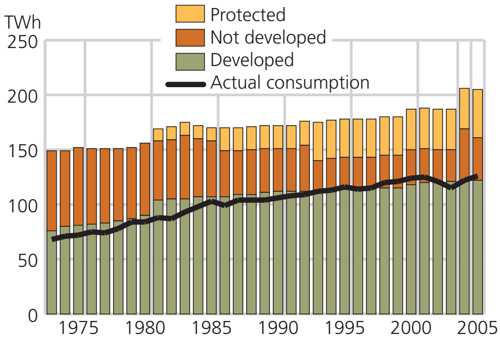
Source: Energy statistics, Statistics Norway and Norwegian Petroleum Directorate.

Figure 3.4. Norway's hydropower resources as of 1 January 2006[1]. TWh per year



[1] In 2005, a number of additional river systems were included in the category "protected" in the Protection Plan for Watercourses.
Source: Norwegian Water Resources and Energy Directorate.

Figure 3.5. Hydropower resources: developed[1], not developed[2] and protected[3]. Actual electricity consumption. 1973-2005[4]



[1] Includes the categories under construction and licence granted.
[2] Includes the categories prior notification submitted and licence application submitted.
[3] River systems protected by the Storting are not included in the figures before 1981.
[4] From 2004 onwards, power plants of capacity 50-10 000 kW were included. As a result, the resource estimate was revised upwards.
Source: Norwegian Water Resources and Energy Directorate.

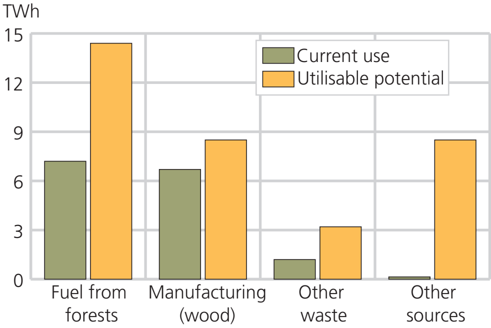
Norwegian hydropower resources

- As of 1 January 2006, Norway's hydropower potential totalled 205.3 TWh per year (see Appendix, table A3), and 58 per cent of this, 119.7 TWh, had been developed.
- Environmental restrictions and the need to consider profitability make it uncertain how much of the remaining hydropower potential is likely to be developed.
- The only large river in Norway that is untouched by hydropower developments is the Tana in Finnmark.
- Hydropower accounts for almost 100 per cent of electricity production in Norway (excluding electricity production on the continental shelf), as compared with 19 per cent for the world as a whole (World Energy Council 2001).
- Norway has the world's highest per capita hydropower production, and is ranked as number one in Europe and number six in the world in absolute terms.

Box 3.2. Commonly used prefixes

Name	Symbol	Factor
Kilo	k	10^3
Mega	M	10^6
Giga	G	10^9
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}

Figure 3.6. Bioenergy in Norway. Current use and utilisable potential



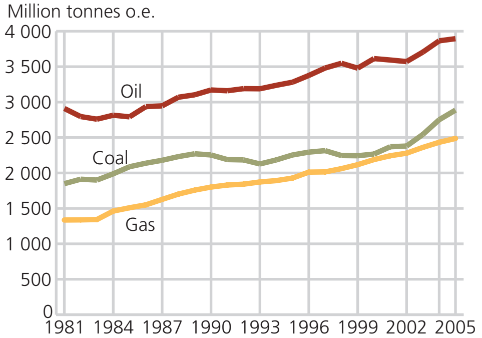
Source: Eid Hohle 2005.

Bioenergy resources in Norway

- Annual consumption of bioenergy resources (wood, wood waste, black liquor, pellets, briquettes) in Norway is about 15 TWh, and the utilisable potential is calculated to be about 35 TWh (Eid Hohle 2005). The utilisable potential indicates how much can be utilised when ecological, technical and economic constraints are taken into account.
- It would be possible to double the consumption of fuel derived from forests, including fuelwood and wood chips, and there is a smaller unused biofuel potential from manufacturing (pulp and paper industry and manufacture of wood products).
- A survey of fuelwood use (Statistics Norway 2006) shows that total fuelwood consumption in 2005 was 1.4 million tonnes, which corresponds to a theoretical energy content of about 6.5 TWh. About one third of the wood was used in modern clean-burning stoves (produced after 1998), which utilise the energy in the wood more efficiently than older stoves. The proportion of clean-burning stoves has risen by 16 percentage points since 2002. The overall efficiency of fuelwood stoves was about 50 per cent in 2005.
- Bioenergy sources that are barely used today offer a total potential of 8.5 TWh. These include energy crops (fast-growing trees and grasses), straw, landfill gas and biogas from manure.

3.2. Extraction and production

Figure 3.7. World production of coal, crude oil and natural gas. 1981-2005



Source: BP 2006.

World production of fossil energy commodities

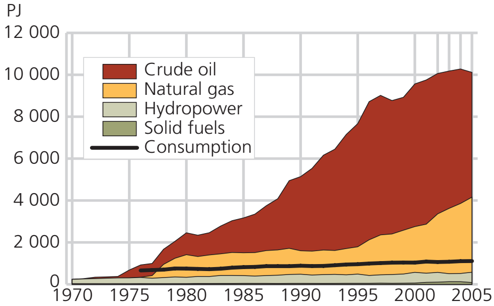
- In 2005, total global extraction of fossil energy commodities increased by 2.4 per cent from the year before to 9.3 billion tonnes oil equivalents. This is 52 per cent higher than in 1981. This upward trend has been particularly marked in the last few years - the rise from 2002 to 2005 was on average 4 per cent per year, as against 1.4 per cent per year in the period 1981-2002. Oil accounted for 42 per cent of the total, while coal and natural gas accounted for 31 and 27 per cent respectively.
- The US, China and Russia are the largest producers of fossil energy commodities. These three countries accounted for more than 40 per cent of total production in 2005 (see table 3.2).
- From 2002 to 2005, world production of coal increased by 21 per cent or 500 million tonnes oil equivalents. This is mainly because production in China increased by more than 50 per cent in this period. North America and Europe (including the whole of Russia: much of Russia's gas is produced in Siberia) account for two thirds of all gas production.
- Oil production is highest in the Middle East, but otherwise more evenly distributed across the different geographical regions.

Table 3.2. World production of fossil energy commodities in 2005

	Oil		Gas		Coal	
	Million tonnes	Per cent	Million tonnes o.e.	Per cent	Million tonnes o.e.	Per cent
Regions						
World	3 895.0	100.0	2 486.7	100.0	2 887.2	100.0
OPEC	1 625.5	41.7	..	..	..	..
OECD	927.7	23.8	971.5	39.1	1 013.4	35.1
North America[1]	642.5	16.5	675.6	27.2	615.3	21.3
Latin America	350.6	9.0	122.0	4.9	47.3	1.6
Europe incl. former Soviet Union	845.0	21.7	955.0	38.4	436.2	15.1
Middle East	1 208.1	31.0	263.3	10.6	0.6	0.0
Africa	467.1	12.0	146.7	5.9	142.8	4.9
Asia og Oceania	381.7	9.8	324.1	13.0	1 644.9	57.0
Major producers						
Oil	Mill.tonnes	Per cent				
Saudi Arabia	526.2	13.6				
Russia	470.0	12.1				
USA	310.2	8.0				
Iran	200.4	5.1				
Mexico	187.1	4.8				
China	180.8	4.6				
Venezuela	154.7	4.0				
Canada	145.2	3.7				
Norway	138.2	3.5				
Kuwait	130.1	3.3				
Gas	Mtoe	Per cent				
Russia	538.2	21.6				
USA	473.1	19.0				
Canada	166.9	6.7				
UK	79.2	3.2				
Algeria	79.0	3.2				
Iran	78.3	3.1				
Norway	76.5	3.1				
Indonesia	68.4	2.8				
Saudi Arabia	62.6	2.5				
Netherlands	56.6	2.3				
Coal	Mtoe	Per cent				
China	1107.7	38.4				
USA	576.2	20.0				
Australia	202.4	7.0				
India	199.6	6.9				
South Africa	138.9	4.8				
Russia	137.0	4.7				
Indonesia	83.2	2.9				
Poland	68.7	2.4				
Germany	53.2	1.8				
Kazakhstan	44.0	1.5				

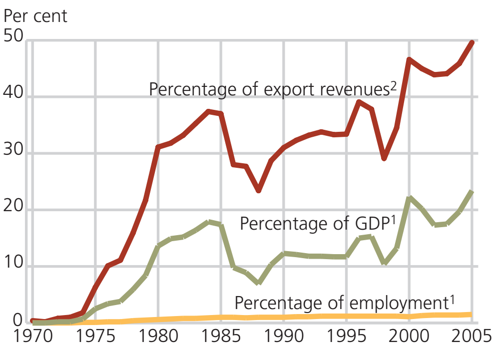
[1] Including Mexico.
Source: BP 2006.

Figure 3.8. Extraction and consumption[1] of energy commodities in Norway. 1970-2005*



[1] Including the energy sectors, excluding international maritime transport.
Source: Energy statistics, Statistics Norway, Norwegian Petroleum Directorate and Norwegian Water Resources and Energy Directorate.

Figure 3.9. Oil and gas extraction. Percentage of exports, gross domestic product (GDP) and employment. 1970-2005*



[1] Including services.
[2] Oil and gas only.
Source: National Accounts, Statistics Norway.

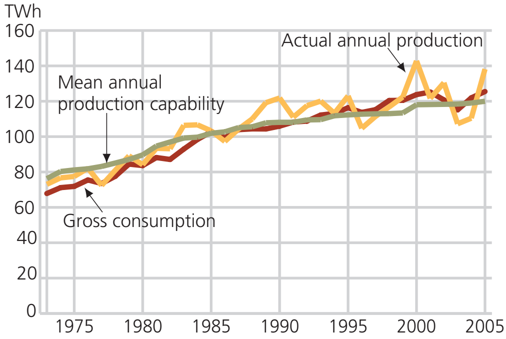
Total extraction of energy commodities in Norway

- There was a slight decrease in total extraction of energy commodities in Norway from 2004 to 2005. Oil and gas extraction accounted for 95 per cent of the total in 2005. Gas production has reached record levels in recent years, and rose by 7 per cent from 2004, while crude oil production dropped by 7 per cent. Extraction of solid fuels was considerably lower than in 2004 as a result of a fire in the Svea Nord coal mine in Svalbard, which closed the mine for several months (see the section on Norwegian extraction of coal in Svalbard).
- Hydropower production increased by 25 per cent from 2004 to 2005, and was the second highest ever recorded. However, it should be noted that production was unusually low in 2004 and unusually high in 2005, as a result of high rainfall.
- In 2005, extraction of primary energy commodities was nine times higher than domestic consumption (see also Appendix, table A11).

Crude oil and natural gas in an economic perspective

- Extraction of oil and gas is Norway's most important industry measured in terms of export revenue and value added (proportion of GDP). In 2005, oil and gas accounted for 50 per cent of the value of the country's total exports. The volume of exports dropped by 4.5 per cent from the year before, but high prices resulted in an increase of 26 per cent in the value of exports.
- Value added in the petroleum sector corresponded to 23 per cent of GDP, but only about 1 per cent of total labour input was directly related to oil and gas extraction.

Figure 3.10. Mean annual production capability, actual hydropower production and gross electricity consumption in Norway. 1973-2005

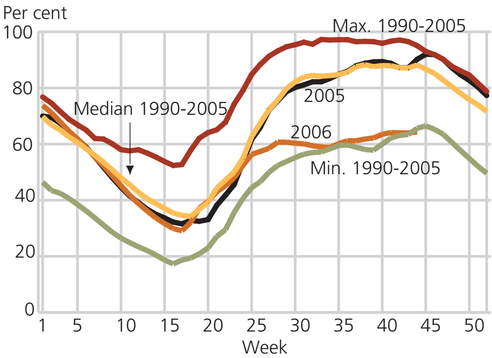


Source: Norwegian Water Resources and Energy Directorate and Energy statistics, Statistics Norway.

Electricity

- In 2005, electricity production in Norway totalled 138 TWh, an increase of about 25 per cent from the year before (see Appendix, table A8). In addition, about 8-10 TWh of mechanical and electrical energy was generated by gas turbines on the Norwegian continental shelf in 2005 (Norwegian Water Resources and Energy Directorate 2006).
- Production was almost 18.5 TWh higher than the mean annual production capability (i.e. production in a year with normal precipitation). The mean annual production capability rose by 0.73 TWh from the year before.
- In 2005, there was an export surplus of 12 TWh.
- Hydropower accounts for about 99 per cent of electricity production in Norway. In recent years, several wind farms have been constructed, and wind power production has reached 507 GWh, which is twice the 2004 level.

Figure 3.11. Degree of filling of Norway's reservoirs during the year, 2005 and 2006. Minimum, maximum and median values for the period 1990-2005. Percentages

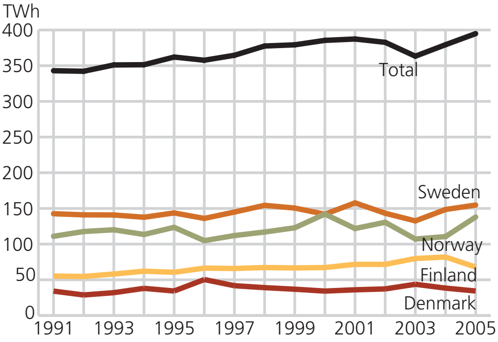


Source: Norwegian Water Resources and Energy Directorate.

Degree of filling of the reservoirs

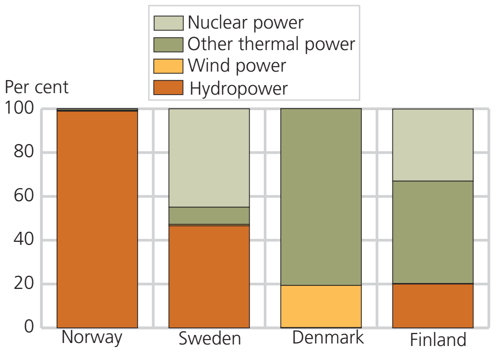
- Water inflow to the reservoirs is of crucial importance for the level of electricity production. Inflow is unevenly distributed over the year, and is normally lowest in winter, when the demand for power is highest. It is therefore necessary to store water in order to be able to produce electricity in winter. The degree of filling of the reservoirs can vary a great deal both between seasons and between years as a result of variations in precipitation and the demand for electricity.
- At the beginning of 2006, the total energy capability of Norway's reservoirs was about 84 TWh, or about 70 per cent of annual mean production.
- The degree of filling of the reservoirs was above the median for 1990-2005 in the first few months of 2005, but a cold spring resulted in considerable reservoir drawdown and late snowmelt, so that the degree of filling was below the median level until mid-June. As a result of warm weather and high rainfall during the summer, the degree of filling was again above the median level, and in the second half of November reached the highest level recorded relative to the median in the period 1990-2005. At the end of 2005, the degree of filling was 6 per cent above the median, and the reservoirs contained water corresponding to 4.7 TWh more than a year before (Norwegian Water Resources and Energy Directorate 2006). However, from mid-February 2006 the degree of filling was generally below the median, and during the summer it was considerably below the median as a result of a long period of dry weather. Even though reservoir levels rose somewhat from the end of August, the degree of filling was still 27 per cent below the median level in early November 2006.

Figure 3.12. Electricity production in the Nordic countries. 1991-2005



Source: Nordel's secretariat (various years).

Figure 3.13. Electricity production in the Nordic countries in 2005, by technology

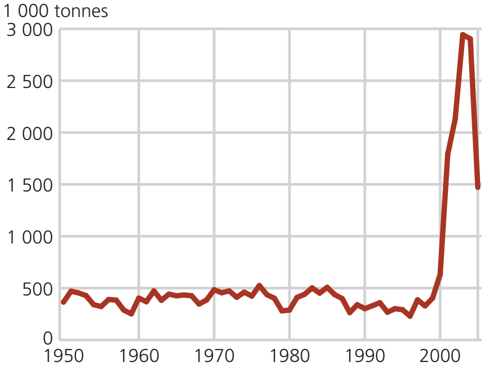


Source: Nordel.

Electricity production in the Nordic countries

- In 2005, total energy production in the Nordic countries excluding Iceland was 394.9 TWh. Sweden is the largest electricity producer in the region, closely followed by Norway (figure 3.12). The technology of electricity production varies widely (figure 3.13). Almost all electricity production in Norway is based on hydropower, while nuclear power is important in Sweden and Finland (45 and 33 per cent, respectively, of the total in 2005). Denmark is the main producer of wind power: in 2005, 6.6 TWh, or 19 per cent of the country's total production, was wind power. In addition, Iceland produced 8.6 TWh of electricity, split between 81 per cent hydropower and 19 per cent geothermal power.
- Energy production in the other Nordic countries influences the electricity balance in Norway. In 2005, Norway was a net exporter, after being a net importer for the two preceding years. Norway exported 15.7 TWh and imported 3.7 TWh. Sweden was also a net exporter, while Denmark and Finland were net importers (Nordel 2006).
- Norway's export surplus in 2005 was 12.0 TWh, of which 8.0 TWh was exported to Sweden and 4.2 TWh to Denmark. In addition, a small quantity was exported to Finland, and Norway imported 0.2 TWh from Russia. Finland imported considerable quantities of electricity from Russia. Both Sweden and Denmark traded electricity with Germany, and Sweden also traded with Poland.

Figure 3.14. Norwegian net production of coal in Svalbard. 1950-2005



Sources: Historical Statistics, Statistics Norway and Store Norske Spitsbergen Kulkompani.

Norwegian extraction of coal in Svalbard

- On 30 July 2005, fire broke out in the Svea Nord mine in Svalbard. As a result, there was no production in the period August 2005-March 2006. The net production volume was 1.5 million tonnes, only half that reached the year before. The mine extracts coal from the largest deposit ever found in Svalbard. It started production in 2002, and can be operated very efficiently. As a result, Norway's annual net production in 2003 and 2004 was 2.9 million tonnes, as against 300 000 to 400 000 tonnes in the 1990s.

- Norway's total coal production for the whole period 1916-2005 is 36.1 million tonnes. At the end of 2005, the reserves of what is defined as marketable coal totalled 50.3 million tonnes, which corresponds to 17 years' production at the 2003 and 2004 rate of extraction.

- In 2005, 6 per cent of the coal sold was delivered to the Norwegian cement industry and 1.5 per cent was used for energy production in Svalbard. The rest was exported to six European countries, over half of it to Germany. Of the total sales, 65 per cent was used for energy production and the rest in manufacturing industries. Because of the reduction in production caused by the fire, the company was unable to meet all its contractual obligations for deliveries.

- In 1916, the newly established Store Norske Spitsbergen Kulkompani took over coal production from the US Arctic Coal Company, which had been operating for 10 years. In 2001, the subsidiary Store Norske Spitsbergen Grubekompani was established, and is now responsible for production. The company made a profit from the first year of ordinary production in 2002, whereas Norwegian coal production had always previously been dependent on government support.

- Norway's sovereignty over the archipelago was recognised when the Spitsbergen Treaty was signed in 1920. Before this, the area had been a no man's land under international law, where many nations were engaged in hunting and research. By 1920, the Soviet Union (before that, Russia) had already been mining coal in Svalbard for some years, and in accordance with the Spitsbergen Treaty, this has continued ever since.

3.3. Environmental impacts of energy production

Table 3.3. Emissions to air from the energy sectors as a proportion of total Norwegian emissions. 2004*. Percentages

Greenhouse gases (expressed as CO_2 equivalents)	**31**
Carbon dioxide (CO_2)	36
Methane (CH_4)	18
Nitrous oxide (N_2O)	1
Acidifying substances (expressed as acid equivalents)	**23**
Sulphur dioxide (SO_2)	15
Nitrogen oxides (NO_X)	31
Ammonia (NH_3)	0
Heavy metals	
Lead (Pb)	1
Cadmium (Cd)	6
Mercury (Hg)	5
Arsenic (As)	7
Chromium (Cr)	6
Copper (Cu)	1
POPs	
Total PAH	1
Dioxins	8
Other pollutants	
Non-methane volatile organic compounds (NMVOCs)	58
Carbon monoxide (CO)	2
Particulate matter	2

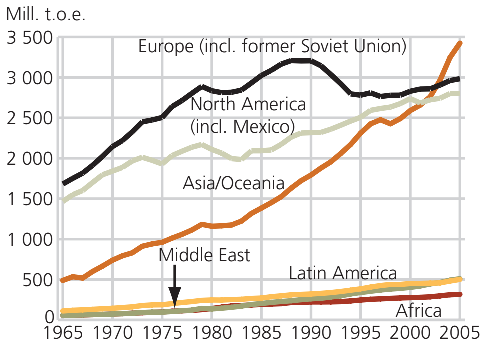
For more information, see Chapter 9: Air pollution and climate change and Chapter 12 (information on oil discharges from petroleum activities on the Norwegian continental shelf, figure 12.4).
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Emissions to air from the energy sectors

- The energy sectors are responsible for a large proportion of emissions to air in Norway, particularly in the case of CO_2, NO_X and NMVOCs.
- The most important source of CO_2 and NO_X emissions in the energy sectors is gas turbines on offshore installations. In the 1990s, they generated annual CO_2 emissions of 5-7 million tonnes. From 1999 to 2005, these emissions rose by 48 per cent to 9.8 million tonnes. Annual emissions of NO_X from this source have increased at a similar rate, and reached 35 000 tonnes in 2005.
- The most important source of NMVOC emissions is evaporation during loading of crude oil offshore. These emissions rose a great deal during the 1990s, and reached a peak in 2001. Since 2002, they have been considerably reduced because of the quantity of oil loaded has dropped while the amount of oil loaded at facilities with VOC recovery equipment has risen. In 2005, emissions totalled 92 000 tonnes, 30 per cent less than the year before and 63 per cent less than in 2001.
- In 2004, 15 per cent of Norway's total emissions of SO_2 were generated by the energy sectors. Oil refining alone accounted for 7 per cent, mainly in the form of process emissions. From 1990 to 2004, emissions from the energy sectors were reduced by 38 per cent, but since total emissions were more than halved in the same period, the energy sectors accounted for a larger proportion of the total in 2004 than in 1990.

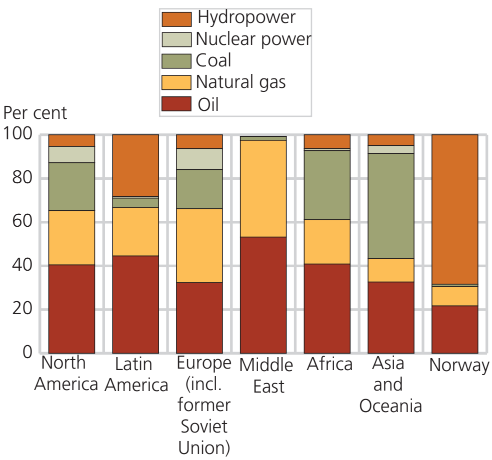
3.4. Energy use

Figure 3.15. World energy use 1965-2005. Mtoe



Source: BP 2006.

Figure 3.16. Energy use by energy carrier (excluding bioenergy) in different regions. 2005

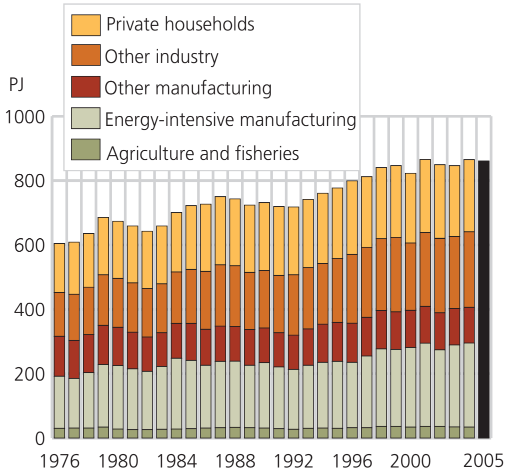


Source: BP 2006.

World energy use

- In 2005, global consumption of energy commodities (excluding bioenergy) totalled 10 537 million tonnes oil equivalents, 2.7 per cent more than the year before. In the period 1965-2005, energy use in Asia/Oceania has risen by a factor of seven (average rise 5 per cent per year), and is now higher than in Europe (including the former Soviet Union) and North America (figure 3.15). Energy use has been rising particularly fast in China: by almost 50 per cent from 2002 to 2005. In 2005, China accounted for 15 per cent of total world energy use, and only the US accounted for a larger share of the total (22 per cent). The EU 25 accounted for 16 per cent of total energy use. The energy commodity that showed the largest rise in consumption from 2004 to 2005 was coal (5 per cent); this was largely due to the steep rise in consumption in China.
- The energy mix varies greatly from one country to another: in 2005, Asia/Oceania accounted for 55 per cent of all coal consumption, while 79 per cent of all nuclear power and 69 per cent of natural gas consumption was in Europe (including the former Soviet Union) and North America. The proportion of hydropower in the energy mix was highest in Norway (68 per cent), followed by Brazil, with 40 per cent.
- Bioenergy is estimated to make up 15 per cent of total world energy use and is an important source of energy in most developing countries: in some, such as Ethiopia and Nepal, bioenergy accounts for as much as 95 per cent of energy use (Eid Hohle 2005).

Figure 3.17. Domestic energy use[1] by consumer group. 1976-2005*



[1] Excluding the energy sectors and international maritime transport. Including energy carriers used as raw materials.
Source: Energy statistics, Statistics Norway.

Norway's energy use in total and split by consumer group

- In 2005, Norway's total energy use (including energy commodities used as raw materials, excluding international maritime transport) was 1 109 PJ, including 248 PJ in the energy sectors (see Appendix, tables A5 and A6), which is only a modest rise from the year before. The energy sectors include oil and gas extraction, gas terminals, oil refineries, coal extraction and the production of electricity and district heating.
- Consumption of energy commodities, excluding the energy sectors and international maritime transport, decreased slightly from the year before, and totalled 861 PJ in 2005 (preliminary figures). Energy use rose by an average of 1.3 per cent per year from 1976 to 2005. In the same period, GDP excluding the oil and gas sector grew by an average of about 2.4 per cent per year.
- Energy-intensive manufacturing and the category "other industry" are the consumer groups where energy use has risen most in the period 1976-2004. Since these groups are dependent on cyclical changes, the rise has been uneven. Energy use by households has risen steadily, while energy use in agriculture and fisheries and in "other manufacturing" has shown some variation during this period, but no clear trend.

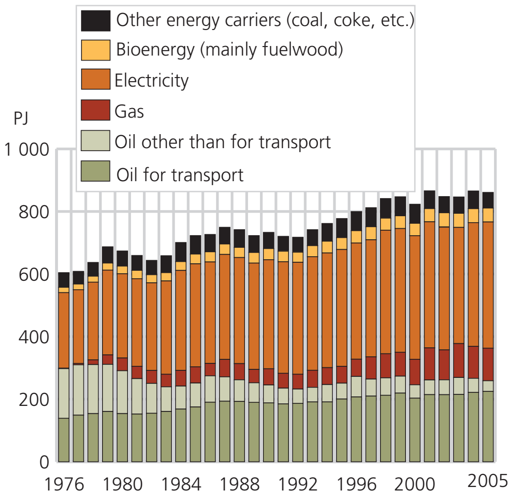
Box 3.3. Environmental pressures caused by the extraction and use of energy

Emissions to air occur during the extraction, transport and use of oil and gas products. These can result in climate change, acidification, the formation of ground-level ozone and local air pollution (see Chapter 9: Air pollution and climate). Emissions to air from the energy sectors in 2004 are shown in table 3.3.

Discharges of oil and chemicals to the sea occur during the extraction and transport of oil and gas products. They may for example injure fish, marine mammals and birds.

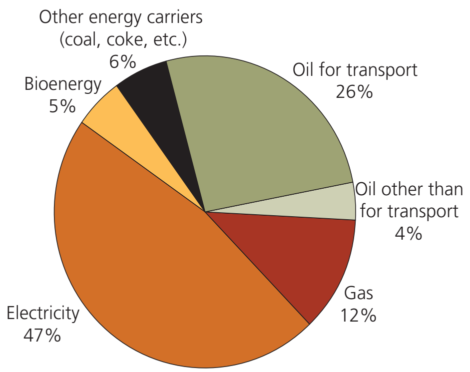
Infrastructure development takes place during the development of new capacity for energy generation, and includes the construction of dams, roads, onshore installations and transmission lines. Hydropower production also results in variable water levels in reservoirs and changes in discharge volumes in rivers. These developments can have an impact on biological diversity and the value of cultural monuments, the cultural landscape and recreational areas.

Figure 3.18. Energy[1] use by energy carrier. 1976-2005*



[1] Excluding the energy sectors and international maritime transport. Including energy carriers used as raw materials.
Source: Energy statistics, Statistics Norway.

Figure 3.19. Energy use by energy carrier. Percentages of total. 2005*

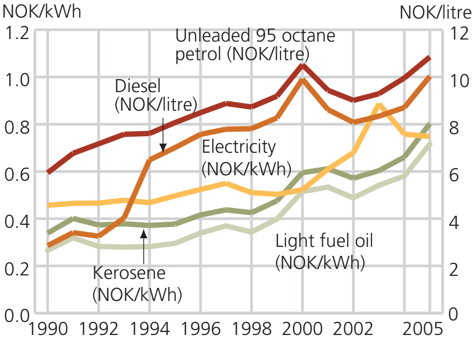


Source: Energy statistics, Statistics Norway.

Consumption by energy commodity

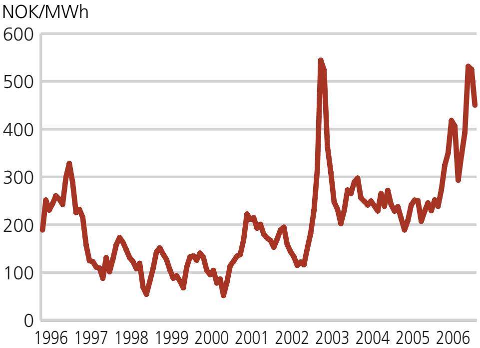
- Total oil consumption, excluding the energy sectors and international maritime transport, dropped by about 13 per cent in the period 1976-2005, despite a rise of 62 per cent in the consumption of oil for transport in the same period (see Appendix, table A5).
- Transport now accounts for 87 per cent of total oil consumption, as compared with 47 per cent in 1976. Consumption of transport oils is increasing.
- Consumption of oil for stationary purposes had dropped to less than one third of the 1976 level by 1992. It then remained at the same level until the last couple of years, when it has been dropping even further.
- Electricity consumption has risen from 241 PJ in 1976 to 404 PJ in 2005. This is a rise of 67 per cent. From 2002 to 2003, high electricity prices resulted in a drop in consumption, but since then consumption has been rising again. This must be seen in the context of a rise in fuel oil prices. See Appendix, tables A8 and A9.
- Some energy commodities, particularly coal, coke and LPG, are also used as factor inputs or reducing agents.

Figure 3.20. Price trends for electricity, kerosene, fuel oil, diesel and petrol. 1990-2005. NOK per kWh and litre, current prices



Source: Energy statistics, Statistics Norway, Norwegian Water Resources and Energy Directorate and Norwegian Petroleum Industry Association.

Figure 3.21. Nord Pool system price[1] for electricity, 1996-2006. NOK/MWh

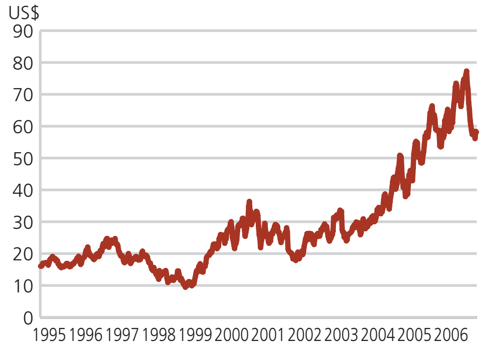


[1] Theoretical market price without any restrictions on transmission.
Source: Nord Pool.

Prices

- The listed prices (average prices from the Norwegian Petroleum Industry Association) of both heating kerosene and light fuel oil rose by over 20 per cent from 2004 to 2005. This, together with a slight decrease in electricity prices, may have contributed to the sharp drop in the consumption of fuel oil and the increase in electricity consumption, even though the price of light heating oil per energy unit was lower than for electricity in this period.
- Lower taxes resulted in a drop in the price of petrol and autodiesel from 2000 to 2002. Taxes on these products were raised from 2002, and prices have therefore increased again.
- Trade in electricity has been deregulated in Norway, and producers and suppliers trade on the joint Nordic power exchange, Nord Pool. The basic price of much of the electricity traded is thus determined by the market at any time. However, some electricity is also traded in the form of bilateral fixed contracts, standard fixed contracts and standard variable contracts. Figure 3.21 is a graph of the average monthly Nord Pool system price in the period 1996-2006. It shows that there can be very large variations from one month to another. However, since 2000, prices have shown a clear rising trend.

Figure 3.22. Spot price of Brent Blend. 1995-2006. USD



Source: Petroleum Intelligence Weekly.

- The average spot price of Brent Blend was just over USD 65 per barrel for the first eleven months of 2006, as compared with USD 54 and 38 per barrel in 2005 and 2004 respectively.
- Several factors explain the sharp increase in oil prices through much of 2005 and the fact they have so far remained high in 2006. Firstly, demand for oil has continued to increase in several parts of the world. Moreover, there has been a drop in oil production in several areas, including Iraq, Nigeria and Alaska. In addition, OPEC has had little spare production capacity. This has resulted in greater concern about the consequences of a drop in production and resulted in large purchases of oil on the futures market.

More information: Lisbet Høgset (lisbet.hogset@ssb.no), Trond Sandmo (trond.sandmo@ssb.no) and Henning Høie (henning.hoie@ssb.no).

Useful websites

Statistics Norway - Electricity, gas and water supply: http://www.ssb.no/english/subjects/10/08/
Statistics Norway - Energy balance and energy accounts: http://www.ssb.no/english/subjects/01/03/10/energiregn_en/
Statistics Norway - Extraction of oil and gas: http://www.ssb.no/english/subjects/10/06/20/
Statistics Norway - Petroleum sales: http://www.ssb.no/english/subjects/10/10/10/petroleumsalg_en/
British Petroleum (World Energy Review): http://www.bp.com/home.do
International Energy Agency: http://www.iea.org/
Ministry of Petroleum and Energy: http://www.odin.dep.no/oed/
Norwegian Water Resources and Energy Directorate: http://www.nve.no/
Norwegian Petroleum Industry Association: http://www.np.no/
Norwegian Petroleum Directorate: http://www.npd.no/

References

BP (2006): Statistical Review of World Energy (downloaded from http://www.bp.com/).

Eid Hohle, E. (ed.) (2005): *Bioenergi. Miljø, teknikk og marked* (Bioenergy. Environment, technology and markets), Brandbu: Energigården.

Nordel (2006): Årsberättelse 2005 (Annual report 2005). www.nordel.org.

Norwegian Water Resources and Energy Directorate (2006): Kvartalsrapport for kraftmarkedet, 4. kvartal 2005 (Quarterly report on the power market, 4th quarter 2005).

OECD/IEA (2005a): *Energy Balances of non-OECD Countries 2002-2003,* Paris: Organisation for Economic Co-operation and Development.

OECD/IEA (2005b): *Energy Balances of OECD Countries 2002-2003,* Paris: Organisation for Economic Co-operation and Development.

OED/OD (2006): Facts 2006. The Norwegian Petroleum Sector. Ministry of Petroleum and Energy and Norwegian Petroleum Directorate.

Statistics Norway (2006): Størst vedforbruk i Oppland – minst i Oslo (Fuelwood consumption highest in Oppland and lowest in Oslo). Magazine 14.11.2006. http://www.ssb.no/vis/magasinet/miljo/art-2006-11-14-01.html

Store Norske (2006): Årsberetning og regnskap 2005 (Annual report and accounts). Longyearbyen.

World Energy Council (2001): *Survey of Energy Resources 2001*. London: World Energy Council.

4. Agriculture

The total size of agricultural areas in use has remained stable at a time when the relative importance of agriculture to the national economy has declined. There have been major changes in farming that have affected the environment both on farmed land and in adjacent areas and river systems.

Farming results in environmental changes both to farmed land, such as alterations in biotopes and landscapes, and to adjacent areas in the form of runoff of nutrients into water bodies and emissions to air from agricultural processes. There has been a particular focus on eutrophication of water bodies caused by nutrient enrichment. The open cultural landscape we are familiar with today has largely been created by farming, and is continuously being shaped by the farming methods in use. The agricultural sector manages substantial biological and cultural assets in the form of cultivated animal and plant resources, buildings and types of landscapes. These represent environmental qualities that most people perceive as positive, but they can come under threat as agriculture is made more and more effective, both at the level of the individual farm and through merging of holdings to form larger units. Consequently, agricultural policy has given more weight to these factors in recent years, while the focus on production objectives has been toned down.

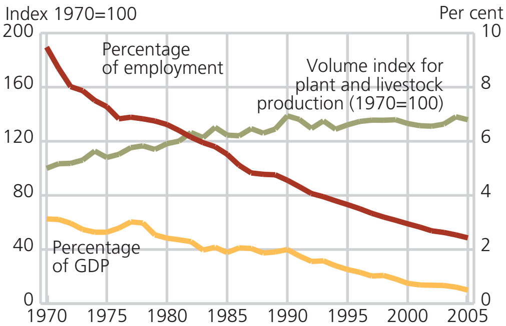
At the same time farming areas are also affected by pollution caused by other activities, including ozone and heavy metals, and pressure to convert farmland for development.

One of the most important objectives of farming is to safeguard the national food supply (Report No. 19 (1999-2000) to the Storting). The food production potential in Norway is primarily restricted by the climatic conditions and the availability of land resources suitable for farming. Consequently, protecting agricultural land resources has high priority. Farming practices have impacts on the quality of agricultural products and thus on human health through factors such as the nutritional content of food, pesticide residues and animal diseases that are transmissible to humans.

This chapter takes a closer look at the natural resource base (land resources) and activities in the agricultural sector that have environmental impacts in the form of changes in the landscape and emissions to water and air. A brief summary of the economic importance of agriculture as an industry is also included.

4.1. Main economic figures for agriculture

Figure 4.1. Trends in agricultural production volume (index 1970=100) and share of employment and GDP. 1970-2005*



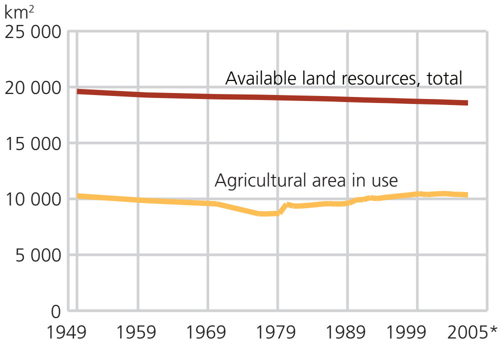
Source: Budget Committee for Agriculture (2006) and Norwegian National Accounts, Statistics Norway.

Agriculture in an economic perspective

- From 1970 to 2005, employment fell by 66 per cent (from over 140 000 to 47 700 normal full-time equivalents). In comparison, manufacturing employment fell by approximately 31 per cent.
- Agriculture's share of GDP fell from 3.1 to 0.5 per cent. In comparison, manufacturing declined from 18.6 to 8.7 per cent.
- Agricultural production has increased by about 36 per cent in the same period. However, production volume has not increased since 1990.

4.2. Land resources

Figure 4.2. Available land resources and agricultural area in use. Norway. 1949-2005*

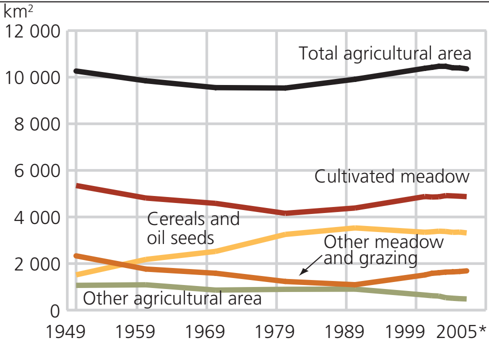


Source: Agricultural statistics, Statistics Norway and Grønlund and Høie (2001).

Available land resources and cultivated areas

- A relatively small proportion of the total area of Norway is suitable for agriculture. About 3 per cent of the country is cultivated, as compared with over 10 per cent in the world as a whole. Some of the land resources available are not in use for agriculture, either temporarily or on a permanent basis. In 1979 and 1989, this applied to 6-7 per cent of the total area. Areas that are not being used can be taken into use again later for agricultural purposes, but may also become overgrown by forest or be converted for purposes that prevent future agricultural production.
- Almost the same proportion of land is classified as cultivable, but these areas are generally less valuable than land that is already being cultivated. Most of the cultivable land is in areas with a climate that is most suitable for the production of grass and other fodder crops. The scarcity of land resources means that the current self-sufficiency rate is between 45 and 50 per cent.
- From 1949 to 2005, the available land resources (cultivated and cultivable land) have decreased by over 1 000 km^2 or 5.2 per cent as a result of the conversion of land for purposes that prevent future agricultural production. The proportion of the available resources actually cultivated was 56 per cent in 2005, as compared with 52 per cent in 1949. Until the early 1990s, government grants were provided for new cultivation, and considerable areas were brought under cultivation every year.

Figure 4.3. Agricultural area in use. 1949-2005*

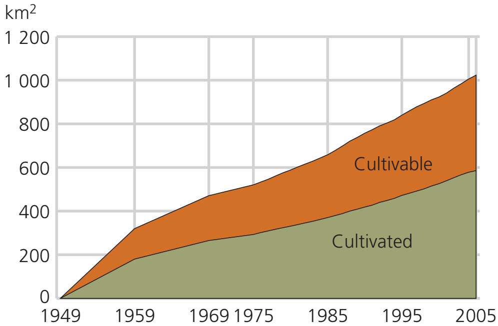


Source: Agricultural statistics, Statistics Norway.

Agricultural area in use

- From 1949 to the mid-1970s, the agricultural area in use decreased from 10 300 km² to 8 700 km². After a modest rise in the late 1970s and early 1980s, the area in use remained at around 9 500 km² until the end of the 1980s. It then rose again over the next 10 years. The most recent rise is probably related to the transition from support based on production to support based on the area farmed, and to stricter requirements with regard to the minimum area for manure spreading. In 2005, the agricultural area in use is about 10 400 km².
- In 1949, the area of cereals and oil seeds was 15 per cent of the agricultural area in use. This proportion rose until the early 1990s, when it reached 37 per cent. Since then it has dropped again, to 32 per cent in 2005. See also Appendix, table B1.
- The area of natural meadow, surface cultivated meadow and fertilised pasture dropped by more than half from 1949 to the mid-1980s. It started to rise again from the late 1980s, and now accounts for 16 per cent of the agricultural area in use.

Figure 4.4. Accumulated conversion of cultivated and cultivable land[1]. 1949-2005*



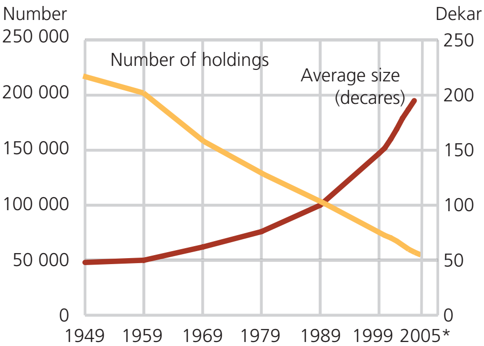
[1] For the period 1949-1975 data is only available for cultivated areas that were converted. The area of cultivable land converted in this period has been estimated on the basis of the ratio between cultivable and cultivated land converted 1976-1997.
Source: Statistics Norway, Ministry of Agriculture and Food and Norwegian Agricultural Authority.

Conversion of cultivated and cultivable land and new cultivation

- The most important threat to agricultural land resources is their conversion for purposes that prevent future agricultural production. An estimated 1 023 km^2, or about 5 per cent of the total area suitable for agriculture, has been converted for such purposes since 1949.
- The authorities have set the target of halving the annual conversion of the most valuable soil resources for other purposes than agriculture by 2010. In the period 1994-2003, an average of 13 400 decares of cultivated land was converted for other purposes. The area converted in 2005 was 7 700 decares, which is the lowest figure registered since1980.
- In the 1950s, 1960s and 1970s, an annual average of about 80 000 decares was brought under cultivation on the basis of government grants. Since the grant scheme was discontinued, a significant decrease in new cultivation activities has been recorded. In 2005, the municipalities approved new cultivation of about 11 000 decares of land.

4.3. Size of holdings and cultural landscape

Figure 4.5. Number of holdings and average size of agricultural area in use (decares[1]). 1949-2005*



[1] 1 decare = 0.1 hectare.
Source: Agricultural statistics, Statistics Norway.

Holdings - number and size

- The number of holdings in Norway has been reduced to about a fourth since 1949; this is equivalent to a loss of 8 holdings a day. Figures for the last few years indicate a rising rate of farm closures. In the ten-year period 1989-1999, the average annual decrease was 2.9 per cent, while the corresponding figure for the five-year period 1999-2004 was 4.3 per cent.
- Since 1949, the average size of holdings has almost quadrupled. Much of the land on abandoned holdings is initially taken over as additional land by the remaining holdings, often as rented area. In 1989, 23 per cent of the agricultural area in use was rented. In 2005, this share had increased to 38 per cent.

Box 4.1. Structural changes and the cultural landscape

Major structural changes have taken place in agriculture over the last few decades, and they have followed three distinct trends:

- The agricultural area is split between fewer and larger holdings
- Each holding produces fewer products (specialisation at holding level)
- Production of important products is concentrated to a greater extent in certain regions (specialisation at regional level).

All these trends have changed the conditions for nutrient cycles in the agricultural system and the way farming shapes the cultural landscape. Requirements relating to the means of production have also been affected: this also applies to buildings, which are an important part of Norway's cultural heritage.

Larger holdings, technological advances such as increased size of machinery and tools, and greater pressure to increase earnings are all factors that tend to lead to an increase in the size of fields. An increase in the size of fields reduces the length of ecotones and results in less variation in the landscape within a given area. This reduces biological diversity and gives the agricultural landscape a more monotonous appearance.

4.4. Pollution from the agricultural sector

Table 4.1. Emissions to air from agriculture. Greenhouse gases and acidifying substances. 2004*

	Emissions from agriculture. 1 000 tonnes	Percentage of total emissions in Norway
Greenhouse gases	4 760[1]	8.9
Carbon dioxide (CO_2)	411	0.9
Nitrous oxide (N_2O)	6.9	47
Methane (CH_4)	105.4	46
Acidifying substances	1.3[2]	19.2
Ammonia (NH_3)	20.2	88.1
NO_X	5.3	2.4
SO_2	0.1	0.4

[1] CO_2 equivalents.
[2] Acid equivalents.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Emissions to air

Emissions to air where agriculture is an important source:

- Nitrous oxide (N_2O): nitrogen runoff, use of commercial fertiliser and manure, livestock, biological nitrogen fixation, decomposition of plant material, cultivation of mires and deposition of ammonia. There is a high level of uncertainty in the estimates of nitrous oxide emissions from agriculture (see Chapter 9).
- Methane (CH_4): livestock. Between 80 and 90 per cent is released directly from the gut.
- Ammonia (NH_3): animal manure (about two-thirds), the use of commercial fertiliser and treatment of straw with ammonia.

Box 4.2. Pollution from the agricultural sector

Farming results in air and water pollution. Agriculture is a major source of discharges of nutrients to water (nitrogen and phosphorus) (see further details in Chapter 12). In 2004, agriculture accounted for about 46 and 56 per cent respectively of anthropogenic phosphorus and nitrogen inputs to what is termed the North Sea area (the coastal area between the Swedish border and Lindesnes). These inputs are described in more detail in Chapter 12. Eutrophication is a particularly serious problem locally in water recipients where much of the surrounding land is agricultural.

Measures to limit runoff of nutrients can be divided into three main groups:
- Better fertiliser management to reduce the surplus of nutrients in soils
- Better cultivation systems to protect soils against erosion
- Technical measures, such as improving drainage, enlarging manure storage facilities, etc.

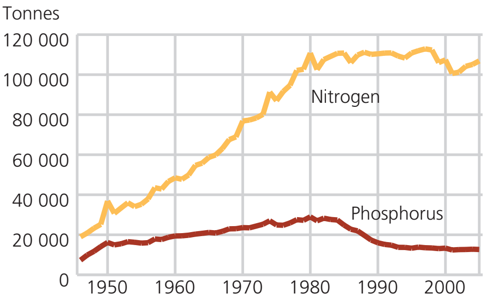
Farming also makes a substantial contribution to emissions of ammonia (NH_3), methane (CH_4) and nitrous oxide (N_2O) to air (see Table 4.1 and Appendix, Tables G3-G5). Emissions of ammonia result in acid rain, while methane and nitrous oxide are greenhouse gases (see Chapter 9). No measures have as yet been implemented to reduce emissions to air from the agricultural sector. The use of pesticides in farming also results in various forms of pollution.

Box 4.3. Measures to prevent soil erosion

A large proportion of pollution from the agricultural sector is a result of erosion, i.e. transport of soil with surface water runoff from fields. Most erosion takes place on fields that are ploughed in autumn. When ploughed in autumn, fields are left for up to three-quarters of the year with no plant cover to protect the soil from rain and melt-water. In the long term, erosion also reduces the production capacity of the soil.

To reduce soil erosion, the authorities provide grants for areas that are vulnerable to erosion on condition that the farmers leave them under stubble during the winter, i.e. do not till these areas in autumn. This support scheme also applies to some other types of areas such as areas lightly harrowed in autumn, directly sown autumn cereals, autumn cereals sown after light harrowing and catch crops. Support is provided because crop yields are expected to be lower in the following season without autumn tillage. In the long run, however, reducing soil loss will help to maintain soil quality, with a potentially positive impact on future crop yields.

Figure 4.6. Sales of nitrogen and phosphorus in commercial fertilisers. 1946-2005

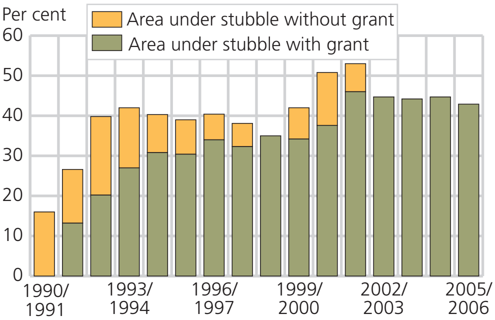


Source: Agricultural statistics, Statistics Norway, and Norwegian Food Safety Authority.

Application of commercial fertiliser

- As a rule, heavy application of fertiliser results in poor utilisation of the nutrients and may therefore increase pollution in lakes and rivers. The amount of fertiliser applied is therefore increasingly determined on the basis of soil samples and recommended standards. Since 1998, a fertilisation plan has been mandatory for holdings that apply for production grants.
- Since the early 1980s, the use of phosphorus fertiliser has been more than halved. In 2001 and 2002, the amount of nitrogen fertiliser used was 10 per cent lower than in the peak years 1996-1998, but in recent years there has once again been a moderate rise.

Figure 4.7. Proportion of cereal acreage left under stubble[1] in autumn. 1990/1991-2005/2006*

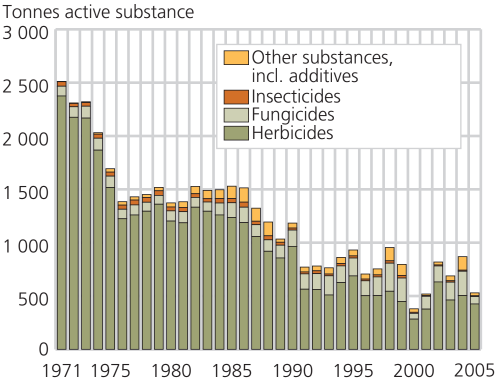


[1] Total area under stubble not recorded in 1998/99 and after 2001/02.
Source: Agricultural statistics, Statistics Norway, Ministry of Agriculture and Food and Norwegian Agricultural Authority.

Soil management

- In general, areas with vegetation cover or that are not ploughed in autumn are less vulnerable to erosion and runoff of nutrients than tilled areas. The area under stubble (i.e. area that is not tilled between harvesting and spring) increased from 16 per cent in 1990-1991 to 42 per cent in 1992-1993. The area remained at about this level until 2000, but increased to 53 per cent in 2002. The same trend has been evident for the proportion of the area under stubble for which support is granted.
- The area under stubble in winter 2005-2006 for which support was granted was 1.4 million decares. This support scheme also applies to some other types of areas such as areas lightly harrowed in autumn, directly sown autumn cereals, autumn cereals sown after light harrowing, catch crops and grassed channels. Grants were provided for a total area of 200 000 decares in the season 2005-2006. From 2005, these schemes have been included in the regional environmental programmes, and the way these are organised varies from county to county.

Figure 4.8. Sales of chemical pesticides, measured in tonnes of active substance. 1971-2005

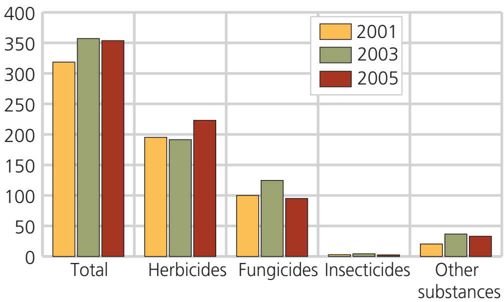


Source: Norwegian Food Safety Authority.

Use of pesticides

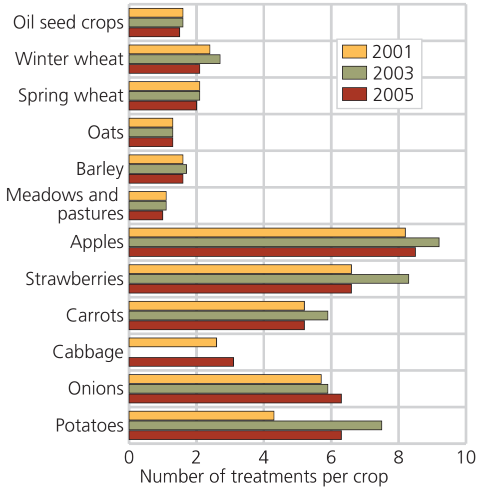
- The sales statistics apply to sales by importers to distributors and do not therefore show actual annual usage. Statistics for recent years are influenced by the fact that there have been changes in the taxation system, which have resulted in some hoarding of pesticides. In 1999, the system was changed from a flat-rate tax levied as a percentage of the sales value to a tax differentiated according to the hazardous properties of the pesticides. The new system resulted in a general rise in tax rates. Further changes in the taxation system entered into force in October 2004, and the taxes were raised again from 1 January 2005.

Figure 4.9. Use of pesticides, by type of product. 2001, 2003 and 2005. Tonnes of active substance



Source: Agricultural statistics, Statistics Norway (Bjørlo 2006).

Figure 4.10. Average number of treatments for crops in surveys. 2001, 2003 and 2005

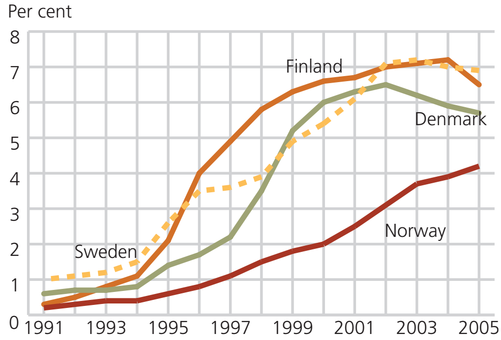


Source: Agricultural statistics, Statistics Norway (Bjørlo 2006).

- In 2001, 2003 and 2005, Statistics Norway conducted surveys to collect statistics on the actual use of pesticides. The crops surveyed in 2005 accounted for 97 per cent of the total agricultural area in use. Figure 4.10 shows which crops were included.
- Pesticide use may vary considerably from one year to another, largely because of weather conditions. To give an even more reliable picture of consumption patterns and trends over time, such surveys must be repeated at regular intervals.
- Only 6 per cent of the area of meadow and pasture was treated with chemical pesticides in 2005. For the other crops surveyed in 2005, the proportion of the area treated with pesticides varied from 81 per cent to almost 100 per cent, with an average of 94 per cent.
- There is some use of pesticides outside the agricultural sector, for example in gardens, on golf courses, along roads and railways and in forestry.
- Crops are vulnerable to pests to a varying extent. Among the crops in the survey, the number of treatments varied from an average of 1.1 in meadows and pastures to 8.2 in apple production.
- From 2001 to 2003, the number of treatments increased for all crops except onions. From 2003 to 2005, the number of treatments dropped for the crops that are normally treated often, such as potatoes, vegetables, strawberries and apples. The number of treatments for cereals, oil seed crops and pasture remained stable. The changes must be considered in conjunction with weather conditions in the years in question.
- According to the results of the 2005 survey, pesticides were generally used at the recommended application rates or somewhat below this.

4.5. Ecological farming

Figure 4.11. Areas farmed ecologically or in the process of conversion in the Nordic countries. Percentage of total agricultural area. 1991-2005



Source: Debio (Norway), KRAV (Sweden), Danish Plant Directorate (Denmark), Evira and agricultural statistics from TIKE (Finland).

Ecologically cultivated area in the Nordic countries

- Ecological farming increased in all the Nordic countries in the 1990s. Norway, with 4 per cent in 2005, has the lowest percentage, as against 6-7 per cent in the other Nordic countries. In the last two to three years, the area ecologically farmed has remained stable or dropped slightly in Sweden, Denmark and Finland. This may be because of a reduction in the price mark-up on ecological products relative to conventional products as a result of lower demand than expected. In addition, environmental grants have been introduced, and their requirements are less strict than those for certification for ecological farming. Some farmers who wish to operate in an environmentally sound way may have been satisfied with meeting the requirements for environmental grants. In 2005, there were signs of stagnation in the Norwegian ecological farming.

- The Norwegian authorities' target is for 10 per cent of the agricultural area to be ecologically farmed by 2009. Based on the agricultural area in use in 2005, this corresponds to just over 1 million decares. The area farmed ecologically in Norway is still rising, but has not increased much in the past two years. In 2005, the area converted to ecological farming and the area in the process of conversion totalled 430 000 decares. From 2004 to 2005, there was a small reduction in the number of milk cows and sheep on ecologically-run holdings.

Box 4.4. Ecological farming

Ecological farming (or organic farming) is a collective term for various farming systems based on some common principles:

- No use of commercial fertiliser or chemical/synthetic pesticides
- Cultivation of a variety of crops and diversified crop rotation
- Cultivation systems should have a preventive effect on disease and pests
- Organic material recycled as far as possible
- Balance between livestock numbers and areas of farmland with respect to fodder production and use of manure.

Ecological agriculture has certain environmental advantages over conventional farming systems:

- Less loss of nutrients and thus less pollution
- More varied agricultural landscape and therefore greater species diversity in and around agricultural areas
- No pesticide residues in soils or products
- Product quality often perceived as higher.

Ecological agriculture is considerably more labour-intensive than conventional agriculture, and yields are generally lower. Product prices are higher, but there are fewer sales channels.

The Agricultural Agreement has included support schemes for ecological farming practices since 1990. Requirements relating to ecological agricultural production are laid down in regulations issued by the Ministry of Agriculture and Food, and the organisation Debio is responsible for inspection and control. Each holding run on ecological principles must be approved by Debio and must be inspected at least once a year.

More information: Henning Høie (henning.hoie@ssb.no, environmental impacts of agriculture) and Ole Rognstad (ole.rognstad@ssb.no, agriculture).

Useful websites

Statistics Norway agricultural statistics: http://www.ssb.no/english/subjects/10/04/
Statistics Norway national accounts: http://www.ssb.no/english/subjects/09/01/
Debio: http://www.debio.no/
Ministry of Agriculture and Food: http://odin.dep.no/land/
Norwegian Agricultural Authority: http://www.slf.dep.no/
Norwegian Agricultural Economics Research Institute: http://www.nilf.no/
Norwegian Food Safety Authority: http://www. mattilsynet.no
Norwegian Institute for Agricultural and Environmental Research:
http://www.bioforsk.no/
Norwegian Forest and Landscape Institute: http://www.skogoglandskap.no/

References

Bjørlo, B. (2006): *Bruk av plantevernmidler i jordbruket i 2005* (Use of pesticides in agriculture in 2005. [In Norwegian with English abstract]). Reports 2006/42, Statistics Norway. http://www.ssb.no/emner/10/04/10/rapp_200642/

Budget Committee for Agriculture (2006): *Volum- og prisindekser for jordbruket. Regnskapsåra 1959-2005* (Volume and price indices for agriculture. Accounting years 1959-2005). Norwegian Agricultural Economics Research Institute.

Grønlund, A. and H. Høie (2001): Indikatorer for bruk og vern av jordressursene (Indicators for use and protection of agricultural land resources). *Kart og Plan 3, 2001*, Oslo/Ås: Scandinavian University Press.

Report No. 19 (1999-2000) to the Storting: *Om norsk landbruk og matproduksjon* (Norwegian agriculture and food production). Ministry of Agriculture and Food.

5. Forest and uncultivated land

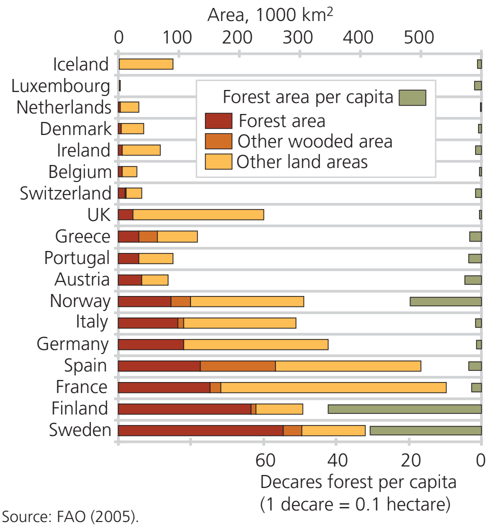
The Norwegian forests contain a wide variety of resources and environmental qualities. In terms of the economy, forests are primarily important as a source of raw materials for the sawmilling and pulp and paper industries. The forest, with its biological diversity, also has considerable intrinsic value as an ecological resource and as an outdoor recreation area for an increasingly urbanized population. This provides a basis for utilizing the resources of uncultivated areas for tourism as well.

However, varying interests in forests and forest resources are continuing to lead to conflicts between different groups of forest users. In order to reduce the adverse effects on ecology of timber production and its disadvantages to recreational users, the forestry industry itself and the authorities have in recent years placed greater emphasis on multi-use considerations.

This chapter describes the forestry industry and the importance of forest and uncultivated areas in a wider perspective. The growing stock in Norway has increased considerably for many years because the rate of roundwood removals has been lower than the natural increment. This accumulation of carbon in forests has resulted in an annual uptake of CO_2 by forest that is equivalent to about 55 per cent of Norway's total anthropogenic CO_2 emissions each year. This is one of the topics described here, together with the biological diversity of forests and their sensitivity to environmental pressures such as climate change and air pollution. Game species, the large predators and reindeer husbandry are also discussed.

5.1. Distribution of forests in Norway and Europe

Figure 5.1. Forest area and total land area in selected EU and EFTA countries



Source: FAO (2005).

Forested area

- About 125 000 km² (38 per cent) of Norway's area is forested. Of, this, about 75 000 km² is productive forest (Norwegian Forest and Landscape Institute 2006). This equals about 23 per cent of the total land area of Norway. Almost half of this forested area is managed in combination with agricultural operations.
- About 1.45 million km² or 36 per cent of the total area of the EU countries is forested. Sweden and Finland have the largest areas of forest. With Norway, these countries have the largest area of forest relative to population.
- Forestry and forest industries employ 2.2 million persons in the EU area today (UN-ECE/EC 2000).

Box 5.1. Protection of forests in Norway

Norway's forests need protection even though both the total area of forest and the amount of timber forests contain are rising. Modern, efficient forestry has made large areas of forest more uniform, and has reduced the area of forest that is allowed to develop without human intervention. Different habitats contain specially adapted species of insects, plants and other organisms. Forest protection is therefore necessary to maintain diversity in forests and rare types of habitats.

An estimated 22 000 forest plant and animal species have been recorded in Norway, and about 1 400 of these are rare or endangered (Directorate for Nature Management 1999). Norway has ratified the Convention on Biological Diversity, which was adopted by the UN Conference on Environment and Development in 1992, and is therefore required to take steps to identify and monitor its biological diversity.

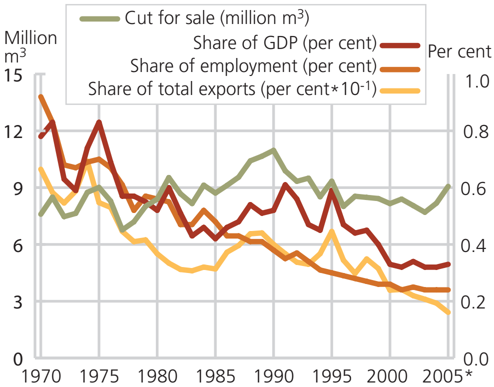
As of 1 January 2006, a total of 984 km² or 1.3 per cent of the productive forest area (75 346 km²) in Norway was protected. Included in this figure are protected forest areas in the national parks (Directorate for Nature Management 2006).

By comparison, 3.7 per cent of the total area of productive forest in Sweden was protected in 2000. The corresponding figure for Finland was 4.1 per cent in 2002 (Swedish Environmental Protection Agency 2005 and METLA 2004).

In November 2003, the Norwegian Parliament discussed a recent white paper on the Government's environmental policy and the state of the environment in Norway (Report No. 25 (2002-2003) to the Storting). The white paper includes plans for a further increase in the protection of forests. Work is now organised according to a three-track strategy: traditional forest protection, forest protection on state-owned land and voluntary forest protection in collaboration with the Norwegian Forest Owners' Federation.

5.2. Forestry

Figure 5.2. Forestry: share of exports, employment and GDP. Annual roundwood removals. 1970-2005*



Source: National accounts and forestry statistics, Statistics Norway.

Roundwood removals and economic importance

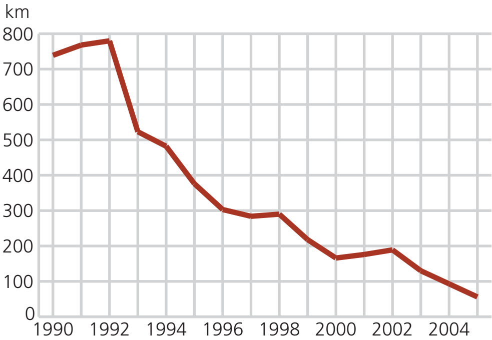
- In 2005, forestry's share of total employment was 0.24 per cent. This is equivalent to 4 600 full-time equivalents, down from 13 700 in 1970. In relative terms, employment has declined by about the same extent as in agriculture.
- Forestry's share of Norway's GDP dropped from 0.78 per cent in 1970 to 0.33 per cent in 2005. Forestry's share of GDP has declined less sharply than that of agriculture.
- The gross value of the roundwood removed for commercial purposes in 2005 was NOK 2.8 billion, and wood and wood processing products worth NOK 13.9 billion were exported from Norway.

Box 5.2. Forest owners' attitudes to protection of their forests differ between the Nordic countries

A Nordic report (Vatn et al. 2005) analyses the reasons why the protection of forest and wetland biodiversity gives rises to different levels of conflict in Norway, Sweden and Finland. The analysis was based on interviews with forest owners in the three countries, part or all of whose property has been protected. The main finding was that conflicts are closely linked to how the protection process is organised and carried out. In all three countries, the majority of those interviewed were positive to idea of protecting biodiversity. In Finland and Sweden, the majority of the owners were also positive to protection on their own land provided that they were given full economic compensation, but Norwegian owners were far more negative. There was also considerable dissatisfaction with the protection process in Norway, where it has largely been a "top down" process. There was also considerable dissatisfaction with the environmental authorities been responsible for the protection process in Norway. In Finland and Sweden, the forest authorities have played a much greater role, and the forest owners appeared to have markedly greater confidence in them. However, it should also be noted that the type of protection has tended to be less strict in Finland and Sweden (for example, some use of time-limited protection). Trials of various forms of voluntary protection are now under way in all three countries.

For more information, see: Vatn, A., E. Framstad and B. Solberg (red.) (2005): Virkemidler for forvaltning av biologisk mangfold. Delrapport 3. Tiltak og virkemidler for vern av biodiversitet i skog og våtmarker. (Instruments for management of biodiversity. 3. Measures and instruments for protecting biodiversity in forests and wetlands) TemaNord 2005:563, Nordic Council of Ministers.

Figure 5.3. Annual construction of new forest roads for year-round use. 1990-2005



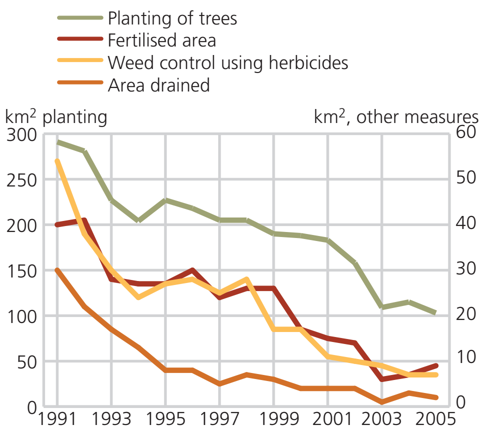
Source: Forestry statistics, Statistics Norway.

Forest roads

- For many years, the construction of forest roads has been an important contributory cause of the reduction in the size and number of wilderness-like areas in Norway (SSB/SFT/DN 1994). At the beginning of 2005, the total registered length of forest roads (whole-year roads and summer roads for lorries) was 48 400 km.
- However, the rate of construction of forest roads has dropped from 780 km forest roads for year-round use in 1992 to 56 km in 2005.
- A total of NOK 97 million was invested in forest roads in 2005, and NOK 29 million of this was in the form of public grants, NOK 14 million less than in 2004.

For the size of wilderness-like areas, see Chapter 8 Land and land use.

Figure 5.4. Silviculture measures that have an environmental impact[1,2]. 1991-2005*



[1] The figures refer to silviculture funded by the Forest Trust Fund and/or government grants.
[2] No figures are available for the county of Finnmark in 1998.
Source: Forestry statistics, Statistics Norway.

Silviculture

- There has been a decrease in silvicultu-re activities since the beginning of the 1990s. Public funding for such activities was discontinued in 2003. However, some funding is now available again in the form of municipal grants.
- The planting of trees is the largest single silviculture investment. A total of NOK 73 million was invested in planting in 2005, and an area of 103 km² was planted.
- There may be several reasons for the decline in the use of chemical herbicides: increased focus on environmental considerations in forestry, restrictions on the use of spraying, annulment of grants and reduced profitability in forestry.
- The county of Nord-Trøndelag accounted for half of all forest drainage in 2005.

Box 5.3. Environmental inventories in forests - biodiversity

Forestry planning and adequate information about forests and the environment form the main basis of long-term, sustainable forest management. Forestry planning, which is funded by government grants, is carried out in accordance with regulations concerning government grants for forestry planning, which include various provisions relating to purpose, requirements for standards and inventory methods, organisation, etc. Registration of biological diversity is now included in forestry planning. Forestry planning aims to obtain localised information to enable forest owners to base their activities on documented facts about forest areas, resources and areas of environmental value. Forestry plans are primarily intended as a tool for owners to generate value-added based on the rational use of forestry resources and sustainable forest management and to function as the basis for annual plans and operations.

It is important that the registration of biodiversity in forests included in forestry planning is conducted according to clearly defined instructions so that the registration can be documented and verified and the results are objective and comparable. This is important in order to ensure that the work of registration maintains a clear and reliable profile, and because the various environmental considerations will always involve consequences for commercial activities.

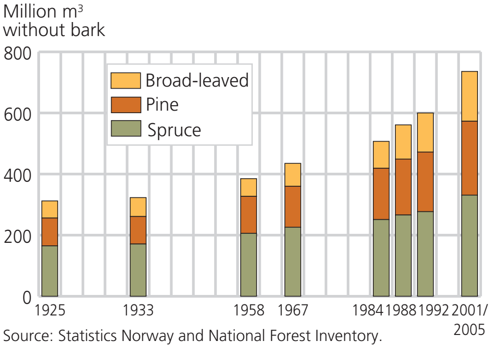
The environmental inventory method used in forestry planning is based on extensive research and documentation of ecological relationships, and clearly indicates how the method was developed and the specific data to be registered. The Norwegian Forest Research Institute, a key forestry research institute under the Ministry of Agriculture and Food, coordinated the development of the method. On the basis of the project's scientific results, a registration methodology was developed to capture important environmental qualities in connection with forestry plans drawn up on request from individual forest owners. The project was funded by the Ministry of Agriculture and Food, and government support is provided for forest owners who request forestry plans that include registration of biodiversity. The registration scheme was fully operational from 2001, and registration has been carried out in about 20 km^2 of productive forest. In 2006, NOK 25 million was allocated for forestry planning including environmental inventories.

A booklet is available describing the registration method, and courses have been held for forestry planners and other users. The Norwegian Institute of Land Inventory (NIJOS) was involved in the establishment of a practical registration procedure. The Norwegian Forest Research Institute and the Norwegian Institute of Land Inventory have now been merged to form the Norwegian Forest and Landscape Institute. The booklet is available in Norwegian on this institute's website (http://www.skogoglandskap.no).

As work on environmental registration continues, new information can be expected to emerge that will be valuable in connection with the environmental adaptations implemented by the forestry industry in accordance with government policy and the Living Forests Standards. This work is also relevant to the national programme to survey and monitor biological diversity (Ministry of Agriculture and Food 2006).

5.3. Increment and uptake of CO_2 by forest

Figure 5.5. Volume of the growing stock. 1925-2001/2005

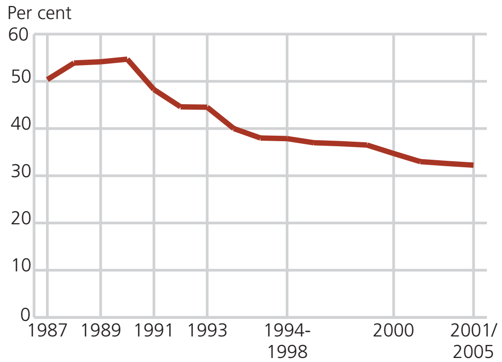


Source: Statistics Norway and National Forest Inventory.

Forest volume and utilisation rate of the growing stock

- Since the early 1920s, roundwood removals have been less than the annual increment. In 1925, about 80 per cent of the increment was cut, whereas only about one third was cut in the period 2001-2005 (see also Appendix, tables C1 and C2). As a result, the volume of the growing stock below the coniferous forest line has more than doubled since 1925.
- In 2005, the gross increment in Norwegian forests was almost 26 million m^3.

Figure 5.6. Utilisation rate of the growing stock[1]. 1987-2001/2005



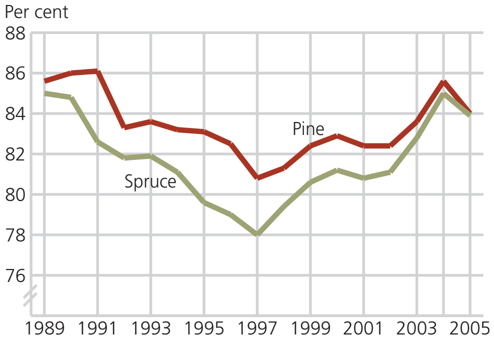
[1] Utilisation rate is defined here as the volume of roundwood removals in relation to gross increment.
Source: Forestry statistics, Statistics Norway and National Forest Inventory.

Uptake of CO_2

- The increase in the biomass (branches and roots included) of forests in 2004 resulted in an uptake of carbon by forest that corresponded to 24 million tonnes of CO_2 or about 55 per cent of the total anthropogenic CO_2 emissions in Norway. This figure is based on the methodology used by Rypdal et al. (2005), but the estimate is somewhat higher because improvements have been made in the method for estimating forest biomass, and the figures reported to the UN Climate Change Convention have therefore been changed.
- Estimates of carbon pools in dead wood and soil have been made. Carbon levels have increased by an amount corresponding to 4 million tonnes of CO_2 or 10 per cent of total anthropogenic emissions in 2003 (Rypdal et al. 2005).

5.4. Forest damage

Figure 5.7. Mean crown condition for spruce and pine. 1989-2005



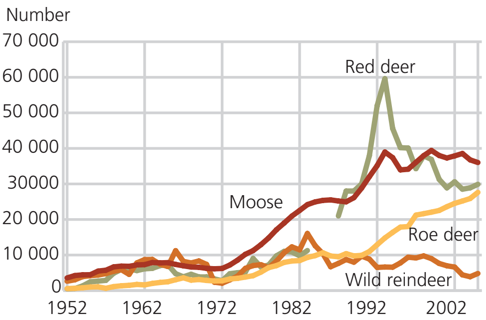
Source: Norwegian Forest and Landscape Institute.

Forest damage in Norway

- Crown density is an indicator of the forest's state of health. Decreasing crown density was the trend from the first survey in 1989 and up to 1997. Since then, crown density of both spruce and pine has improved, with the exception of a small setback for both species in 2005.
- Mean crown density was 83.9 per cent for spruce and 84.0 per cent for pine in 2005.
- The crown colour of spruce was greener in 2005 than the year before. Pine showed a significant improvement in crown colour status, and an improvement was also recorded for birch.

5.5. Game species

Figure 5.8. Number of moose, red deer, wild reindeer and roe deer killed. 1952-2005

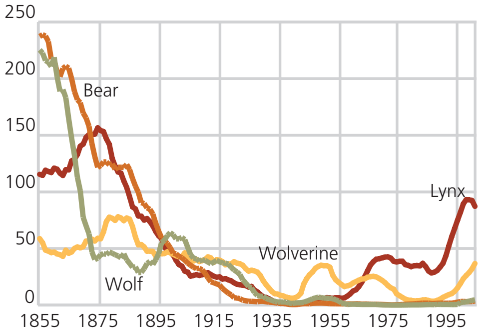


Source: Hunting statistics, Statistics Norway.

Cervids

- The numbers of forest-living cervids have risen considerably in the last 20-30 years, particularly as a result of clear-cutting and selective shooting.
- The grazing pressure exerted by large populations of cervids influences the vegetation, and this can affect the landscape and biological diversity.
- The total yield in 2005 was 4 765 tonnes of moose meat, 1 585 tonnes of venison and 167 tonnes of wild reindeer meat (see also Appendix, table C3).

Figure 5.9. Number[1] of predators killed. 1885-2005



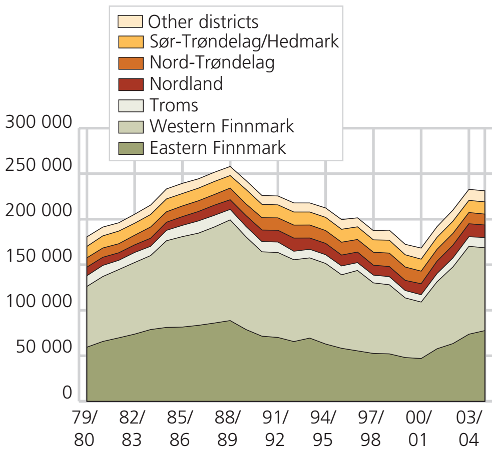
[1] Average number past ten years.
Source: Hunting statistics, Statistics Norway.

The large predators

- Relentless hunting of all four species of large predators had almost exterminated wolves and bears by the middle of the 20th century. Wolves and bears were protected throughout Norway in 1971 and 1973 respectively.
- In recent years, wolf numbers have recovered again in Scandinavia. It is uncertain whether they have spread southwards from northern Scandinavia and Russia or whether reproduction by the few resident animals that were never exterminated has raised their numbers.
- Today, lynx is classified as a game species, and lynx hunting is regulated by means of quotas (see also Appendix, table C4). Wolverines, wolves and bears are protected, but in certain cases, licensed hunters may be permitted to take a certain number of animals, or animals that are a danger to livestock may be culled.

5.6. Reindeer husbandry

Figure 5.10. Trends in the size of the spring herd. 1979/80-2004/05*



Source: Norwegian Reindeer Husbandry Association.

Geographical scope and economic importance

- Reindeer husbandry is a small sector in national terms, but shares user interests with others in an area equivalent to 40 per cent of the total area of Norway.
- There was a large reduction in the size of the spring herd (stock size before calving starts in May) in Finnmark in the period 1988/89-2000/01. This was a result of management measures implemented because of overgrazing, increased losses to predators and difficult weather conditions in winter in several years at the end of the 1990s. In the past four years, the size of the reindeer stock in Finnmark has increased substantially due to good calving seasons, primarily due to very favourable weather conditions during the winter season.

5.7. Management of uncultivated areas

Table 5.1. Processing of applications for exemptions under the Act relating to motor traffic on uncultivated land and in water courses. Whole country. 2001-2005

	Number of applications processed by the municipalities	Number approved	Percentage approved
2001[1]	12 674	11 863	94
2002[1]	14 186	13 255	93
2003[1]	13 208	12 557	95
2004	18 025	15 926	88
2005	18 218	15 269	84

[1] No. of applications in reporting municipalities (between 80 and 95 per cent of all municipalities).
Source: Statistics Norway.

Motor traffic

- Motor traffic in uncultivated areas is in principle prohibited. However, under the Act relating to motor traffic on uncultivated land and in watercourses, local authorities may grant exemptions from the Act, allowing the use of motor traffic for certain purposes. No data on actual traffic is available, but KOSTRA (a system for reporting and publishing local government information) provides information on the use of exemptions by local government authorities.
- In all, 84 per cent of all applications for exemption were approved in 2005. The number of applications was at its highest since KOSTRA reporting started in 2001. However, the percentage of exemptions granted decreased, resulting in fewer exemptions than the year before.
- See also Chapter 8, Land and land use, where municipal land use management and building activity in the coastal zone (100-metre belt) is described.

More information: Ketil Flugsrud (kfl@ssb.no: forest balance), Trond Amund Steinset (tra@ssb.no: forest and game), and Henning Høie (hei@ssb.no: management of uncultivated areas).

Useful websites

Statistics Norway forestry statistics: http://www.ssb.no/english/subjects/10/04/20/
Statistics Norway, hunting statistics: http://www.ssb.no/english/subjects/10/04/10/
Norwegian Forest Research Institute: http://www.nisk.no/
Norwegian Forest and Landscape Institute: http://www.skogoglandskap.no/
Norwegian Reindeer Husbandry Association: http://www.reindrift.no/
The Living Forests Project: http://www.levendeskog.no/Engelsk_Default.asp

References

Directorate for Nature Management (1997): *Overvåkning av biologisk mangfold i åtte naturtyper* (Biological diversity monitoring in eight different ecosystems). Report 1997-7 from the Directorate for Nature Management.

Directorate for Nature Management (2006): the Directorate's website (http://english.dirnat.no).

FAO (2005): Global Forest Resources Assessment 2005. Progress towards sustainable forest management. FAO Forestry paper 147.

METLA (2004): *Skogstatistisk årsbok* (Statistical Yearbook of Forestry). Helsinki: Finnish Forest Research Institute.

Ministry of Agriculture and Food (2006): The Norwegian text on registration of biological diversity in forests in Box 5.3 was prepared by the Ministry of Agriculture and Food, Department for Forest and Resource Policy.

Norwegian Forest and Landscape Institute (2006): http://www.skogoglandskap.no/

Rypdal, K., V.V. Holst Bloch, K. Flugsrud, T. Gobakken, B. Hoem, S.M. Tomter and H. Aalde (2005): *Emissions and removals of greenhouse gases from land use, land-use change and forestry in Norway.* Report 11/05, Norwegian Institute for Land Inventory.

SSB/SFT/DN (1994): *Naturmiljøet i tall 1994* (The natural environment in figures 1994). Statistics Norway, the Norwegian Pollution Control Authority and the Directorate for Nature Management. Oslo: Scandinavian University Press.

Swedish Environmental Protection Agency (2005): the Agency's website (www.naturvardsverket.se). Background data on forest protection.

UN-ECE/EC (2000): *Forest Condition in Europe. 1999 Executive Report, Federal Research Centre for Forestry and Forest Products,* United Nations Economic Commission for Europe and the European Commission.

Vatn, A., E. Framstad and B. Solberg (red.) (2005): Virkemidler for forvaltning av biologisk mangfold. Delrapport 3. Tiltak og virkemidler for vern av biodiversitet i skog og våtmarker. (Instruments for management of biodiversity. 3. Measures and instruments for protecting biodiversity in forests and wetlands) TemaNord 2005:563. Nordic Council of Ministers.

6. Fisheries, sealing, whaling and fish farming

Stocks of several important demersal fish species in the North Sea are still at very low levels. The same is true of the Barents Sea capelin stock. The spawning stock of Northeast Arctic cod is considered to be within safe biological limits. However, the fishing mortality is considered to be too high and there is considerable illegal fishing. In 2005, production of farmed salmon increased to 582 000 tonnes.

In the Barents Sea and Norwegian Sea, the stocks of Northeast Arctic cod, saithe and haddock and Norwegian spring-spawning herring are at satisfactory levels. The Barents Sea capelin stock is very low and is classified as having reduced reproductive capacity. The stocks of redfish (*Sebastes marinus* and *S. mentella*) are at present at historically low levels. The state of the Northeast Arctic Greenland halibut stock is somewhat uncertain, but there seems to have been some growth in the spawning stock since 1996. The blue whiting stock seems to be in relatively good condition even though it has been heavily exploited, and far more heavily than recommended, in recent years. However, the current fishing pressure means that the stock is very vulnerable and is dependent on a continued high level of recruitment. In recent years, the inflow of warm Atlantic water to eastern parts of the Norwegian Sea has been high, resulting in high temperatures in this area. This may be one reason for the strong recruitment to the blue whiting stock (Iversen et al. 2006).

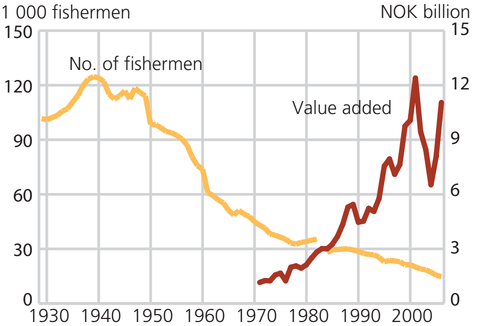
For the last three to four years, there has been poor recruitment to the sandeel, Norway pout and cod stocks, and to some extent to the North Sea herring stock. This is mainly a result of changes in physical and biological conditions, although the cod and sandeel stocks have also been overfished. At the beginning of 2006, temperatures in the North Sea were very high, about 2 °C above normal (Iversen et al. 2006).

The total world catch from marine fisheries was 86 million tonnes in 2004, an increase of about 4 million tonnes compared with the year before. The species with the highest total catch was Peruvian anchovy (*Engraulis ringens*). The catch of this species was 10.7 million tonnes, which corresponds to more than four times the total yield of Norwegian fisheries and 12 per cent of the total world catch in marine areas. Total world aquaculture production in 2004 was 45 million tonnes.

In 2006, the Norwegian Government presented a white paper on the integrated management of the marine environment of the Barents Sea–Lofoten area (Report No. 8 (2005-2006) to the Storting) The summary of the white paper states that *«The purpose of this management plan is to provide a framework for the sustainable use of natural resources and goods derived from the Barents Sea and the Barents Sea–Lofoten area and at the same time maintain the structure, functioning and productivity of the ecosystems of the area.»*. The white paper also describes measures to prevent acute oil pollution, reduce long-range transboundary pollution, develop an ecosystem-based management regime and combat illegal, unreported and unregulated fishing (IUU fishing).

6.1. Principal economic figures for the fisheries

Figure 6.1. Value added[1] in the fishing, sealing and whaling industry 1970-2005, and number of fishermen 1926-2005

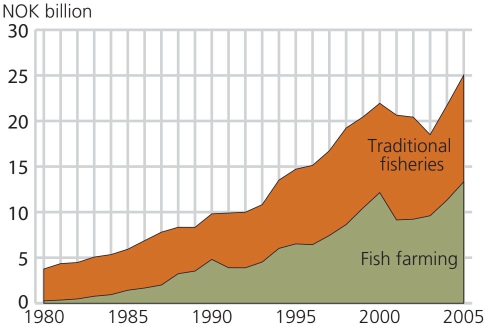


[1] Value added in basic values. Current prices.
Source: Directorate of Fisheries and National Accounts, Statistics Norway.

GDP and employment

- According to the Norwegian national accounts, fishing, sealing, whaling and fish farming contributed NOK 11.0 billion, or 0.6 per cent, to Norway's gross domestic product (GDP) in 2005.
- The fishing industry accounted for 0.7 per cent of total employment in 2005. At the end of 2005, 14 785 fishermen were registered in Norway. The number of fishermen has dropped by about 88 per cent since the late 1930s. Since 1990, the reduction has been 46 per cent. Farming of salmon and trout employs about 3 000 people.

Figure 6.2. First-hand values in traditional fisheries and fish farming. 1980-2005



Source: Directorate of Fisheries and Fisheries statistics, Statistics Norway.

Production and prices

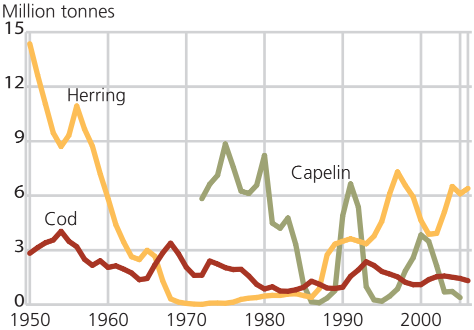
- The growth in the value of the traditional Norwegian marine fisheries continued from 2004 to 2005. In 2003, prices were low and the total first-hand value was NOK 8.9 billion. The first-hand value rose by NOK 1.5 billion from 2003 to 2004 and by a further NOK 1.3 billion to NOK 11.7 billion from 2004 to 2005. In current prices, the first-hand value in 2005 was at the same level as in the record year 2001. The rise in first-hand value is explained by higher prices (Statistics Norway 2006).

- The preliminary figures from the national accounts for production in fisheries, sealing, whaling and fish farming show a rise of 5.6 per cent from 2004 to 2005, measured in constant prices (Statistics Norway 2006).

- The export price for fresh salmon rose by 6.6 per cent from 2003 to 2004 and by almost three times as much, 17.1 per cent, from 2004 to 2005. The quantity of fresh salmon exported has continued to rise, by 7 per cent from 2003 to 2004 and by 13 per cent from 2004 to 2005 (Statistics Norway 2006).

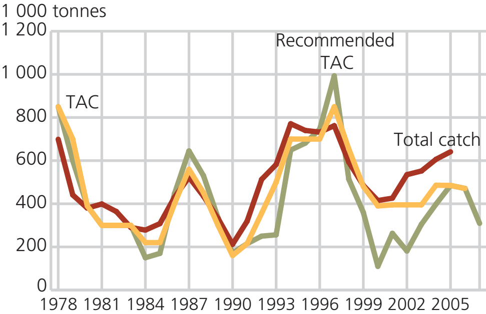
6.2. Trends in stocks

Figure 6.3. Trends for stocks of Northeast Arctic cod[1], Norwegian spring-spawning herring[2] and Barents Sea capelin[3]. 1950-2006



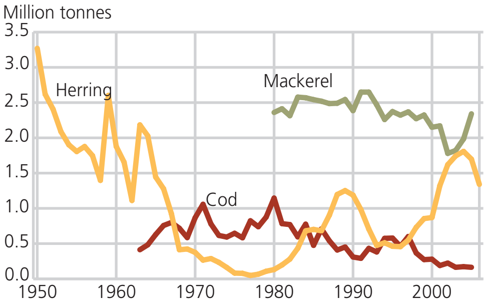
[1] Fish aged three years and over. [2] Spawning stock.
[3] Fish aged one year and over.
Source: ICES and Institute of Marine Research, Bergen.

Figure 6.4. Recommended TACs, TACs actually set and catches[1] of Northeast Arctic cod. 1978-2007



[1] Unreported catches were estimated at 90 000 tonnes in 2002 and 2004, 115 000 tonnes in 2003 and 166 000 tonnes in 2005.
Source: ICES and Institute of Marine Research, Bergen.

Figure 6.5. Trends for stocks of cod in the North Sea[1], North Sea herring[2] and mackerel[2,3]. 1950-2006



[1] Fish aged one year and over. [2] Spawning stock. [3] Southern, western and North Sea mackerel.
Source: ICES and Institute of Marine Research, Bergen.

Barents Sea-Norwegian Sea

- The spawning stock of Norwegian spring-spawning herring was estimated to be 6.4 million tonnes in 2006. The stock is above the precautionary reference point, and is considered to have good reproductive capacity.
- The total stock of capelin in the Barents Sea in autumn 2005 was estimated to be below 0.4 million tonnes. The collapse of this stock has been caused by weaker recruitment, higher natural mortality and reduced individual growth.
- The total stock of Northeast Arctic cod was estimated to be about 1.3 million tonnes in 2006.
- Illegal fishing is a serious problem, and total landings in recent years have been considerably above the TAC (total allowable catch). The TAC for 2006 was 471 000 tonnes. This was the level recommended by the International Council for the Exploration of the Sea (ICES), and was set according to new rules for calculating the annual TAC. For 2007, ICES has recommended that the TAC should be cut to only 309 000 tonnes.

North Sea

- The spawning stock of North Sea herring was estimated to be about 1.3 million tonnes in 2006, a little over the precautionary level. The last three year classes have been weak.
- The North Sea cod stock is at a historical low, and it is being harvested unsustainably.
- The total spawning stock of mackerel has been decreasing for some time. The estimate for 2005 indicates an increase, but this is very uncertain.

Box 6.1. Reference points for the spawning stock of some important fish stocks

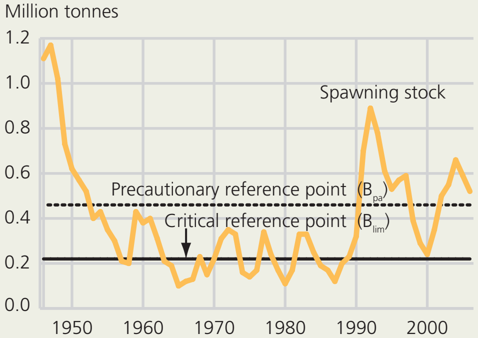
The International Council for the Exploration of the Sea (ICES) and its Advisory Committee on Fishery Management (ACFM) have defined reference points for the levels of different species' spawning stocks and fishing mortality. These are important tools for the authorities in their efforts to take a precautionary approach to fisheries management. The critical spawning stock reference point (B_{lim}) is considered to be a danger level below which there is a high probability of poor recruitment. The level is defined on the basis of historical stock data and current theories on the dynamics of fish stocks. The precautionary reference point (B_{pa}) is somewhat higher, and can be interpreted as a warning level: if a spawning stock falls below this level the authorities should consider taking steps to allow the stock to recover to a higher and safer level in order to safeguard sustainable fisheries.

The table below shows B_{lim} and B_{pa} for some important stocks, and their estimated spawning stocks in 2005.

Stock	B_{lim} (critical reference point) 1 000 tonnes	B_{pa} (precautionary reference point) 1 000 tonnes	Estimated spawning stock 2005. 1 000 tonnes
Northeast Arctic cod	220	460	590
Northeast Arctic saithe	136	220	690
Norwegian spring-spawning herring	2 500	5 000	6 000
North Sea herring	800	1 300	1 700
North Sea cod	70	150	< B_{lim}
North Sea saithe	106	200	240
Mackerel (total stock)	No biological basis for definition of limit	2 300	2 300

The figure below shows changes in the spawning stock of Northeast Arctic cod since 1946. The spawning stock was about 520 000 tonnes in 2006, which is slightly above the precautionary level. Although the size of the spawning stock is reasonably satisfactory, fishing mortality (i.e. the proportion of total mortality that is due to fishing) is considered to be too high.

Spawning stock biomass and critical (B_{lim}) and precautionary (B_{pa}) reference points for Northeast Arctic cod. 1946-2006



Source: Institute of Marine Research and ICES.

Box 6.2. More about stock trends and fisheries management

- In 2006, the stock of *Norwegian spring-spawning herring* was well above the precautionary level defined by marine scientists. The strong 2002 year class indicates that the future for the stock is promising.

- The decline in the total stock of *Barents Sea capelin* is due to weak recruitment, increased natural mortality and reduced individual growth. This collapse of the stock is not considered to have been caused by fishing. Predation by cod and herring on capelin and capelin larvae is an important cause of the higher natural mortality. The Norwegian-Russian Fisheries Commission decided, as recommended by the ICES Advisory Committee on Fishery Management, to close the fishery for Barents Sea capelin in winter 2006.

- The spawning stock of *Northeast Arctic cod* - around 520 000 tonnes in 2006 - is somewhat above the precautionary level, but the fishing mortality is still considered to be too high. One important reason for the increase in spawning biomass after 2000 is earlier maturation.

- The spawning stock of *North Sea herring* was substantially depleted in the period 1989-1994, from about 1.2 million tonnes to about 500 000 tonnes. The poor state of the stock in 1990s was a result of years of overfishing. There have been positive developments in recent years as a result of higher recruitment and strict management, so that fishing mortality of mature herring has been low and catches of young herring have been limited. The current spawning stock is above the precautionary level. However, the fact that three weak year classes (2002-2004) are currently recruiting to the stock means that special caution is required.

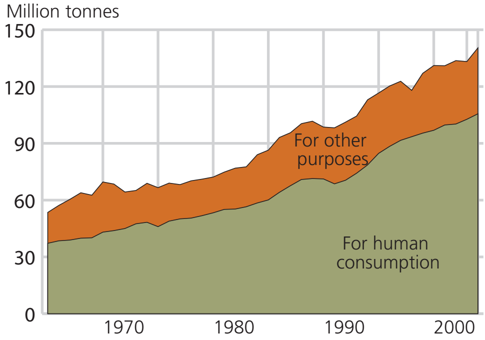
- Several of the stocks of demersal fish in the North Sea have remained low for many years. The *cod stock in the North Sea* has been heavily fished, and the spawning stock is at an all-time low. ICES has recommended a zero catch of cod, but Norway and the EU have nevertheless set quotas. The stock size of *whiting* is uncertain. The stocks of saithe and haddock have shown positive trends in recent years. The spawning stocks of Norway pout and sandeel are considered to be at low levels. Both these species are short-lived, and it is difficult to give reliable long-term prognoses.

- For management purposes, the spawning stocks of *mackerel* from the three spawning grounds (the North Sea, south-west of Ireland and off Spain and Portugal) are now considered as one stock (Northeast Atlantic mackerel). These stocks mix on feeding grounds in the North Sea and Norwegian Sea. The largest component of the stock is found off Ireland. Stock estimates for mackerel are made every three years, and the estimated stock size has been substantially reduced compared with the 2003 ICES estimate. However, the catch data are uncertain because considerable quantities are discarded or unregistered, and the estimates of the stock size are therefore also uncertain.

Source: *Marine Resources and Environment 2006* (Iversen et al. 2006). See also Box 6.1 and Appendix, table D1.

6.3. Fisheries

Figure 6.6. World fisheries production[1], by main uses. 1965-2004



[1] Production data does not include marine mammals (seals, whales, etc.) or plants. Aquaculture is included.
Source: FAO.

Table 6.1. World fisheries production. 2004

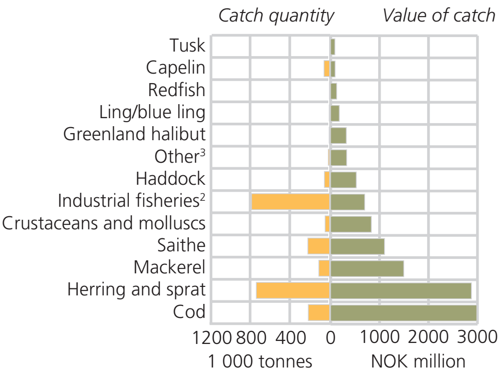
	1 000 tonnes	Per cent
Total production	**140 475**	**100**
Marine fisheries	85 788	61,1
Freshwater fisheries	9 219	6,6
Aquaculture (fish, crustaceans, etc.) in marine waters.	19 717	14,0
Aquaculture (fish, crustaceans, etc.) in inland waters	25 752	18,3

Source: FAO.

World catches

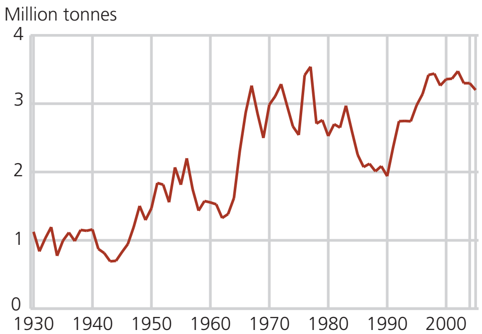
- Production in the world's fisheries, including both inland and marine catches and aquaculture production, has increased substantially: from slightly more than 50 million tonnes in 1965 to about 140 million tonnes in 2004.
- The proportion used for human consumption in 2004 was 75 per cent. Table 6.1 shows production split by type.
- The species with the highest total catch in 2004 was Peruvian anchovy (*Engraulis ringens*) at 10.7 million tonnes: this figure was 4.5 million tonnes higher than in 2003 (see also Appendix, table D8).

Figure 6.7. Norwegian catches[1] by groups of fish species, molluscs and crustaceans. 2005



[1] Catches delivered by Norwegian vessels in Norway and abroad.
[2] Includes greater and lesser silver smelt, Norway pout, sandeel, blue whiting and horse mackerel.
[3] Includes the categories hake/pollack/whiting, other flatfish, other demersal fish, miscellaneous deepwater species and other, unspecified fish.
Source: Directorate of Fisheries.

Figure 6.8. Total production[1] in Norwegian fisheries. 1930-2005



[1] Fish farming production is included.
Source: Directorate of Fisheries and Fisheries statistics, Statistics Norway.

Norwegian catches

- In 2005 the total catch in Norwegian fisheries (including crustaceans, molluscs and seaweed) was 2.5 million tonnes, and the value of the catch was NOK 11.7 billion. The total catch was about 130 000 tonnes lower than in 2004, but the value was almost NOK 1.3 billion higher.
- Cod and herring are the species with the highest catch value, 3.0 and 2.9 billion NOK, respectively.
- The catch of blue whiting remained high in 2005, at 739 000 tonnes. This is nevertheless 220 000 tonnes less than in 2004. The catch of sandeels was very low, 17 000 tonnes. The catch of Norway pout was only 300 tonnes, and no ordinary fishing for this species was allowed in 2005.
- The total catch in Norwegian fisheries is now two to three times higher than in the 1930s.
- Total production in the fisheries and fish farming in 2005 was about 3.2 million tonnes, of which 2.5 million tonnes was in the traditional fisheries.
- The highest level of catches in the traditional fisheries in the period since 1930 is 3.5 million tonnes in 1977. In the same year, more than 2 million tonnes capelin was caught.

Box 6.3. World catches and Norwegian catches

Total catches in the world's marine fisheries in 2004 rose by over 4 million tonnes from the year before to about 86 million tonnes. There was a moderate increase in catches in inland fisheries, to 9.2 million tonnes.

The catches in the Southeast Pacific increased by about 5 million tonnes compared with 2003. Total landings of *anchoveta* increased by 4.5 million tonnes, while the catch of *Chilean jack mackerel* was about the same as the year before. Together with South American pilchard (*Sardinops sagax*), these two species make up about 80 per cent of the catches in the Southeast Pacific. There were no dramatic changes in catches in other marine areas. The Northwest Pacific is the world's most productive fishing area, and catches have varied between 20 and 24 million tonnes since the end of the 1980s. Total catches in the Northeast Atlantic have remained stable at about 11 million tonnes for a number of years.

According to FAO (2004), 52 per cent of major fish stocks for which data is available are fully exploited, while 16 per cent are overexploited. It is estimated that 8 per cent of the fish stocks have been depleted or are recovering from depletion.

In 2004, world aquaculture production (excluding plants) rose by 2.8 million tonnes (7 per cent).

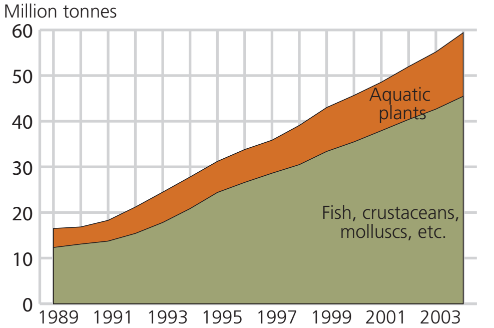
Norway ranks as number 10 among the world's largest fishing nations (excluding farmed production), with a total catch of 2.5 million tonnes in 2004. At the head of the list are China (16.9 million tonnes), Peru (9.6 million tonnes), the US (5.0 million tonnes), Chile (4.9 million tonnes), Indonesia (4.8 million tonnes) and Japan (4.4 million tonnes). See also Appendix, tables D7 and D8.

In the Norwegian fisheries, the catch of herring in 2005 was about 130 000 tonnes higher than in 2004, and the value of the catch increased by NOK 850 million to NOK 2.9 billion. The catch of cod decreased by 5 000 tonnes from 2004, but the value of the catch rose by about NOK 200 million to NOK 3.0 billion. The mackerel catch dropped by about 40 000 tonnes and its value was NOK 1.5 billion. The catch of capelin rose from 49 000 tonnes to 67 000 tonnes with a value of NOK 93 million. There was no fishery for Barents Sea capelin in 2005. The shrimp catch was 48 000 tonnes and its value was NOK 679 million. The Norwegian catch of blue whiting was 739 000 tonnes, a decrease of over 200 000 tonnes from 2004. After six years of negotiations, the EU, the Faeroe Islands, Iceland and Norway have reached agreement on management of the blue whiting stock and allocation of the TAC. The total catch of this species in 2005 was estimated to be about 20 per cent lower than in 2004, when it reached a record level at 2.4 million tonnes. In 2005, catches of Norway pout were only permitted as a bycatch when fishing blue whiting, and the catch was therefore the lowest recorded, only a little over 300 tonnes. There was also a marked reduction in the catch of sandeels, which totalled 17 000 tonnes. This is only one tenth of the catch in 2002.

See also figures 6.6 and 6.8 and Appendix, table D2. More about Norwegian fisheries at: http://www.ssb.no/english/subjects/10/05/fiskeri_en/

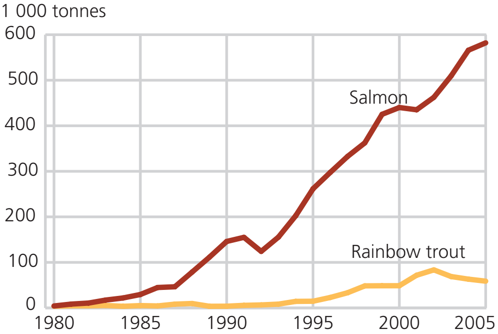
6.4. Aquaculture

Figure 6.9. World aquaculture production. 1989-2004



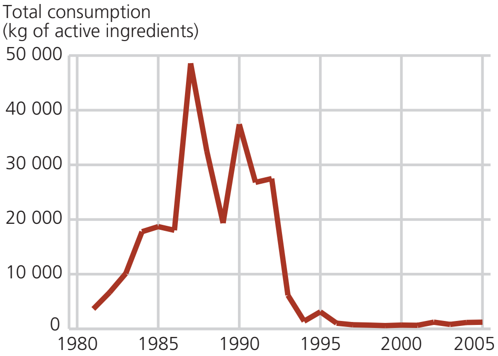
Source: FAO.

Figure 6.10. Fish farming. Volume of salmon and rainbow trout sold. 1980-2005



Source: Fisheries statistics, Statistics Norway.

Figure 6.11. Consumption of medicines[1] (antibiotics) in fish farming. 1982-2005



[1] Based on sales figures from pharmaceutical wholesalers and feed suppliers.
Source: Norwegian Institute of Public Health.

World aquaculture production

- In 2004, world aquaculture production totalled 45.5 million tonnes fish, crustaceans, molluscs, etc. corresponding to about 48 per cent of the total catch in marine and inland fisheries for that year.
- Production of aquatic plants totalled 13.9 million tonnes in 2004.
- World aquaculture production has more than trebled since 1989.

Salmon and trout farming in Norway

- Production of farmed salmonids has increased dramatically since the industry was established in the early 1970s. In 2005, salmon production (sold quantity) totalled 582 000 tonnes.
- Production of trout was about 59 000 tonnes in 2005.
- In 2004, Norwegian production of Atlantic salmon accounted for a little under half the total global production of this species (1.26 million tonnes). Over 80 per cent of farmed salmon is exported.

Fish health in salmon farming

- Health problems include viral, bacterial and parasitic diseases, and other problems such as winter ulcers, gill inflammation, heart and skeletal muscle inflammation and deformities.
- The consumption of antibiotics was highest in 1987, when it reached 49 tonnes. Consumption in 2005 was 1 215 kg, which is an increase of 50 kg from 2004. These figures apply to all species of farmed fish and are based on sales figures. See Appendix, table D3.

Box 6.4. More about aquaculture production

In 2004, world aquaculture production of fish, crustaceans, molluscs, etc. totalled 45 million tonnes, and freshwater production accounted for 60 per cent of this (see also table 6.1). In addition, 13.9 million tonnes of aquatic plants were produced. China is by far the largest aquaculture producer, accounting for almost 70 per cent of total production (animals and plants) in 2004.

The species farmed in the largest volume was the Pacific oyster (4.4 million tonnes), followed by a number of species of carp. On a list of 30 farmed species of which over 200 000 tonnes were produced in 2004, Atlantic salmon ranked tenth and mussels eighteenth. World production of Atlantic salmon in 2004 was 1.2 million tonnes.

Although salmon is the dominant species in Norwegian fish farming in terms of both volume and value, there is also increasing interest in several other species. *Mussel farming* is gaining ground. According to preliminary figures from the Directorate of Fisheries, production in 2005 was 4 300 tonnes. There is a very large potential for the production of mussels in Norwegian waters, both from a biological and environmental point of view and in terms of resources. According to FAO, 527 000 tonnes of mussels were produced on a global basis in 2004.

Production of other fish species than salmon and trout for human consumption is still relatively modest in volume. In 2005, 350 tonnes of farmed Arctic char, 7 400 tonnes of cod, 1 170 tonnes of halibut and 2 550 tonnes of other farmed species were sold in Norway.

According to the Directorate of Fisheries, total losses from sea-water rearing units in 2005 were 27.5 million fish (25 million salmon and 2.5 million trout). This included 714 000 salmon and 8 000 trout that were reported to have escaped from fish farms. In addition, almost 167 000 farmed cod (as compared with 19 000 in 2004) and 6 000 farmed halibut were reported to have escaped. Other losses are attributed to mortality, fish discarded at slaughtering plants and unknown causes.

The EU is the most important market for farmed Norwegian salmon. However, access to this market has for many years been influenced by steps taken by the EU to limit imports of Norwegian salmon through various trade policy instruments. The introduction of tariff quotas and a minimum import price (February), provisional anti-dumping duties (June) and a bilateral agreement on a minimum price (June) did not have any marked effect on Norwegian exports in 2005. In January 2006, the EU adopted a Council Regulation imposing an anti-dumping duty on imports of farmed salmon from Norway for a five-year period. The Regulation also lays down a minimum import price of EUR 2.80 per kg for whole fresh and frozen farmed salmon from Norway. Minimum prices are also laid down for processed salmon. In February 2006, the Government decided to bring the anti-dumping measures before the WTO Dispute Settlement Body (Statistics Norway 2006).

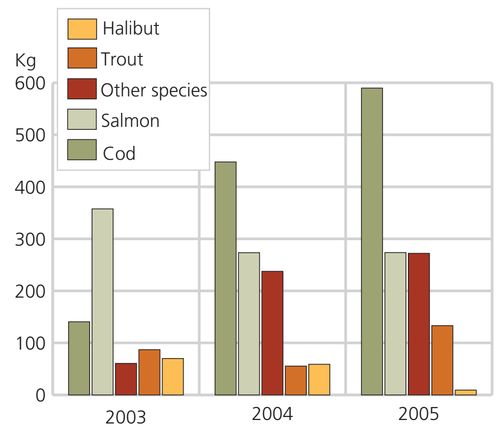
Box 6.5. Some important diseases and health problems associated with fish farming

This information on the incidence of disease in salmon farming in 2005 is based on figures in *Annual report on the coastal zone and aquaculture 2006* (Svåsand et al. 2006). Serious diseases include the following:

- Furunculosis, caused by the bacterium Aeromonas salmonicida (new cases registered in 2005: 1 fish farm).
- Bacterial kidney disease (BKD), caused by the bacterium Renibacterium salmoninarum (new cases registered in 2005: 2 fish farms).
- Infectious salmon anaemia (ISA), a virus disease (new cases registered in 2005: 11 fish farms).
- Infectious pancreatic necrosis (IPN), a virus disease (new cases registered in 2005: more than 200 fish farms).
- Pancreas disease (PD), a virus disease (new cases registered in 2005: 35 fish farms)
- Heart and skeletal muscle inflammation, a virus disease (new cases registered in 2005: at least 83 fish farms).

Other serious diseases that cause considerable losses include cardiomyopathy syndrome (CMS) and winter ulcers.

Figure 6.12. Use of antibiotics in fish farming[1], by species. 2003-2005

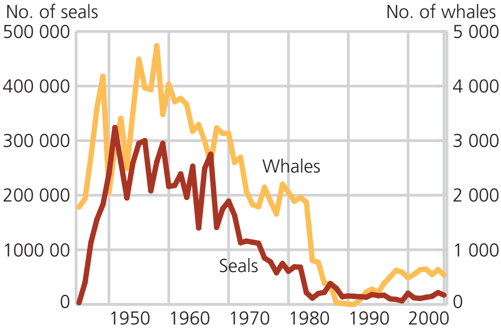


[1] Statistics based on prescriptions.
Source: Norwegian Food Safety Authority.

- An analysis of prescription-based statistics carried out by the Norwegian Food Safety Authority showed that of the total consumption of antibiotics in fish farming in 2005 (1 280 kg), 590 kg or 46 per cent was used for cod.
- Despite strong growth in production, consumption of antibiotics for salmonids (salmon and trout) has been decreasing slowly in recent years.

6.5. Sealing and whaling

Figure 6.13. Norwegian sealing and whaling[1]. 1945-2006



[1] In the period 1988-1992, scientific whaling only.
Source: Directorate of Fisheries.

- In 2005, the total seal catch was 17 771 harp seals (10 566 in the East Ice and 7 205 in the West Ice) and 3 826 hooded seals (in the West Ice). Preliminary figures for 2006 indicate a total catch of 13 384 harp seals (3 304 in the West Ice and 10 086 in the East Ice) and 3 647 hooded seals. The value of the catch in 2005 was NOK 3.9 million.
- The quota for the small whale hunt in 2005 was 797 animals, and the catch was 639 animals. The value of the small whale catch in 2005 was about NOK 24 million. Preliminary figures for 2006 indicate a catch of 542 whales with a value of NOK 21 million. The quota for 2006 was set at 1 052 whales.

Box 6.6. Sealing and whaling

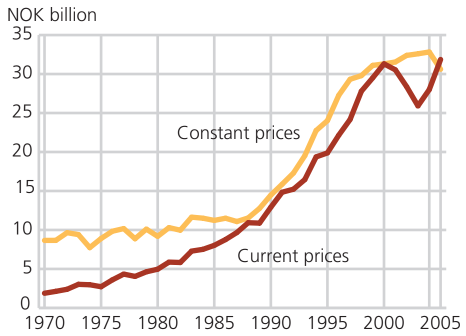
Norwegian *sealing* has essentially been based on two species, harp seals and hooded seals, and has taken place in the Newfoundland area (until 1983), the West Ice (off Jan Mayen) and the East Ice (drift ice areas at the entrance to the White Sea). The most recent estimates for stocks of harp seals are 600 000 year-old and older animals in the West Ice and about 2 million in the East Ice. The stock of hooded seals in the West Ice numbers about 100 000 animals (Iversen et al. 2006). Since the early 1980s, catches of seals have been small, varying between 10 000 and 40 000 animals per season.

Norwegian catches of *small whales* have consisted mainly of minke whales. The traditional commercial hunt was discontinued after the 1987 season, but was resumed in 1993, when 226 whales were taken.

The *Northeast Atlantic minke whale stock* (which includes animals on the whaling grounds in the North Sea, along the Norwegian coast, in the Barents Sea and off Svalbard) is estimated at 80 500 animals. The most recent estimate for the minke whale stock in the *Jan Mayen area* is 26 700 animals (Iversen et al. 2006).

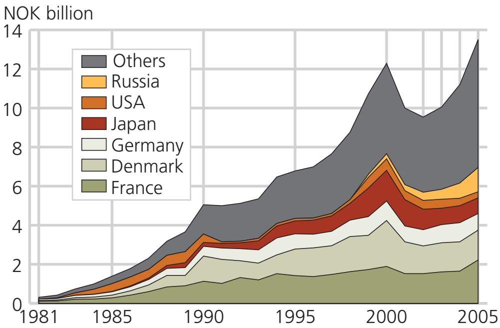
6.6. Exports

Figure 6.14. Value of Norwegian fish exports. Current and constant prices (2000 NOK). 1970-2005



Source: National accounts, Statistics Norway.

Figure 6.15. Exports of salmon[1], by main importing countries. 1981-2005. Current prices



[1] Mostly farmed fish, although other salmon is also included.
Source: External trade statistics, Statistics Norway.

- In 2005, Norway exported about 2 million tonnes of fish and fish products to a value of NOK 32 billion (see Appendix, tables D4 and D5). Exports to EU countries accounted for 59 per cent of the total.
- According to FAO, Norway was in 2004 the world's second largest exporter of fish in terms of value behind China, and ahead of Thailand, the US, Denmark, Canada, Spain and Chile. The value of Norway's fish exports corresponded to about 6 per cent of the value of total world fish exports (see Appendix, table D7).
- Salmon exports totalled NOK 13.5 billion in 2005. This is an increase of more than NOK 2 billion from 2004 (see Appendix, table D6).
- Denmark and France have for a number of years been the most important importers of Norwegian farmed salmon. Exports to Denmark (NOK 1.5 billion) were about the same as in 2004, but exports to France (NOK 2.2 billion) increased considerably from 2004 to 2005.
- Exports to Russia totalled NOK 1.25 billion. China is a new, interesting market for salmon, although the value of exports in 2005 was only NOK 104 million.

More information: Frode Brunvoll (frode.brunvoll@ssb.no).

Useful websites

Directorate of Fisheries: http://www.fiskeridir.no/
FAO - UN Food and Agriculture Organization: http://www.fao.org/
Institute of Marine Research: http://www.imr.no/
International Council for the Exploration of the Sea: http://www.ices.dk/
Statistics Norway - Fishery statistics: http://www.ssb.no/english/subjects/10/05/

References

FAO (2006): Yearbook of Fishery Statistics. Summary tables at: ftp://ftp.fao.org/FI/STAT/summary/default.htm, Food and Agriculture Organization of the United Nations.

FAO (2004): The state of world fisheries and aquaculture (SOFIA) 2004. Food and Agriculture Organization of the United Nations.

Iversen, S., Fossum, P., Gjøsæter, H., Skogen, M. and Toresen, R. (2006): Havets ressurser og miljø 2006 (Annual report on marine resources and environment). *Fisken og havet*, Special issue 1-2006, Institute of Marine Research, Bergen.

Report No. 8 (2005-2006) to the Storting: Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands. Ministry of the Environment.

Statistics Norway (2006): Økonomisk utsyn over året 2005 (Economic Survey 2005). *Økonomiske analyser* (Economic Analyses) 2006, 1.

Svåsand, T., Boxaspen, K., Dahl, E. and Jørgensen, L.L (ed.) (2006): Kyst og havbruk 2006 (Annual report on the coastal zone and aquaculture). *Fisken og havet,* Special issue 2-2006, Institute of Marine Research, Bergen.

Other literature

Ministry of Fisheries (1999): *Fiskeridepartementets miljøhandlingsplan 2000-2004* (Ministry of Fisheries' environmental action plan 2000-2004).

Ministry of Fisheries and Coastal Affairs (2005): *Fiskeri- og kystdepartementets miljøhandlingsplan 2005–2008* (Environmental action plan for the Ministry of Fisheries and Coastal Affairs 2005-2008). April 2005.

Myers, R. A. and B. Worm (2003): Rapid Worldwide Depletion of Predatory Fish Communities. *Nature,* Vol. 423, pp. 280-283, May 15, 2003.

Report No. 12 (2001–2002) to the Storting: Protecting the riches of the seas. Ministry of the Environment.

Report No. 20 (2002-2003) to the Storting: *Strukturtiltak i kystfiskeflåten* (Structural measures for the coastal fishing fleet). Ministry of Fisheries.

Report No. 27 (2003–2004) to the Storting: Norway's policy on marine mammals. Ministry of Fisheries and Coastal Affairs.

Report No. 19 (2004-2005) to the Storting: *Marin næringsutvikling. Den blå åker* («Fields of blue». Industrial and commercial development of marine resources). Ministry of Fisheries and Coastal Affairs.

Report No. 22 (2005-2006) to the Storting: *Om dei fiskeriavtalane Noreg har inngått med andre land for 2006 og fisket etter avtalane i 2004 og 2005* (Concerning the fisheries agreements Norway has concluded with other countries for 2006 and fishing according to the agreements in 2004 and 2005). Ministry of Fisheries and Coastal Affairs.

Statistics Norway (2006): Fiskeristatistikk 2004 (Fishery statistics 2004). NOS (Official Statistics of Norway) D 348.

Statistics Norway (2006): Lakse- og sjøaurefiske 2005 (Salmon and Sea Trout Fisheries 2005). NOS (Official Statistics of Norway) D 355.

Statistics Norway (2006): Fiskeoppdrett 2004 (Fish farming 2004). NOS (Official Statistics of Norway) D 359.

Statistics Norway (2006): Fish farming, 2005. Preliminary figures. Value of farmed salmon continues to climb. *Today's statistics* 24 August 2006 (http://www.ssb.no/english/subjects/10/05/fiskeoppdrett_en/).

7. Water resources and water supply

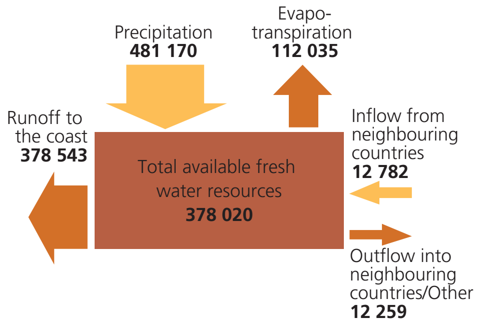
Water is of vital importance to life and health and to society as a whole. Good water and sufficient water is therefore a primary objective in the supply of water. The drinking water regulations of 4 December 2001 (Ministry of Health 2001) require all water works supplying more than 50 persons or 20 households or holiday homes, or supplying water to food manufacturers, health institutions, etc., to be approved by the authorities.

Figures from the Norwegian Institute of Public Health's water works register show that of a total of 1 616 water works subject to reporting requirements (municipal and private) in 2004, 338 recorded unsatisfactory results for pH and 130 recorded unsatisfactory results for water colour. In addition, thermo-tolerant intestinal bacteria in the water were found at 103 water works. The quality of drinking water supplied by some private and small municipal water works is still unsatisfactory. There are many reasons for this. Even though the regulations require all water from surface water sources to be disinfected, many small water works still do not do this adequately. The microbiological quality of drinking water may be unsatisfactory in periods as a result and may, at worst, cause illness. Warnings that water must be boiled before use must therefore sometimes be issued in areas supplied by smaller water works. However, the quality of drinking water for most users in Norway is good (Norwegian Food Safety Authority 2006).

About 90 per cent of the population in Norway receive their water supplies from surface sources. These water sources are vulnerable to acid rain, which for a long time has been regarded as one of the major environmental problems in Norway. However, a substantial reduction in sulphur and nitrogen discharges in Europe has reduced the acidification load in Norwegian inland waters. Nonetheless, there is still a long way to go before the natural ecosystems in the most vulnerable areas have recovered, and new international agreements, such as the Gothenburg Protocol, have already been concluded to reduce discharges of harmful substances even further.

7.1. Availability and consumption of water

Figure 7.1. Annual available water resources in Norway[1]. Average 1971-2000. Million m³

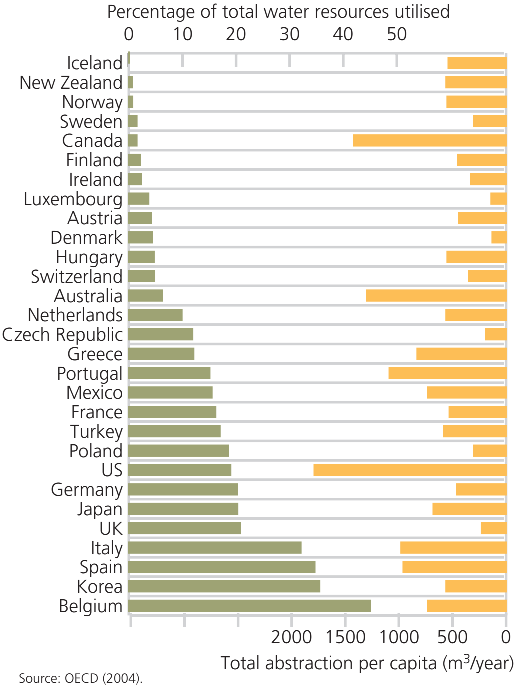


[1] Records of precipitation do not make it possible to calculate inputs with the same accuracy as runoff. As a result, there is a discrepancy between total inputs and total runoff in the figure.
Source: Norwegian Water Resources and Energy Directorate 2006.

Available water resources

- Water resources available in Norway in a normal year total about 378 billion m^3.
- 97 per cent of the annual input of water resources is in the form of precipitation, while the remainder is in the form of incoming water flows via rivers from our three neighbouring countries.
- About 79 per cent of the annual input of water drains to the sea and to neighbouring countries through watercourses and run-off. The rest evaporates.

Figure 7.2. Percentage of total water resources utilised and abstraction per inhabitant in OECD countries at the turn of the century

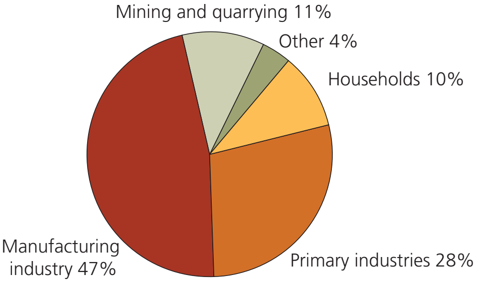


Source: OECD (2004).

Water withdrawal and consumption

- Only 0.7 per cent of the water resources available each year in Norway is utilised (water used in hydropower production is not included) before draining to the coast (97 per cent) or via rivers to neighbouring countries (3 per cent).
- The only OECD countries that utilise a smaller percentage of their total available water resources than Norway are Iceland (0.1 per cent) and New Zealand (0.6 per cent).
- About 550 m^3 of water is abstracted annually per inhabitant in Norway. This is well below the average for the OECD countries (910 m^3). The average in the US 1 790 m^3, and in Denmark 130 m^3.

Figure 7.3. Total water consumption by sector[1]. 2003 or latest year for which figures are available



[1] Leakages not included.
Source: Provisional figures from Statistics Norway.

- A total of about 3 400 million m^3 of water is used annually in Norway. The largest share, just under 1 600 million m^3, is used in manufacturing. The sectors that utilise most are the metal industry, the chemical industry, refineries and the oil and gas industry.
- Over 340 million m^3 is used by households. Approximately 90 per cent of this is supplied by public water works. Manufacturing industry and the primary industries (agriculture, forestry and fish farming) largely meet their water needs from their own sources.

Box 7.1. The EU Water Framework Directive

As a party to the EEA Agreement, Norway is required to implement the Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000). The Directive, which entered into force in 2003, provides a framework for other EU directives of importance to water resource management, including the Urban Waste Water Treatment Directive (see box 12.2). The main objective of the Directive is to protect and, if necessary, improve the quality of inland waters, estuaries, coastal waters and groundwater. Other objectives include promoting sustainable water resource use, and protecting terrestrial ecosystems that directly depend on water, such as wetlands.

The main principle in the framework directive is that inland waters, coastal waters and groundwater should have "good status" with regard to water quality. This means that by 2015 the volume and quality of bodies of water should not deviate substantially from the "natural" conditions that would have existed without the impact of human activity.

The new key elements in the directive in relation to current Norwegian water resource management are as follows:

- coordination of administrative arrangements
  - administrative arrangements based on river basin districts
  - programmes and measures based on river basins and river basin districts
  - clear assignment of responsibilities and coordination between authorities (cross-sectoral management)
- specified environmental objectives for all water and a stronger focus on ecological conditions
- greater need for investigation and monitoring.

A management regime based on river basins means that all water within a river basin district and all activities that may affect the quality or amount of water are viewed as a whole, irrespective of administrative boundaries such as municipal, county or national borders. A management plan must also be drawn up for each river basin, and must include the following elements:

- environmental objectives
- action plans (programmes of measures) for water bodies
- description of the river basin
- impact of human activity
- protected areas (e.g. designated protected areas, recreation areas, areas defined as a result of other directives)
- the results of the monitoring of water bodies required by the directive

Management plans must be produced for all river basin districts by 2009. Norway is required to report to the EFTA Surveillance Authority (ESA) on the progress of the various processes and developments in the status of water bodies.

The Ministry of the Environment has coordinating responsibility for the Directive, with the County Governors responsible at the regional level. A steering group with representatives from the relevant directorates has been established to oversee the implementation of the directive in Norway. The overall plan for implementation was updated in June 2006.

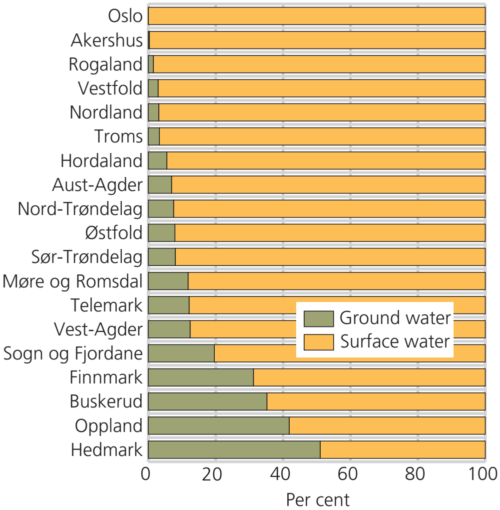
The steering group has established a national reference group, whose main task is to provide viewpoints and advice to the steering group on public participation at national, regional and local level in preparations for and implementation of the directive.

See also the indicators for ecological status in aquatic ecosystems in the indicator set for sustainable development presented in Chapter 2.

Sources: Norwegian Pollution Control Authority, Norwegian Institute for Water Research and Water Framework Directive (*http://ec.europa.eu/environment/water/water-framework/index_en.html l*).

7.2. Public water supplies

Figure 7.4. Percentage of population connected to municipal water works, split by type of water source. By county. 2004

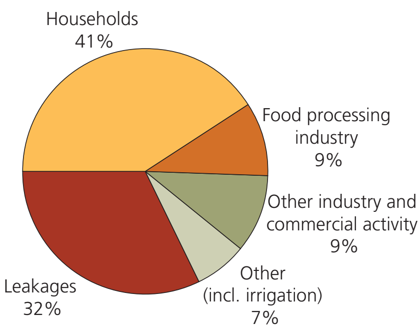


Source: National Institute of Public Health, water works register.

Water sources

- In 2004, about 90 per cent of Norway's population was served by public water supplies from 1 616 water works. These water works, which include municipal, intermunicipal, state-owned and privately-owned water works, are subject to reporting requirements and registered in the Water Works Register of the National Institute of Public Health. Water works that only supply holiday homes are not included. The remaining 10 per cent of the population was supplied by smaller water works or from their own water sources.
- In 2004, 62 per cent of Norway's public water works used surface water as their source of water, while the remainder used groundwater, and in a few cases sea water.
- The counties that in 2004 had the highest percentage of the population connected to water works using groundwater as their source were Hedmark, Oppland and Finnmark.

Figure 7.5. Percentage of public water supplies used by various sectors[1]. 2004



[1] The figure is based on data for 1 281 water works.
Source: National Institute of Public Health, water works register, Nordheim and Einan (2005).

Production and consumption of water[1]

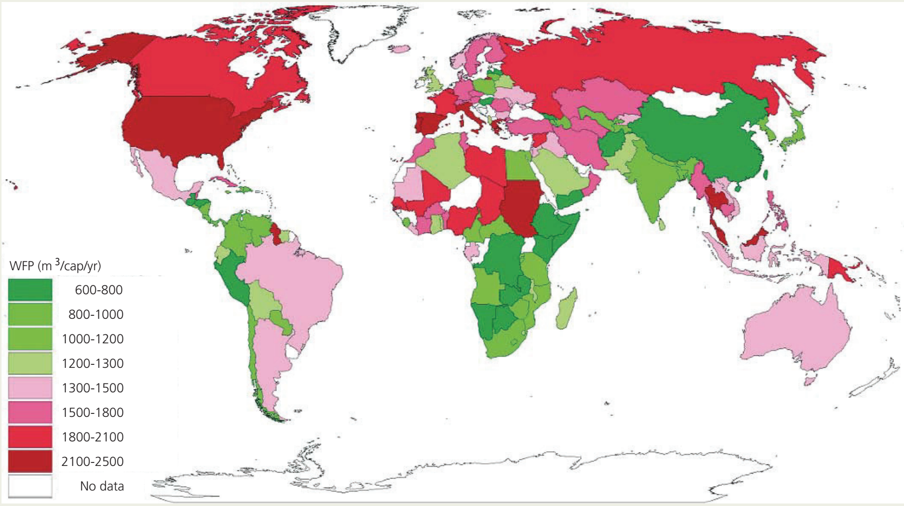
- In 2004, water production at Norwegian water works was calculated to be 755 million m^3, with households using 41 per cent of this total.
- About a third of the water produced was lost due to leakages from pipelines.
- Average household consumption is estimated at 205 litres per person per day.
- There is substantial uncertainty associated with these figures as they are largely based on estimates from the water works.

[1] Source: Nordheim and Einan 2005.

Box 7.2. Water footprint

Water is in increasingly short supply in a number of parts of the world. The concept of a "water footprint" has been developed to give a picture of the true level of water consumption by a population. A nation's water footprint is an aggregated indicator of the water volume needed to produce the goods and service consumed in the country. This concept is closely linked to the concept of "virtual water". The virtual water content of goods or services is the volume of water required to produce them. International trade involves flows of virtual water over long distances through the import and export of agricultural products and other goods. It is estimated that 16 per cent of global water consumption today is used in the production of goods for export, and not for domestic consumption. To correct for this, a nation's water footprint is assessed on the basis of water consumption in the country, minus virtual water that leaves the country, plus virtual water that is imported.

National water footprints around the world. Cubic metres water per person and year. 2004



Note: Average national water footprint per capita m3/capita/year). Green means that the nation's water footprint is equal to or smaller than global average. Countries shown in red have a water footprint beyond the global average
Source: Chapagain and Hoekstra (2004) (in the report *Water - a shared responsibility, The United Nations World Water Development Report 2* (UNESCO-WWAP 2006). http://unesdoc.unesco.org/images/0014/001454/145405E.pdf)

Water footprints in figures

The global water footprint has been calculated at 7 450 Gm^3/year[1], which corresponds to 1 240 m^3/person/year. However, there are large variations between countries. India and China have the largest national water footprints in absolute terms, 987 and 883 Gm^3/year respectively: the US, on the other hand, has the largest footprint relative to population, at 2 480 m^3/person/year. China has a relatively low footprint relative to its population, 700 m^3/person/year. It should also be noted that there may be large local and regional variations within countries.

Norway's total water footprint is 6.56 Gm^3/year, which corresponds to 0.09 per cent of the global water footprint. This corresponds to a per capita footprint of 1 467 m^3/person/year, somewhat above the global average of 1 300 m^3/person/year.

Cont.

..cont.

The size of the water footprint is largely determined by consumption of food and other agricultural products. Countries such as the US, Canada, France, Spain, Portugal, Italy and Greece, where meat consumption is high, have relatively high water footprints because production of meat requires a large input of water. Consumption of industrial goods also contributes to the high water footprint of some relatively wealthy countries.

Other factors also contribute to the size of a nation's water footprint. In rich countries, consumption of goods and services is generally higher, and this is reflected in a higher average water footprint. Evaporation and water-inefficient agricultural practices are the main reasons why some African countries, Thailand, Cambodia and Turkmenistan have relatively high water footprints.

Reduction of water footprints

Water footprints can be reduced in various ways. One is to break the link between economic growth and increased water consumption, for example by adopting production techniques that require less water per unit produced. Another is to change consumption patterns, for instance by reducing meat consumption. Such changes can be brought about by various means, including pricing, awareness raising and labelling of products. Thirdly, production can be shifted from water-poor areas to areas with more water, thus improving global efficiency in water consumption. However, it is uncertain how feasible this is political and economic terms.

Uncertainty and improvements

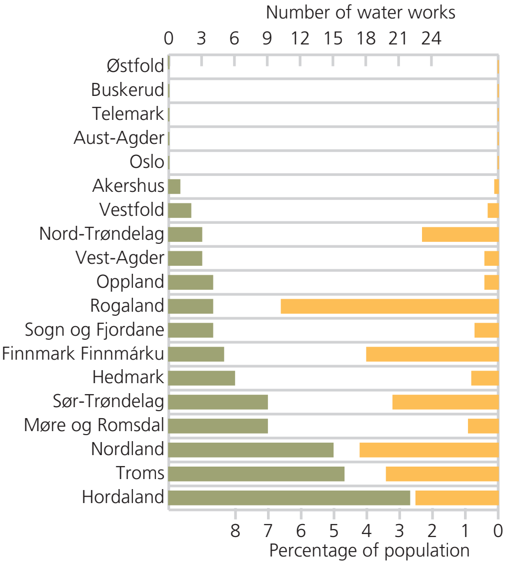
The methodology for calculating water footprints is still being developed. One weakness is that figures for water consumption by agricultural plants are based on water needs and not actual consumption, which results in a certain level of uncertainty in the calculations. Furthermore, the current methodology does not consider water quality - only water quantities are taken into account.

The challenge now will be to develop the method further and make use of the water footprint concept as a practical tool for analysing how consumption patterns influence water consumption, how countries can "export" parts of their water footprint to reduce the pressure on domestic water resources, and how other countries can benefit from relatively rich water resources by exporting goods whose consumption requires a large amount of water.

[1] 1 Gm^3 (Giga cubic metre) corresponds to 1 000 000 000 cubic metres.

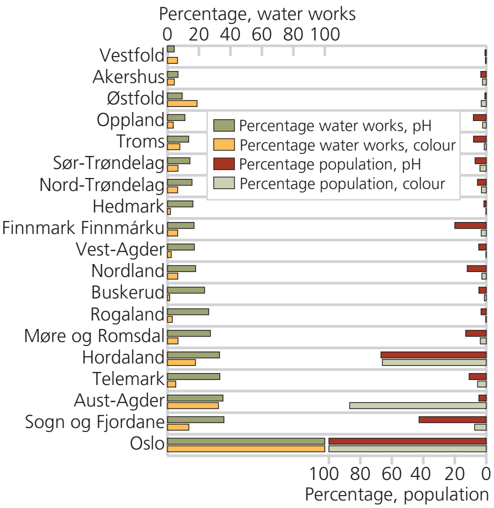
Source: Chapagain, A.K. and A.Y. Hoekstra (2004).

Figure 7.6. Number of water works that do not satisfy the requirements with respect to content of thermo-tolerant pathogenic bacteria, and percentage of the population who have to boil drinking water. By county. 2004



Source: National Institute of Public Health, water works register.

Figure 7.7. Percentage of public water works that do not satisfy the requirements with respect to pH and colour, and percentage of population affected. By county. 2004[1]



[1] The figure is based on information from 1 616 water works that report having conducted pH and colour tests. In Oslo, the information refers to one water works comprising several treatment plants. The main treatment plant is currently not satisfactory, but a new plant has been planned/is under construction.
Source: National Institute of Public Health, water works register.

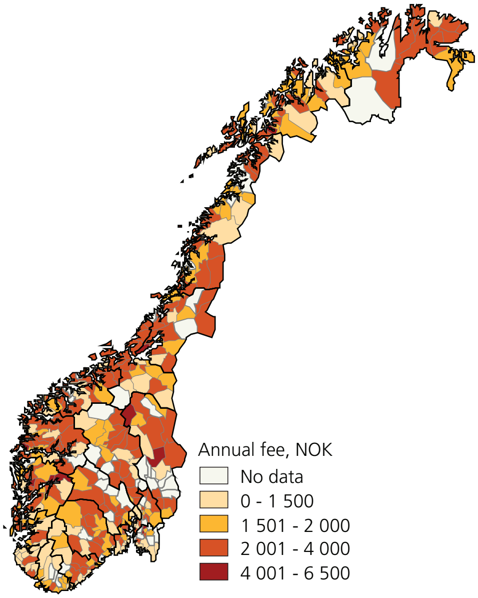
Water quality

- It is important to ensure that drinking water does not contain pathogenic bacteria. The drinking water regulations contain an absolute requirement for all water to be disinfected or treated to prevent the spread of infection. The treatment of drinking water involves adding chemicals (primarily chlorine), the use of UV radiation or membrane filtration.
- A number of water works using surface water as their source are finding it hard to comply with the requirements with respect to thermo-tolerant pathogenic bacteria in water. In 2004, the highest percentages of unsatisfactory samples were recorded in the counties of Hordaland, Troms and Nordland.
- Figures from 2004 show that of a selected 4.1 million people in Norway, 1.6 per cent are supplied with drinking water that does not satisfy water quality with regard to *E.coli.* The *E. coli* bacteria is a common indicator of the presence of intestinal bacteria in drinking water.
- A number of water works are finding it difficult to meet the acidity and colour requirements.
- Acidic water corrodes pipelines and can result in a high metal content in drinking water. High humus content colours the water brown and may cause sludge and unwanted bacterial growth in water pipeline systems. Chlorination of water containing humus may result in the formation of organochlorine compounds, with potential effects on odour, taste and health.
- A pH level that is too low is mainly due to acid rain and runoff from acidic rock such as granite and gneiss. The problem of coloured water is mainly due to humus and organic material deposited in water sources during rainfall and minor flooding.

7.3. Fees in the municipal water sector

Norwegian legislation lays down that municipal water and waste water fees may not exceed the necessary costs incurred by the municipalities in these sectors. The fees must follow the principle of full costing, and must be based on estimates of the direct and indirect operating, maintenance and capital costs of water and waste water services. The annual fees must be calculated on the basis of measured or stipulated water consumption, or in two parts, one fixed and one variable. For properties where no water meter is installed, water consumption is as a general rule stipulated on the basis of the size of the buildings.

Figure 7.8. Annual fees for water supply, by municipality. 2006. NOK



Source: KOSTRA, Statistics Norway.

Water supply fees

- In 2005, the average water supply fee for the county as a whole was reduced by 0.8 per cent.
- The fees vary significantly between municipalities, from NOK 365 to NOK 6 330.
- The reasons for the large variations in water supply fees have not been systematically surveyed, but in general, local conditions such as the type of water source, topography and population density will be important.

More information: Kari B. Mellem (kbm@ssb.no) (financial data) and Jørn Kristian Undelstvedt (jku@ssb.no).

Useful websites

Statistics Norway - Water and waste water statistics:
http://www.ssb.no/english/subjects/01/04/20/
Statistics Norway - Environmental protection expenditure statistics:
http://www.ssb.no/english/subjects/01/06/20/
Norwegian Food Safety Authority: http://www.mattilsynet.no/
Norwegian Institute of Public Health: http://www.fhi.no/english/

References

Chapagain, A.K. og A.Y. Hoekstra (2004): *Water footprint of nations.* Value of Water Research Report Series No. 16, Delft: UNESCO-IHE, Institute for Water Education.

Ministry of Health (2001): *Drikkevannsforskriften - Forskrift om vannforsyning og drikkevann* (Regulations relating to water supplies and drinking water). FOR 2001-12-04, no. 1372.

Nordheim, C.F. and B. Einan (2005): Metode for å bestemme vannuttak, vannproduksjon og vannforbruk på sektorer – 2004, upublisert notat.(Methods of determining water withdrawal, water production and water consumption by sector. 2004, unpublished memo) Norwegian Institute of Public Health.

Norwegian Food Control Authority (2006): “Utfordringer og mål for norsk drikkevannsforvaltning” (Norwegian drinking water management – problems and targets). http://www.mattilsynet.no/vann/generell_info/utfordringer_og_m_l_for_norsk_drikkevannsforvaltning_36420 [15.09.06]

OECD (2004): *OECD Environmental Data. Compendium 2004*. Organisation for Economic Co-operation and Development. Paris.

UNESCO-WWAP (2006): *Water - a shared responsibility.* The United Nations World Water Development Report 2. United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris, France and Berghahn Books, New York, USA. http://unesdoc.unesco.org/images/0014/001454/145405E.pdf

8. Land and land use

With a land area of 304 280 km^2 and 4.6 million inhabitants, Norway has the second lowest population density in Europe after Iceland, with 15 inhabitants per km^2. Because of Norway's climate, geology and topography, a large proportion of the country has not been developed for settlement and agriculture. Nearly 80 per cent of the population lives in urban settlements, where population density is over 100 times the national average. These densely built-up areas, and the productive agricultural and forest areas surrounding them, are therefore under considerable pressure. But land use intensity has increased in many sparsely settled areas too, as a result of road construction, the building of holiday cabins, the construction of power lines, and so on.

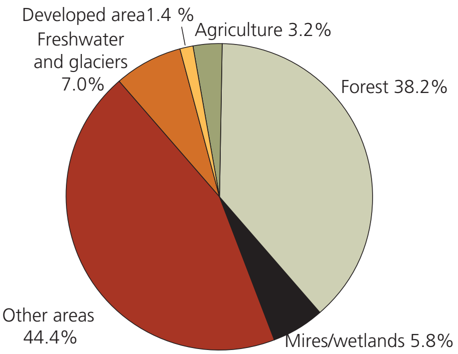
How the land is used is of great importance in terms of economics and the environment, and it affects people's lives. Changes in land use result in changes in the cultural landscape and the local environment. This may have considerable impact on human health and quality of life, and on the productivity and ecological qualities of the natural environment.

Resource and environmental conflicts often result as settlement patterns become increasingly concentrated along the coast in the southern half of Norway and in the most productive agricultural areas. These can include the conversion of the most valuable agricultural areas for other purposes, pressure on recreational areas in and around urban settlements, conflicts about whether to demolish or restore old buildings, and more concentrated pollution. On the other hand, population concentrations provide opportunities for environmental gains such as reduced energy use for transport and residential areas, a greater range of play and recreational areas and more efficient water, sewage and waste disposal schemes.

In Report No. 21 (2004-2005) to the Storting, regional planning and land use policy was established (see box 8.4) as a new priority area for environmental policy, and strategic objectives and national targets were defined. The white paper highlights the fundamental importance of a national land use policy in order to achieve sustainable management of Norway's total land resources and to create a healthy physical environment. The policy focuses on land as a basis for settlement and commercial development, for experiencing the natural surroundings and for recreational purposes, and on safeguarding the values inherent in the landscape and biological and cultural diversity. The objective of sustainable land use management should not only be to avoid environmental conflict as a result of the conversion or degradation of environmental assets, but also to make a contribution towards long-term solutions and enhance the environment.

8.1. Land use in Norway

Figure 8.1. Proportion of different types of land cover[1]. Mainland Norway. 2006



[1] Land cover is the physical coverage of land, e.g. forest, cultivated land, buildings, roads.
Source: Norwegian Mapping Authority and Statistics Norway.

The most common types of land use

- In 2006, developed land contained a total of 4.3 million buildings, 4 100 km of rail track and 93 000 km of public roads, in addition to about 73 000 km of forest roads and other roads (Norwegian Mapping Authority 2006, and Norwegian National Rail Administration 2006).
- Agricultural area in use covers about 10 400 km² and productive forest about 75 000 km² (Norwegian Forest and Landscape Institute 2006).
- The remaining land area comprises other cultivated land, non-developed coastal areas, scrub and heaths, marginal forest, and mountains. About 2 600 km² of the mainland is under permanent ice and snow (Wold 1992).

Box 8.1. Norway's main geographical features

The geographical location of the country and its elongated form with variations in climate, quaternary geology and topography mean that the conditions for land use vary widely. The mainland is 323 802 km² in total (304 280 km² land and 19 522 km² fresh water) and 1 752 km in length. It stretches from Lindesnes in the south (57° 58' N) to Kinnarodden in the north (71° 7' N). The mainland is bounded to the south, west and north by a 2 650 km long coastline, not including fjords, bays and islands. In terms of altitude, 31.7 per cent of the land area lies 0-299 metres above sea level. As much as 20.1 per cent of the land area lies at least 900 metres above sea level and productivity (in terms of vegetation) is therefore low (see also Statistical Yearbook of Norway 2006, pp. 15-24 and 43- http://www.ssb.no/english/yearbook/).

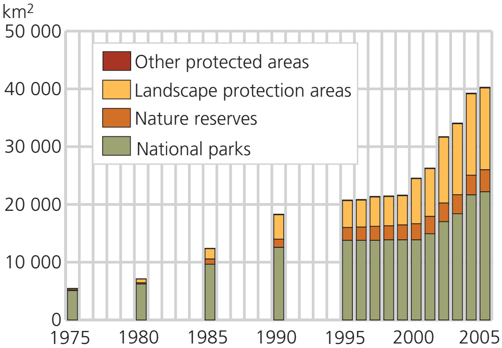
Box 8.2. Protected areas. Overview of legislation

Most of the protected areas in Norway are protected under the Nature Conservation Act. Other legislation and treaties of importance in this connection include:
- Wildlife Act
- Planning and Building Act
- Act relating to salmonids and fresh-water fish
- Forestry Act
- Cultural Heritage Act
- Svalbard Environmental Protection Act
- Act relating to Jan Mayen
- Act relating to Bouvet Island, Peter I's Island and Queen Maud Land
- Antarctic Treaty

In addition there are so-called administratively protected areas. These are areas or individual trees or groups of trees on public ground.

8.2. Protection and development

Figure 8.2. Areas protected under the Nature Conservation Act. Whole country. 1975-2005. km²



Source: Directorate for Nature Management (2006).

Areas protected under the Nature Conservation Act

- The total area protected under the Nature Conservation Act has expanded considerably since 1975. As of 1 January 2006, protected areas included 25 national parks, 1 753 nature reserves, 159 protected landscapes and 98 other types of protected area. See also Appendix, table F5.
- Areas protected under the Nature Conservation Act account for 40 288 km² or about 12 per cent of Norway's total area. In addition, some areas are protected under other legislation. The total area protected has risen by 2.6 per cent over the last year.
- As of 1 January 2006, a total of 994 km² of productive forest was protected. This is equivalent to 1.3 per cent of the total area of productive forest, and includes protected forest in the national parks (Directorate for Nature Management 2006).
- There are 163 municipalities where less than 1 per cent of the land area is protected under the Nature Conservation Act. Most of the municipalities with a high proportion of protected areas have large areas of mountain, glacier or other marginal areas. There are 42 municipalities where more than 25 per cent of the total area is protected under the Nature Conservation Act.

Box 8.3. Building activity in the 100-metre belt along the coast

Protecting areas of recreational value is an expressed national target. Several specific indicators have been drawn up as operational tools to monitor developments in relation to the national targets for the priority area *Outdoor recreation* in environmental policy.

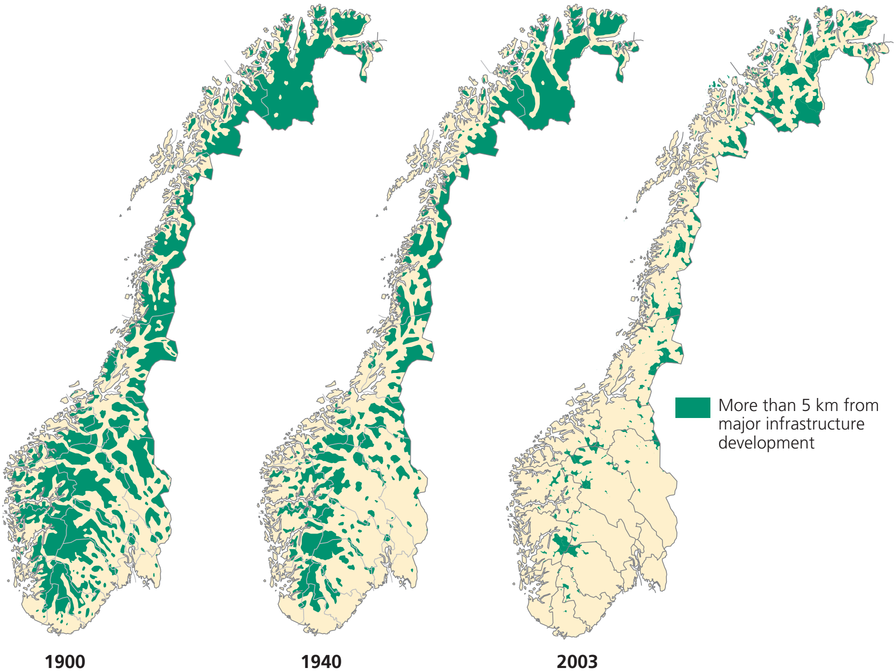
Access to the 100-metre belt along the coast is one such indicator. The mainland coastline is 83 300 km long, including islands, fjords and bays. This is equivalent to twice the circumference of the earth at the equator. Most of the urban settlements and a large proportion of other built-up areas, including holiday cabins, are concentrated along the coast. As much as 23.8 per cent of the total length of the coastline is less than 100 metres from the nearest building (registered in the GAB, the official Norwegian register for property, addresses and buildings, as of 1 January 2006). From Halden in the south-east to Hordaland in the west, a stretch of the coast specifically mentioned in the context of the indicators, as much as 39.4 per cent of the coastline is less than 100 metres from a building. This indicates that public access to the 100-metre belt of the coastal zone is considerably restricted in some parts of this stretch of the coast.

Read more in: http://www.ssb.no/english/subjects/01/01/20/strandsone_en

Wilderness-like areas

- The size of wilderness-like areas is an indicator of pressure on biological diversity. In wilderness-like areas, pressure from human activity is low, and there is little disturbance of the original biological diversity.
- Wilderness-like areas have been dramatically reduced from about 48 per cent of Norway's land area in 1900 to between 11 and 12 per cent today.

Figure 8.3. Wilderness-like areas[1]. 1900, 1940 and 2003

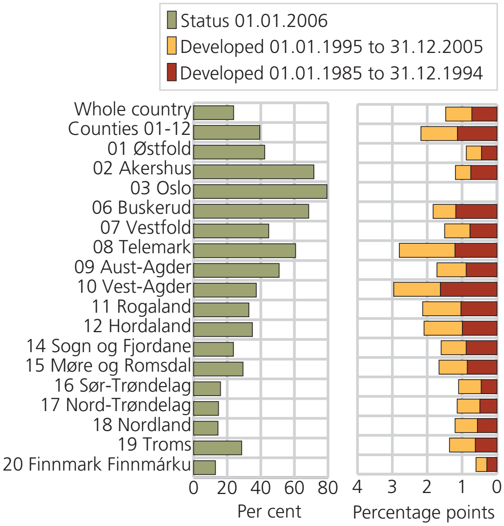


[1] Wilderness-like areas are defined as lying at least 5 km from the nearest major infrastructure development, defined as public roads and railways (except tunnels): forest roads: farm tracks, access roads and roads to summer farms exceeding 50 m in length: ancient tracks improved for use by tractors and off-road vehicles: tracks approved for motor vehicles when the ground is not snow-covered (Finnmark): power lines carrying 33 kV or more: reservoirs (entire extent of water at highest regulated water level), regulated rivers and streams: power plants, penstocks, canals, levees, embankments and flood protection works.
Source: Brun, M. NOU-1986 / Directorate for Nature Management 2004 / Geodatasenteret AS 2004. Editing and graphic production: Geodatasenteret AS 2004.

Access to the coast

Norway's strategic objective for outdoor recreation, which is a priority area of environmental policy, is that *«everyone shall have the opportunity to take part in outdoor recreation as a healthy and environmentally sound leisure activity that provides a sense of well-being both near their homes and in the countryside»*. Coastal areas offer very valuable opportunities for outdoor recreation. At the same time, there is great pressure to allow development of these areas, which means that public access for recreation purposes is becoming more and more restricted.

Figure 8.4. Proportion of the coastline less than 100 m from the nearest building in 2006. Changes from 1985 to 2006



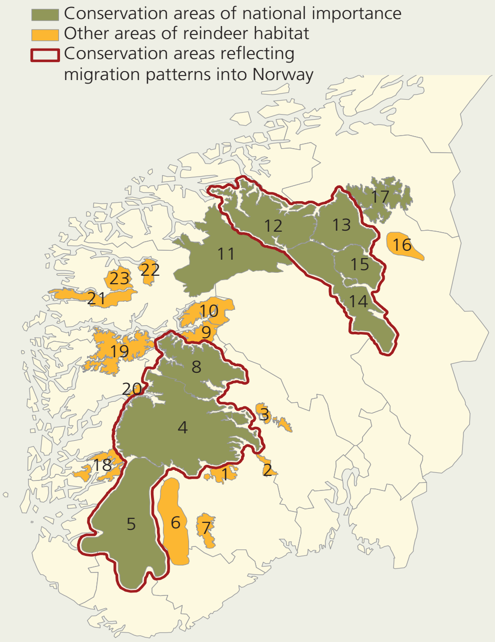
Source: Land use statistics, Statistics Norway (2006a).

- More than 23 per cent of the coastline is less than 100 m from the nearest building. In the counties around the inner Oslofjord, more than two thirds of the coastline is less than 100 m from the nearest building.
- Since 1965, the Planning and Building Act has restricted developments along the shoreline, and tighter restrictions have been introduced since then. Despite this, buildings were constructed or altered along 1.5 per cent, or 1 250 km, of the shoreline from 1985 to 2006.
- The greatest changes have taken place in the southern parts of the country, where the largest proportion of the coastline was already developed (for detailed figures, see Appendix, table F4).

Box 8.4. Regional planning and land-use policy

This priority area was introduced in the most recent white paper on the Government's environmental policy and the state of the environment in Norway (Report No. 21 (2004-2005) to the Storting). The white paper highlights the fundamental importance of a national land use policy for achieving sustainable management of Norway's total land resources and to create a satisfactory physical environment. The policy focuses on land as a basis for settlement and commercial development, for experiencing the natural surroundings and for recreational purposes, and on safeguarding the values inherent in the landscape and biological and cultural diversity.

Proposal for reindeer conservation areas in Norway



Areas of reindeer habitat

1 Brattfjell-Vindeggen
2 Blefjell
3 Nordefjell-Reinsfjell
4 Hardangervidda
5 Setesdal - Ryfylke
6 Setesdal Austhei
7 Vårmyr - Roan
8 Nordfjella
9 Lærdal - Årdal
10 Vest-Jotunheimen
11 Ottadalen
12 Snøhetta
13 Knutshø
14 Rondane
15 Sølnkletten
16 Tolga Østfjell
17 Forelhogna
18 Etne-Sauda
19 Fjellheimen
20 Oksenhalvøya
21 Sunnfjord
22 Svartebotnen
23 Førdefjella

Source: Norwegian Institute for Nature Management.

- Norway is the only country in Europe where there are intact high-mountain ecosystems with populations of wild reindeer. Because Norway is home to most of the wild reindeer in Europe, this is considered to be a species for which Norway has special responsibility.
- Changes in land use, particularly the construction of roads and railways and hydropower developments, have contributed to the fragmentation of wild reindeer habitat.
- In order to safeguard the remaining areas of wild reindeer habitat, a proposal has been drawn up to establish two reindeer conservation areas that reflect the pattern of reindeer migration into Norway and other conservation areas that are considered to be important for their survival in Norway in the future.

National targets - land regional planning and land use policy

1. Mountain areas shall be managed through a whole-landscape approach that safeguards their cultural and natural resources while providing opportunities for appropriate types of commercial development and outdoor recreation.

Cont.

..cont.

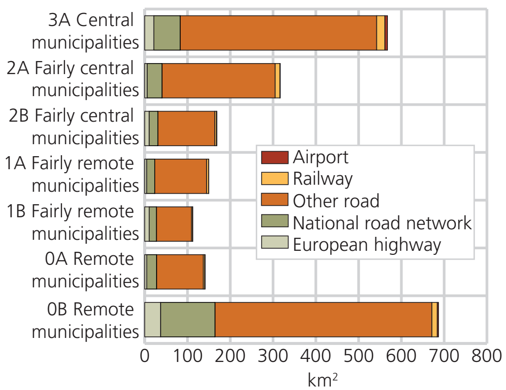
2. The environmental qualities of landscapes shall be safeguarded and developed through improved knowledge and targeted planning and land-use policy.
3. Areas of wild reindeer habitat shall be safeguarded.
4. The annual conversion of high-quality arable land for other purposes than agriculture shall be halved. Particularly valuable areas of cultural landscape shall be documented and management plans put in place by 2010.
5. Coordinated planning procedures, including evaluation of user and environmental interests, shall be followed for the establishment of energy generation plants requiring large areas of land.
6. The environmental and recreational qualities of the coastal zone shall be safeguarded, and easy access to the shoreline shall be provided for the general public.
7. Land-use policy for river systems shall be based on an integrated approach to management of the river landscape, zones adjoining watercourses and water resources.
8. Holiday housing shall be sited and designed to harmonise with the landscape and its environmental qualities, with a focus on resource use and aesthetic qualities.
9. Urban settlement development shall promote a high quality of life and good health through good urban planning and design, environmentally friendly transport and the provision of good, easily accessible outdoor areas.
10. Near housing, schools and day care centres, there shall be adequate opportunities for safe access and play and other activities in a varied and continuous green structure, and ready access to surrounding areas of countryside.

Source: Report No. 21 (2004-2005) to the Storting: The Government's environmental policy and the state of the environment in Norway.

Areas developed for transport purposes

In this context, developed areas means the areas that are physically part of or occupied by roads, railways and airports. Development for these purposes is generally not reversible, and takes over areas that could have been used for agriculture. Such developments also result in fragmentation of landscapes and habitats. The scale of development for transport purposes varies between municipalities depending on their centrality. Centrality describes a municipality's geographical position in relation to a centre with higher-order functions (e.g. financial and business services).

Figure 8.5. Areas covered by infrastructure (km²), by type of municipality. 2005

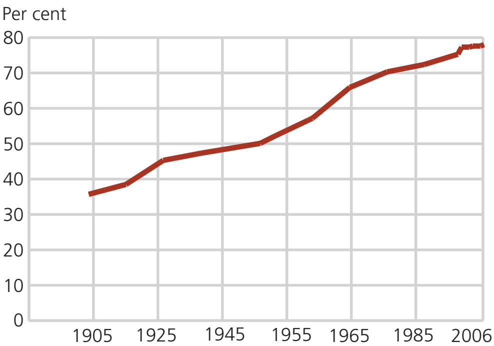


Source: Land use statistics, Statistics Norway.

- The largest areas have been developed in the remote and most central municipalities, where developed areas total more than 1 200 km².
- The largest proportion of the area developed for transport purposes consists of «other roads». In central municipalities, these are generally municipal roads, while in remote and fairly remote municipalities they are mainly forest roads.
- The national road network occupies a small area compared with «other roads», about 400 km².
- Airports and railways occupy the smallest area, totalling about 70 km².

8.3. Area and population in urban settlements

Figure 8.6. Percentage of population resident in urban settlements/densely populated areas. 1900-2006



Source: Population statistics, Statistics Norway (2006b).

Population trends and area of urban settlements

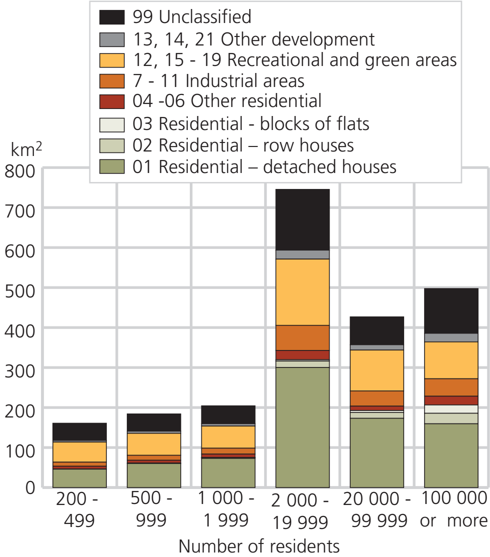
- In 2005, the population living in urban settlements increased by 1.3 per cent. A total of 78 per cent of the Norwegian population now lives in urban settlements. The area of urban settlements increased by 44 km².
- As of 1 January 2006, the average population density in Norwegian urban settlements was 1 594 inhabitants per km². The corresponding figure for 2000 was 1 588 inhabitants per km².
- In the four largest urban settlements, Oslo, Bergen, Stavanger/Sandnes and Trondheim, the population increased by about 25 000 persons, or about 2 per cent, in 2005.
- As of 1 January 2006, 697 urban settlements (77 per cent) had fewer than 2 000 inhabitants. These settlements accounted for only 13 per cent of the total population living in urban settlements, but 25 per cent of the total area of urban settlements.

Table 8.1. Urban settlements, residents and area, by size of population. 1 January 2006. Change from 2005 to 2006

Size groups of urban settlements, by number of residents	2006			Change from 2005 to 2006		
	Population	Total area in km²	Number of areas	Population	Total area in km²	Number of areas
Total	**3 607 813**	**2 263.10**	**905**	**47 676**	**43.88**	**-4**
200-499	114 912	162.80	330	-454	1.95	-4
500-999	154 617	188.49	221	785	4.37	0
1 000-1 999	207 771	209.92	146	2 292	5.56	0
2 000-19 999	1 020 790	761.39	189	12 450	15.88	0
2 000-99 999	739 200	434.08	15	7 624	7.25	0
100 000 or more	1 370 523	506.42	4	24 979	8.88	0

[1]An urban settlement is an area with at least 200 residents and the distance between the buildings does not normally exceed 50 metres. Urban settlement boundaries are thus dynamic, changing in pace with building patterns and changes in the population.
Source: Statistics Norway (2006b).

Figure 8.7. Land use in urban settlements, by size of population. 2005. km²



Source: Land use statistics, Statistics Norway (2005).

Land use and physically developed area in urban settlements

- Urban settlements make up less than 1 per cent of Norway's total area, but about one fourth of the physically developed area. Infrastructure, buildings and roads make up about 30 per cent of the total area of urban settlements.
- Buildings in urban areas cover about 220 km², and buildings outside urban areas about 200 km².
- Roads account for about 2/3 of the physically developed area in urban settlements. Outside urban settlements, this share is 88 per cent (forest roads included).
- Detached houses account for over one third of the total area of urban settlements.
- Housing density and land use efficiency are lower in small urban settlements, which are therefore less compact than large urban settlements.

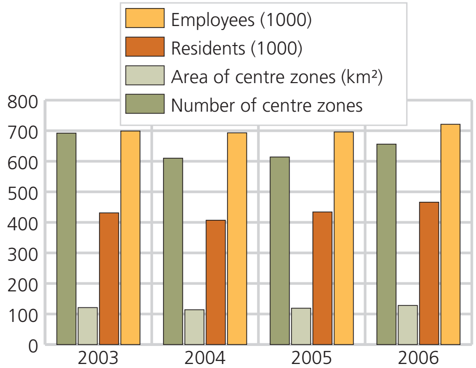
Box 8.5. Delimitation of urban settlements and background data

An urban settlement has been defined by Statistics Norway in simple terms as an area that has at least 200 residents and where the distance between buildings does not normally exceed 50 metres. Urban settlement boundaries are thus dynamic, changing in pace with building patterns and changes in the population.

In addition to the increasing expansion of the major urban settlements, general population growth has resulted in some small areas of scattered settlement developing into urban settlements. At the same time, in areas where the industrial structure is weak, a declining population has meant that some urban settlements are no longer classified as such. Changes in methods of operation in the primary industries and the evolution and concentration of the manufacturing industries and service sectors have resulted in major changes in settlement patterns over the last 100 years. Urban settlements vary widely in size, both measured by area and by population, but most of Norway's urban settlements are small.

As of 1999, urban settlement statistics are based on correlation between the National Population Register and the GAB register, the official Norwegian register for property, addresses and buildings. With the help of numerical addresses, address or building coordinates and a geographical information system (GIS), buildings and the associated population are grouped together into urban settlements. The quality of the statistics will always depend on how complete and accurate the register data are.

Figure 8.8. Number of centre zones, centre zone area, employees in wholesale and retail trade and residents in centre zones. 2003-2006



Source: Statistics Norway (2006c).

Centre zones

- Centre zones (see box 8.7) only figured in 218 of Norway's 432 municipalities as of 1 January 2006, and tend not to be formed in the smallest municipalities (Statistics Norway 2006c).
- As of 1 January 2006 there were a total of 656 centre zones with a population of about 466 000 in Norway. Even though the number of centre zones has varied since 2000, the area and population have been relatively constant. As companies become established and close down, small centres may be formed one year and disappear the next, but this has little effect on the total area and number of inhabitants in such centres.
- The number of employees in centre zones was 721 000.
- About 10 per cent of the population lives in centre zones. The population density in these zones is 3 600 persons per square kilometre, as compared with 1 600 per square kilometre in urban settlements. In other words, population density is twice as high in centre zones as in urban settlements as a whole.

Box 8.6. Land use calculation, data sources and uncertainty

Land use statistics for urban settlements are calculated on the basis of building and property figures in the GAB register, the official Norwegian register for property, addresses and buildings, information on commercial activity in the form of a business code from the Register of Business Enterprises, and area calculated from the outline of buildings in cartographical series (mainly on a scale of 1:1 000). Land use is quantified at two geographical levels: physically developed areas and aggregated land use areas (functional areas). Land use in terms of physical development means roads, railways, buildings, etc. Aggregated land use areas refer to functional use (residential (gardens and smaller roads included), transport, industry, commercial, etc.).

Methods and uncertainty are described in technical documentation reports (Statistics Norway 2002b-f).

Box 8.7. Operationalisation of the concept of the centre zone

In January 1999, a national policy decision, applicable for up to five years, was adopted to call a temporary halt to the establishment of shopping centres outside central parts of towns and urban settlements (Ministry of the Environment 1999). One important reason for this decision was the desire to actively strengthen the development of urban settlement centres and to counteract the tendency towards a pattern of increased transport by private car to large shopping centres outside urban areas.

As a result of this national policy decision, there was a need for a clearer definition of the concept of the centre to ensure that the decision could be uniformly practised by central and local authorities. A pilot project was therefore launched by Statistics Norway in cooperation with the Oslo and Akershus county administration to operationalise the concept of the centre core based on criteria of physical concentration and diversity of activity:

- retail trade must take place
- there must be either a public administration centre, a health and social centre or other social/personal services
- at least three main industries must be represented
- the maximum distance between the buildings where these undertakings are located must not exceed 50 metres.

A 100-metre zone was added around the centre core to comprise the *centre zone*.

See map showing centre zones and urban settlements http://www.ssb.no/emner/01/01/20/tettstedskart (in Norwegian only).

Box 8.8. Indicators for sustainable urban development

The national programme for sustainable development in five towns (Ministry of the Environment 1995) resulted in the formulation of a number of general targets for sustainable urban development. Their objective was to reduce land use for development and transport purposes and to safeguard natural surroundings and local outdoor areas to maintain biological diversity and opportunities for recreation, and to improve access to inland water bodies and the sea. In connection with these goals, a number of indicators were formulated (Norwegian Pollution Control Authority 2000):

- Urban settlement area per resident
- Traffic area per resident
- Base area for residential buildings in urban settlements per resident
- Proportion of population resident in urban settlement centre
- Proportion of population within walking distance of various service functions
- Average distance from centre to new housing

These indicators were described in more detail in *Natural Resources and the Environment 2002. Norway* (Statistics Norway 2002a).

8.4. Municipal land use management

The status of biological diversity, recreation and cultural heritage in municipal land-use planning

- A municipality uses the land-use part of the municipal master plan as the basis for safeguarding areas of special value. This can be done in various ways, for example by adopting plans with a special focus on environmental assets such as biological diversity, opportunities for outdoor recreation and cultural heritage.
- Of these environmental assets, the municipalities place greatest emphasis on outdoor recreation. Biological diversity has to a lesser degree been a priority area, but the share of municipalities with plans has increased substantially since 2001. This is probably related to the funds allocated to municipalities to register and assign a value to biological diversity.
- The decisive factor underlying these differences may be municipalities' perception of their areas of responsibility. Classic nature conservation and cultural heritage conservation has traditionally been regarded as a central government responsibility, while outdoor recreation has to a greater extent been delegated to local government.
- Densely populated municipalities seem to incorporate these aspects in their municipal master plan to the greatest extent.
- The average age of the plans has been decreasing, indicating that they are being updated more frequently.
- See also Chapter 5.7 Management of uncultivated areas.

Table 8.2. Percentage of municipalities with an adopted plan with special focus on biological diversity, outdoor recreation and preservation of the cultural heritage. Average age of plans in the reporting year

	Biological diversity		Outdoor recreation		Cultural heritage	
	Percentage of municipalities with plan	Age. Years	Percentage of municipalities with plan	Age. Years	Percentage of municipalities with plan	Age. Years
Whole country						
2001	17	4.6	62	3.7	28	5.5
2002	20	4.2	57	3.4	..	5.3
2003	29	2.3	59	2.3	30	5.2
2004	32	2.7	61	2.6	30	4.8
2005	39	3.1	60	2.8	30	4.7
By population in municipalities, 2005						
Over 300 000	100	3.0	100	0.0	100	1.0
50 000-300 000	67	3.6	83	1.1	50	4.7
30 000-50 000	58	3.9	75	3.4	50	3.5
20 000-30 000	67	4.8	89	4.3	65	4.8
10 000-20 000	48	2.7	55	4.1	41	4.3
5 000-10 000	36	3.2	65	3.1	23	5.9
2 000-5 000	31	2.5	61	2.0	29	3.7
Under 2 000	34	2.9	46	3.0	15	6.7

Source: Statistics Norway.

Administration of plans in areas of particular environmental value

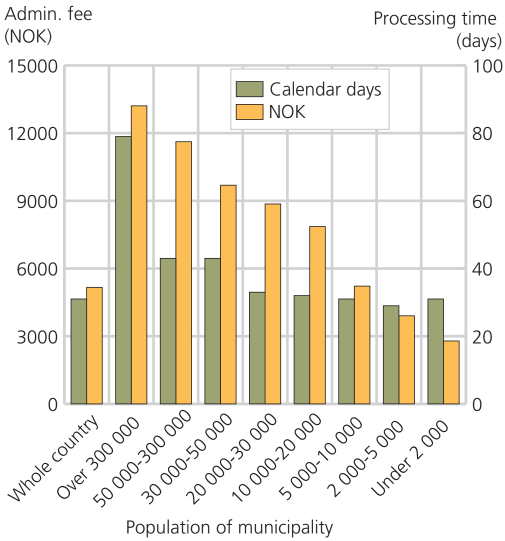
- Plans can be binding or in the form of guidelines indicating which projects can be implemented. Reports on projects in areas of particular environmental value (defined as agricultural areas, areas of natural environment and outdoor recreation areas, the 100-metre belt along the coast and special areas set aside for the preservation of the cultural heritage) show that most applications are in accordance with plans and are approved (see table 8.3).
- Applications for exemptions from adopted plans are granted more often than they are rejected. This applies to all types of area.
- The percentage of exemptions granted along the coastline and in areas along rivers and lakes where building is prohibited has increased from 69 per cent in 2001 to 73 per cent in 2005. The percentage increase is highest along the coast, while along rivers and lakes the percentage of exemptions granted has decreased.
- The case load in municipalities does not seem to influence the percentage of exemptions granted.

Table 8.3. Building project applications in areas of particular environmental value. 2001-2005

Type of area	Year	No. of cases processed[2]	Applications consistent with plan, percentage approved	Applications that include exemptions, percentage approved	Rejected applications, percentage
Projects in agricultural areas, areas of natural environment and outdoor recreation areas[1]	2001	15 853	70	23	8
	2002	17 167	74	20	6
	2003	7 801	62	29	9
	2004	7 175	69	26	5
	2005*[3]	4 375	50	40	10
Projects in the coastal zone where building is prohibited[1]	2001	1 636	.	67	33
	2002	1 570	.	69	31
	2003	1 175	.	74	26
	2004	1 167	.	74	26
	2005*[3]	1 429	.	72	28
Projects along rivers and lakes where building is prohibited[1]	2001	336	.	80	20
	2002	410	.	80	20
	2003	325	.	74	26
	2004	295	.	68	32
	2005*[3]	330	.	78	22
Projects in areas set aside for preservation of the cultural heritage	2001	799	79	12	10
	2002	568	71	16	13
	2003	866	73	11	17
	2004	636	68	19	14
	2005*	948	66	19	14

[1] As from 2003, exemptions apply exclusively to new buildings.
[2] The number applies to municipalities that have reported for the years 2001-2003. About 80 per cent of the municipalities have reported. For 2004 and 2005 the figures apply to the whole country.
[3] From 2005, agriculture in not included.
Source: Statistics Norway.

Figure 8.9. Administrative municipal fee for building of single-family dwelling and average case processing time for undertakings for which application is required, by size of population. 2005



Source: Statistics Norway.

Fees and case processing time in municipal land use management

- In 2005, net expenses for land use planning accounted for 0.5 per cent of total net municipal operating expenses. Fees have been rising much faster than prices generally in recent years, so that the municipalities are covering an increasing proportion of their expenses through the fees they collect.
- The size of fees increases with the size of the municipality, measured by population. This may be because more interests are affected by cases involving regulation or building in larger municipalities. There may be more objections, resulting in an increase in the administrative load. It is also likely that the initial processing of these cases must be conducted more thoroughly because there are more considerations to be taken into account, and in order to avoid or be better prepared for subsequent objections or other complaints.
- The low level of fees compared to expenses in small municipalities may, in addition to less complicated administration, be partly related to the use of low fees as an incentive to attract new businesses.
- Case processing time is longest in the largest municipalities. This may be due to higher case complexity. However, this has not been further analysed.

Box 8.9. Targets and indicators for outdoor recreation

Under the strategic environmental policy objective for the priority area *outdoor recreation*, national target 4 reads as follows: "Near housing, schools and day care centres, there shall be adequate opportunities for safe access and play and other activities in a varied and continuous green structure and ready access to surrounding areas of countryside." (Report No. 21 (2004-2005) to the Storting). On the basis of this target, two indicators have been developed to measure performance over time:
- Percentage of dwellings, schools and day care centres with safe access to play and recreational areas (at least 0.5 hectares) within a distance of 200 metres.
- Percentage of dwellings, schools and day care centres with access to nearby outdoor recreation areas (larger than 20 hectares) within a distance of 500 metres.

These indicators were described in more detail in *Access to outdoor recreational areas - method and results 2004* (Engelien et al. 2005, in Norwegian only), and a county overview is presented in the Appendix, table F3.

More information: Vilni Bloch (vilni.bloch@ssb.no), Erik Engelien (erik.engelien@ssb.no) and Henning Høie (henning.hoie@ssb.no, municipal land use management).

Useful websites

Directorate for Nature Management: http://english.dirnat.no/
Ministry of the Environment: http://odin.dep.no/md/engelsk/
Geological Survey of Norway: http://www.ngu.no/
Norwegian Forest and Landscape Institute: http://www.skogoglandskap.no/
Norwegian Institute for Air Research: http://www.nilu.no/
Norwegian Institute for Water Research: http://www.niva.no/engelsk/welcome.htm
Norwegian Mapping Authority: http://www.statkart.no/
Norwegian Pollution Control Authority: http://www.sft.no/english/
Norwegian Water Resources and Energy Directorate: http://www.nve.no/
Statistics Norway, land use statistics: http://www.ssb.no/english/subjects/01/01/20
Statistics Norway, municipal land use management: http://www.ssb.no/english/subjects/01/miljo_kostra_en/

References

Directorate for Nature Management (2006): the Directorate's website (english.dirnat.no).

Engelien, E., M. Steinnes and V.V. Holst Bloch (2005): Tilgang til friluftsområder. Metode og resultater 2004 (Access to outdoor recreational areas – method and results 2004). Notater 2005/15, Statistics Norway.

Ministry of the Environment (1995): *Nasjonalt program for utvikling av fem miljøbyer* (National programme for sustainable development in five towns), Report T-1115.

Ministry of the Environment (1999): *Rikspolitiske bestemmelser etter § 17-1 annet ledd i Plan- og bygningsloven om midlertidig etableringsstopp for kjøpesentre utenfor sentrale deler av byer og tettsteder* (National policy decision pursuant to § 17-1, second paragraph, of the Planning and Building Act, relating to a temporary prohibition on the establishment of shopping centres). Council of State item 1/99.

Norwegian Forest and Landscape Institute (2006): http://www.skogoglandskap.no/
Norwegian Mapping Authority (2002): Elektronisk vegdatabase og GAB-registeret (Electronic database on roads and the GAB register).

Norwegian Pollution Control Authority (2000): *Å beskrive miljøtilstand og bærekraftig utvikling i byer og tettsteder. Indikatorer og metode* (Describing the state of the environment and sustainable development in towns and urban settlements. Indicators and method). Report TA-1726/2000.

Norwegian National Rail Administration (2006): http://www.jernbaneverket.no

Report No. 21 (2004-2005) to the Storting: *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's environmental policy and the state of the environment in Norway), Ministry of the Environment.

Statistics Norway (2002a): *Natural Resources and the Environment 2002. Norway.* Statistical Analyses No. 58.

Statistics Norway (2002b): Arealstatistikk fra GAB og FKB Bygg – Datagrunnlag og metode for produksjon av arealtall (Land use statistics from the GAB register and FKB Bygg – Background data and method for production of land use figures). Notater 02/72.

Statistics Norway (2002c): *Arealstatistikk fra GAB og BoF – Datagrunnlag og metode for overføring av næringskode* (Land use statistics from the GAB register and the Register of Business Enterprises – Data basis and method for transferring business codes). Notater 02/68.

Statistics Norway (2002d): *Arealbruksstatistikk for tettsteder – Områdemodellering* (Land use statistics for urban settlements – Modelling of areas). Notater 02/64.

Statistics Norway (2002e): *Metode og datagrunnlag for produksjon av arealstatistikk for tettstedsnære områder. Teknisk dokumentasjon* (Methods and background data for the production of land use statistics for areas close to urban settlements). Notater 02/03.

Statistics Norway (2002f): *Arealbruksklassifisering av bebygde arealer. Revidert rutine for tilordning av arealbruksklasse til bygning* (Land use classification of built areas. Revised procedure for allocating land use categories to buildings). Notater 02/02.

Statistics Norway (2003): *Natural Resources and the Environment 2003. Norway.* Statistical Analyses No. 61.

Statistics Norway (2005): Arealbruk i tettsteder, foreløpige tall, 1. januar 2005. Småhusene krever plass (Land use in urban settlements, 1 January 2005. Detached houses take up most urban ground). Today's statistics, 20.09.05, (http://www.ssb.no/english/subjects/01/01/20/arealbruk_en/).

Statistics Norway (2006a): Bygging i strandsonen 1985-2006 (Development in the shore zone, 1985-2006). Today's statistics, 20.06.06, (http://www.ssb.no/english/subjects/01/01/20/strandsone_en/

Statistics Norway (2006b): Befolkningsstatistikk. Befolkning og areal i tettsteder, 1. januar 2006 (Population and land area in urban settlements, 1 January 2006). Today's statistics, 05.07.06, (http://www.ssb.no/english/subjects/02/01/10/beftett_en/)

Statistics Norway (2006c): Aktivitet i sentrumssoner, 2006. Uendra tettleik i sentra (Activity in centre zones. Land use intensity unchanged). Today's statistics, 12.07.06, (http://www.ssb.no/english/subjects/01/01/20/arealsentrum_en/).

Statistics Norway (2006d): Land use planning in municipalities and counties, 2005. More exemptions for new buildings in coastal zone. Today's statistics, 15.03.06, (http://www.ssb.no/english/subjects/01/01/20/fysplan_en/).

Wold, K. (1992): *Nasjonalatlas for Norge. Vann, is og snø* (Atlas of Norway. Water, ice and snow), Hønefoss: Norwegian Mapping Authority.

Other literature

Report No. 29 (1996-97) to the Storting: *Regional planlegging og arealpolitikk* (Regional planning and land use policy), Ministry of the Environment.

Report No. 8 (1999-2000) to the Storting: *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's environmental policy and the state of the environment in Norway), Ministry of the Environment.

Report No. 24 (2000-2001) to the Storting: *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's environmental policy and the state of the environment in Norway), Ministry of the Environment.

Report No. 25 (2002-2003) to the Storting: *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's environmental policy and the state of the environment in Norway), Ministry of the Environment.

Statistics Norway (1982): *Arealbruksstatistikk for tettsteder* (Land use statistics for urban settlements), NOS B 333.

Part 3
Pollution and environmental problems

9. Air pollution and climate change

Preliminary calculations show that in 2005, greenhouse gas emissions in Norway were 9 per cent higher than in 1990, but dropped by a little over 1 per cent from 2004 to 2005. The increase in greenhouse gas emissions since 1990 is mainly due to the growth in emissions from oil- and gas-related activities and road traffic.

Norwegian emissions of greenhouse gases, acidifying substances and hazardous substances (heavy metals and persistent organic pollutants) contribute to a number of environmental problems, for example climate change, acidification, depletion of the ozone layer and the formation of ground-level ozone. Some emissions result in local environmental problems, whereas other pollutants are transported in the atmosphere and give problems elsewhere (see boxes 9.2, 9.3, 9.10-9.13 and 9.15).

International cooperation is very important as a means of reducing emissions that have regional or global effects. In addition to taking part in international environmental cooperation generally, Norway is party to various multilateral environmental agreements, and is committed to reducing emissions of the most important air pollutants.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) quantifies the commitments of industrialised countries under the Convention to reduce their greenhouse gas emissions. After it had been ratified by the required number of countries, the Protocol entered into force on 16 February 2005. Of the important industrialised countries, the US and Australia have not ratified the Protocol. Under the Protocol, each industrialised country has an assigned amount of emissions for the period 2008-2012 and undertakes to reduce or limit emissions to achieve this. The assigned amount is defined as a percentage of the country's greenhouse gas emissions in a base year (most often 1990), and varies from 92 to 110 per cent of emissions in the base year. Norway's assigned amount is for example 101 per cent of its 1990 emissions on average for the period 2008-2012. However, this does not mean that there is an absolute limit for emissions from industrialised countries in this period. As a supplement to national emission reduction measures, these countries can make use of the Kyoto mechanisms, for example emission trading, to acquire further emission units (see box 9.5).

There are eight protocols under the Convention on Long-Range Transboundary Air Pollution. One of them is the Gothenburg Protocol, which is intended to reduce acidification, eutrophication and the formation of ground-level ozone by introducing emission ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and NMVOCs (non-methane volatile organic compounds). The Sofia Protocol laid down emission targets for NO_x and was a forerunner of the Gothenburg Protocol. Norway has also undertaken to reduce its emissions of certain other substances under the LRTAP Convention. Under the Protocol on Heavy Metals, Norway is committed to reducing its emissions of lead, cadmium and mercury, and under the Protocol on Persistent Organic Pollutants (POPs), is committed to reducing emissions of various substances including polycyclic aromatic hydrocarbons (PAHs) and dioxins.

The Norwegian emission inventory (see box 9.1) makes it possible to identify the major sources of each pollutant and to follow emission trends over time. This information is important when considering which measures to implement and evaluating their effects. Figures from the emission inventory are used in Norway's official reports under the various multilateral environmental agreements, which are used in evaluating how far commitments have been met.

Box 9.1. The Norwegian emission inventory

Norway's emission inventory is produced by Statistics Norway and the Norwegian Pollution Control Authority. The inventory includes all the most important pollutants that cause environmental problems such as climate change, acidification and the formation of ground-level ozone, and also includes a number of hazardous substances. The inventory covers only anthropogenic emissions, not natural emissions for example from oceans and forests. The Norwegian Pollution Control Authority and the Ministry of the Environment are responsible for reporting Norway's figures for emissions to air under multilateral environmental agreements such as the Kyoto Protocol. Figures from the emission inventory produced by Statistics Norway and the Norwegian Pollution Control Authority are used in such reports.

Emission figures are compiled partly from data reported by industrial plants, based on measurements or calculations at these plants, and partly from calculations using activity data and emission factors (see Appendix tables G8 and G9). Activity data may include consumption of energy commodities (e.g. fuel oil consumption by manufacturing industries and households) or other data such as the number of sheep put out to pasture, the quantity of waste landfilled, the quantity of ferro-alloys manufactured, etc.

Recalculations

The Climate Change Convention, the Kyoto Protocol and other environmental agreements require industrialised countries to follow a strict regime for calculating and reporting emissions to air. Emission figures are based on calculations with varying levels of certainty, and the environmental agreements therefore require countries to continue efforts to improve the methodology for calculating emissions. As new research results in improvements in methodology, emission figures for all years have to be recalculated. It will be even more important for countries to make these recalculations, and to do so regardless of whether they result in higher or lower emissions, in the commitment period 2008-2012 under the Kyoto Protocol. For more information, see Haakonsen and Rosland (2006).

In connection with recalculations Norway made in 2006, emissions from Russian activity in Svalbard were included for the first time. This has resulted in some increase in Norway's emission figures for all years in the time series.

Preliminary and final figures

In 2006, national emission figures for 2005 were published. These were preliminary figures based on last year's calculations, in addition to emission figures reported by large enterprises and the activity data available now. Experience shows that these emission figures are good estimates for most pollutants at national level.

The 2004 figures are also considered to be preliminary figures. This is because auditing of the energy accounts, which are a very important source of data for the emission inventory, takes about eighteen months to complete. However, we would normally only expect minor adjustments between the preliminary figures for 2004, which are being published now, and the final figures, which will be published in 2007. Because of the requirement to recalculate the figures to take account of new information, even the final figures may be changed. They are then republished, but the adjustments are usually smaller than for the preliminary figures.

Emission figures are presented in a series of tables, for example showing emissions by source (see appendix, table G5) or by sector (see appendix, table G4). Most of the figures in this chapter are based on aggregated figures for emissions by source. Time series for the national emission figures and emissions split by source, sector, county and municipality are also available on Statistics Norway's website at: http://www.ssb.no/english/subjects/01/04/10/.

For documentation of the emission inventory, see Hoem, B.: The Norwegian Emission Inventory 2006. Documentation of methodologies for estimating emissions of greenhouse gases and long-range transboundary air pollutants. Reports 2006/30, Statistics Norway.

Box 9.2. Environmental problems caused by air pollution

Enhanced greenhouse effect	As a result of the natural greenhouse effect, the global mean temperature is about 15 °C instead of -18 °C. But anthropogenic emissions of gases such as CO_2, CH_4, N_2O and fluorinated gases can cause further warming. Since 1750, concentrations of the three most important greenhouse gases, CO_2, CH_4 and N_2O, have risen by 30, 150 and 17 per cent respectively (NILU 2005a). Norway's total greenhouse gas emissions are shown in figure 9.3.
Climate change	Anthropogenic emissions of greenhouse gases, SO_2 and particulate matter can alter the natural chemical composition of the atmosphere. Greenhouse gases cause warming of the atmosphere, whereas SO_2 and particulate matter mainly have a cooling effect. It is difficult to quantify the proportion of climate fluctuations that is a result of human activity. However, the evidence that most of the global warming that has been observed in the last 50 years is anthropogenic has become stronger (IPCC 2001).
Ozone depletion	The atmospheric ozone layer is found in the stratosphere, 10-40 km above the earth, and prevents harmful ultra-violet (UV) radiation from the sun from reaching the surface of the earth. Episodes when the ozone content of the stratosphere is very low and the levels of UV radiation reaching the earth are high have been observed above Antarctica. Observations have also shown that the ozone content of the stratosphere above middle and northern latitudes has dropped. The causes of ozone depletion include anthropogenic emissions of CFCs, HCFCs, halons and other gases containing chlorine and bromine, all of which can break down ozone in the presence of sunlight. Depletion of the ozone layer increases the amount of UV radiation reaching the earth, and may result in a higher incidence of skin cancer, eye injury and damage to the immune system. In addition, plant growth both on land and in the sea (algae) may be reduced (SSB/SFT/DN 1994). For imports of ozone-depleting substances to Norway, see figure 9.15.
Ground-level ozone	Ozone in the lower atmosphere is a pollution problem because it has adverse effects on health, vegetation and materials. Ground-level ozone is formed by oxidation of CH_4, CO, NO_x and NMVOCs in the presence of sunlight. It may also be transported to Norway from other parts of Europe. In Scandinavia the background level varies between 40 and 80 µg/m³ and is generally highest in spring. The number of pollution episodes[1] was lower in 2005 (8) than in 2004 (15). The highest hourly mean concentration in 2005 was 144 µg/m³, recorded at the measuring station Prestebakke (Norwegian Institute for Air Research 2006b). Hourly mean values over 100 µg/m³ were recorded at all measuring stations. The Norwegian Pollution Control Authority's air quality criterion for health (80 µg/m³, 8-hour mean) was frequently exceeded at all measuring stations, but WHO's air quality criterion of 120 µg/m³ was only occasionally exceeded.
Acidification	Emissions of SO_2, NOx and NH_3 acidify soils and water when deposited. This problem is not caused by Norwegian emissions alone, since these substances are also transported for considerable distances in the atmosphere. The extent of the damage depends on the type of soil and vegetation. Lime-rich soil can for example withstand acidification better than other soil types because it weathers to release calcium. Many parts of Norway have lime-poor soils and sensitive vegetation, and the impact of acid rain is greater than in many other areas where deposition of acid components is higher. Fresh-water organisms have suffered the most serious damage, and the effects have been observed particularly in Southern Norway, the southern parts of Western Norway, and Eastern Norway. Sør-Varanger municipality in Finnmark suffers the effects of acid rain from sources in Russia. Acid rain increases leaching of nutrients and metals (especially aluminium) from soils and can cause corrosion damage to buildings. For deposition of sulphur and nitrogen compounds in Norway, see Chapter 9.2. In the last few years, clear improvements have been observed in water chemistry and in the content of acidifying substances in precipitation.

[1] Number of days when one measuring station records a maximum hourly mean concentration of 200 µg/m³ or several measuring stations record an hourly mean concentration of more than 120 µg/m³.

9.1. Greenhouse gases

Climate change

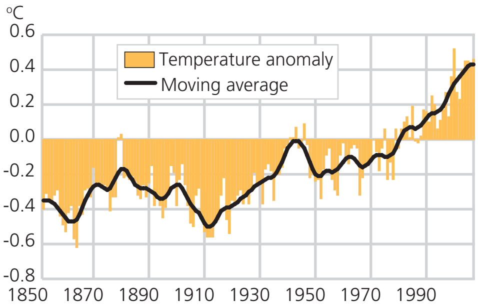
Concentrations of greenhouse gases in the atmosphere are rising as a result of human activity. The most important reason for this is emissions of carbon dioxide (CO_2) from combustion of fossil fuels, which have already resulted in the highest CO_2 concentrations in the atmosphere for at least 650 000 years (Brook 2005), maybe for several million years. As concentrations of greenhouse gases rise, the atmosphere retains more of the thermal radiation from the earth, which causes the global mean temperature to rise and result in climate change. This phenomenon is called the anthropogenic greenhouse effect.

If emissions of greenhouse gases continue to rise, the risk that climate change will have serious, far-reaching impacts will also rise. To solve the problem will require a reorganisation of world energy use, which is the most important source of greenhouse gas emissions. The countries of the world are trying to organise emission reductions within the framework of the Kyoto Protocol (see box 9.5).

National target - Climate change

1. Norway shall comply with its commitment under the Kyoto Protocol, which is that its greenhouse gas emissions in the period 2008-2012 must not be more than 1 per cent higher than in 1990.

Figure 9.1. Global mean temperature[1]. 1850-2005

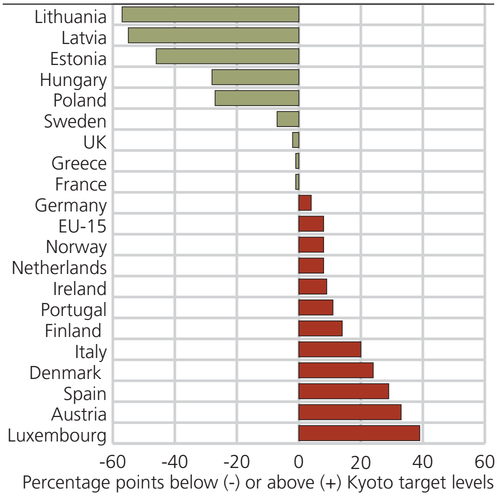


[1] Deviation from the normal value for the period 1961-1990.
Source: Climate Research Unit, University of East Anglia and Hadley Centre, UK Meteorological Office.

Global mean temperature

- The global mean temperature rose by about 0.6 °C during the last century. Some of this rise may be explained by natural variations, but the UN Intergovernmental Panel on Climate Change (IPCC) has concluded that there has been a discernible human influence on the global climate. 1998 was the warmest year registered since records began in 1850, while 2005 was the next warmest with an average temperature 0.46 °C above normal.
- The annual mean temperature in Norway in 2005 was 1.5 °C above average, making it the sixth warmest year since the Norwegian Meteorological Institute started measurements in 1867. The warmest year recorded in Norway is 1990, with an average temperature 1.8 °C above normal (Norwegian Meteorological Institute 2006).

Figure 9.2. "Distance-to-target" for greenhouse gas[1] emissions in 2004 (deviation of actual emissions from Kyoto[2] targets)

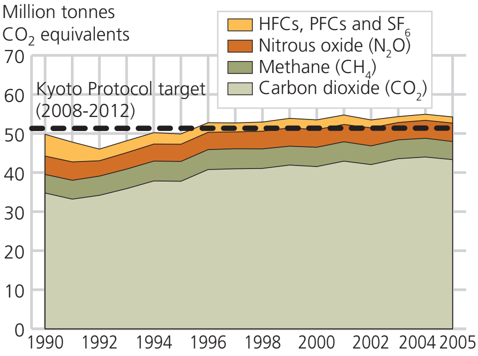


[1] Under the Kyoto Protocol, the base year for emissions of CO_2, CH_4 and N_2O is 1990. Some countries have chosen to use 1995 as the base year for fluorinated gases.
[2] The targets do not mean that there is an absolute limit for these countries' emissions in the Kyoto commitment period (2008-2012). As a supplement to national emission reduction measures, the industrialised countries can acquire further emission units by making use of the Kyoto mechanisms, for example emissions trading with other industrialised countries (see box 9.5).
Source: EEA (2006) and emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Greenhouse gas emissions in other countries

- Aggregate greenhouse gas emissions from the 15 "old" EU states increased by 0.3 per cent from 2003 to 2004 (EEA 2006). The EU member states must reduce their overall emissions by 8 per cent by 2008-2012 compared with the 1990 level to meet their Kyoto commitments unless they decide to make use of emissions trading and the other Kyoto mechanisms. The EU has adopted a burden-sharing agreement to divide this overall reduction among the member states.
- Germany is the EU state with the highest greenhouse gas emissions. In 2004, its emissions totalled 1 015 million tonnes CO_2 equivalents, a reduction of 17.5 per cent since the base year. Under the EU burden-sharing agreement, Germany has undertaken to reduce its greenhouse gas emissions by 21 per cent compared with the base level.
- Greenhouse gas emissions in Spain and Ireland have risen by 48 and 23 per cent respectively in the period 1990-2004. According to the EU burden-sharing agreement, emissions in Spain and Ireland may rise by 15 and 13 per cent respectively compared with the base year level.

Figure 9.3. Total emissions of greenhouse gases in Norway. 1990-2005*. Million tonnes CO_2 equivalents



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Aggregate greenhouse gas emissions in Norway

- Greenhouse gas emissions in Norway dropped by 1 per cent from 2004 to 2005. The overall rise since 1990, the base year for the Kyoto Protocol, is 9 per cent. Emissions totalled 54.2 million tonnes CO_2 equivalents in 2005.
- There were several reasons for the decrease in emissions in 2005, but the most important was probably that higher oil prices resulted in lower consumption of heating kerosene and fuel oil. Another important factor was that emissions from industrial processes dropped, partly because of lower production, but also as a result of measures to control pollution.
- The increase in emissions from 1990 to 2004 is mainly due to the growth in emissions from oil- and gas-related activities, which rose by 81 per cent in the same period. There was also a 28 per cent increase in emissions from road traffic, which is related to a rise in the level of economic activity.
- In 2005, CO_2 accounted for almost 80 per cent of Norway's greenhouse gas emissions. The rise in emissions has also been greater for CO_2 than for other greenhouse gases. Emissions of fluorinated gases have dropped by 72 per cent since 1990.
- It is estimated that emissions will continue to rise and reach 59.2 million tonnes CO_2 equivalents in 2010 unless new climate-related measures are introduced. Projections indicate that the petroleum and transport sectors will account for a substantial proportion of the rise in emissions up to 2010 (Report No. 1 (2006-2007) to the Storting).

Box 9.3. Greenhouse gases. Sources and harmful effects

Substance	Important sources[1]	Effects
Carbon dioxide (CO_2)	Combustion of fossil fuels, changes in land use and deforestation	Enhances the greenhouse effect.
Chlorofluorocarbons (CFCs)	Cooling fluids	Enhance the greenhouse effect and deplete the ozone layer.
Hydrofluorocarbons (HFCs)	Cooling fluids	Enhance the greenhouse effect.
Hydrochlorofluorocarbons (HCFCs)[2]	Cooling fluids	Enhance the greenhouse effect and deplete the ozone layer.
Methane (CH_4)	Agriculture, landfills, production, transport and use of fossil fuels	Enhances the greenhouse effect and contributes to formation of ground-level ozone.
Nitrous oxide (N_2O)	Agriculture, fertiliser production	Enhances the greenhouse effect.
Perfluorocarbons (PFCs)	Aluminium production	Enhance the greenhouse effect.
Sulphur hexafluoride (SF_6)	Magnesium production	Enhances the greenhouse effect.

[1] The table indicates important anthropogenic sources. There are also important natural sources for several of these substances.
[2] Not included in the national greenhouse gas inventory or in the Kyoto Protocol.

Box 9.4. Greenhouse gases and global warming potential

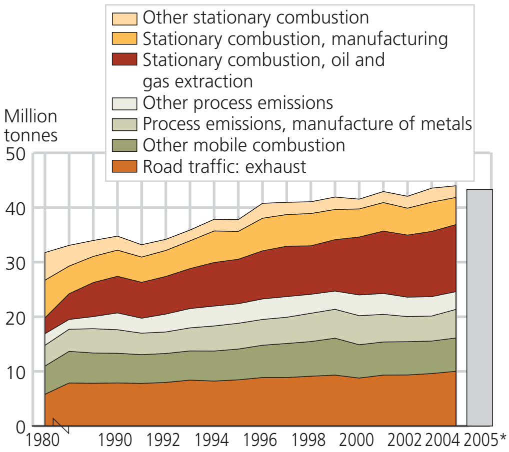
The three most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Anthropogenic emissions of CO_2 are mainly associated with the combustion of fossil fuels, but are also generated by various chemical processes in manufacturing industries. Methane is formed mainly by decomposition of biological waste in landfills and by livestock (agriculture). Manure and the use and production of commercial fertilisers are the main sources of N_2O emissions in Norway.

The GWP value (Global Warming Potential) of a gas is defined as the cumulative impact on the greenhouse effect of 1 tonne of the gas compared with that of 1 tonne of CO_2 over a specified period of time. GWP values are used to convert emissions of greenhouse gases to CO_2 equivalents. The list below shows GWP values for the greenhouse gases to which the Kyoto Protocol applies. The time horizon used here is 100 years.

Substance:	GWP value:
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	
HFC-23	11 700
HFC-32	650
HFC-125	2 800
HFC-134a	1 300
HFC-143a	3 800
HFC-152a	140
HFC-227	2 900
Perfluorocarbons (PFCs)	
CF_4 (PFC-14)	6 500
C_2F_6 (PFC-116)	9 200
C_3F_8 (PFC-218)	7 000
Sulphur hexafluoride (SF_6)	23 900

The Kyoto Protocol sets out binding targets for greenhouse gas emissions by industrialised countries. The Protocol applies to the greenhouse gases CO_2, CH_4 and N_2O, sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Figure 9.4. Emissions of CO_2 by source. 1980-2005*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Carbon dioxide (CO_2)

- In 2005, CO_2 emissions totalled 43.3 million tonnes: this is a decrease of 1.5 per cent from the year before. The overall rise since 1990 is 25 per cent.
- The most important sources of CO_2 emissions are oil and gas extraction and road traffic, which accounted for 28 and 23 per cent respectively of the total in 2004. Process emissions from metal production accounted for 12 per cent of emissions in 2004.

Box 9.5. The Kyoto Protocol and the Kyoto mechanisms

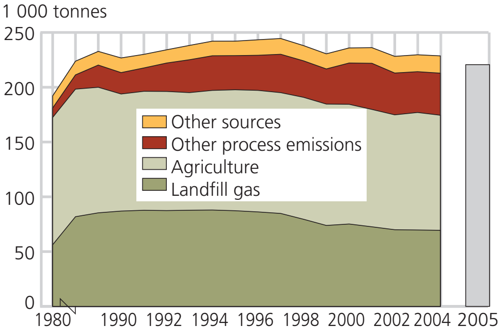
As of May 2007, 171 countries had ratified the Kyoto Protocol. Of these, 36 industrialised countries, including Norway, have been allocated assigned amounts of emissions for the period 2008-2012. Norway's assigned amount is 101 per cent of its 1990 emissions on average for each of the years in the period 2008-2012. However, this does not mean that there is an absolute limit for emissions from industrialised countries during the commitment period. As a supplement to national emission reduction measures, these countries can make use of the Kyoto mechanisms to acquire further emission units. The mechanisms include emissions trading with other industrialised countries and funding approved projects to reduce emissions in developing countries (the Clean Development Mechanism). Emissions from developing countries are not limited in this period, but negotiations on commitments for the period after 2012 have started. The protocol entered into force on 16 February 2005.

Emissions trading
Countries that have undertaken commitments under the Protocol may trade emission units among themselves. A country that can reduce emissions to below the target set out in the Protocol at relatively low cost may sell units to countries where the cost of achieving the target is relatively high. Countries that sell units must reduce their emissions *more* than the Protocol requires, and purchasing countries can reduce them *less*.

Joint implementation
Two countries that have undertaken commitments to reduce emissions may agree that reductions financed by one country and carried out in the other are to be credited to the investor's emission inventory. Since the cost of reducing emissions varies widely between countries, this is a more cost-effective solution than requiring all countries to carry out emission reductions within their own borders.

The clean development mechanism (CDM)
Similar to joint implementation, but CDM is applicable in cases where one party has undertaken a commitment to reduce emissions and the other has not.

Figure 9.5. Emissions of CH_4 by source. 1980-2005*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Methane (CH_4)

- In 2005, CH_4 accounted for 9 per cent of Norway's aggregate greenhouse gas emissions.
- In 2005, CH_4 emissions totalled 221 000 tonnes, 3.5 per cent less than the year before. There has been a 2.7 per cent decrease in emissions since 1990.
- The most important sources of CH_4 emissions are agriculture (livestock and manure) and landfills, which accounted for 46 and 30 per cent of Norwegian emissions, respectively, in 2004.
- The model used to calculate emissions of methane from landfills was improved in the period 2004-2006. As a result, the estimated level of emissions from this source has been cut by more than 50 per cent (see box 9.7).

Box 9.6. Norway's assigned amount of emissions

In 2006, Norway submitted its initial report under the Kyoto Protocol. The report provides the final figures for calculating Norway's assigned amount for the commitment period 2008-2012. The most recent calculations show that Norway's aggregate greenhouse gas emissions in 1990 were 49.8 million tonnes CO_2 equivalents. This means that Norway's emissions for the whole commitment period must be limited to 251.5 million tonnes CO_2 equivalents (49.8 million tonnes * 1.01 * 5). If the average annual emissions are below 50.3 million tonnes, it will not be necessary for Norway to make use of the Kyoto mechanisms. However, the most recent projections of emissions suggest that they will be higher than this, and that Norway will probably have to acquire emission units from other countries.

Box 9.7. Methane emissions from landfills

In 2004, the Norwegian Pollution Control Authority and Statistics Norway reviewed the calculations of greenhouse gas emissions from Norwegian landfills. The figures are calculated using a satellite model that forms part of the national emission model used to produce figures for reporting to the UN Framework Convention on Climate Change and the Kyoto Protocol.

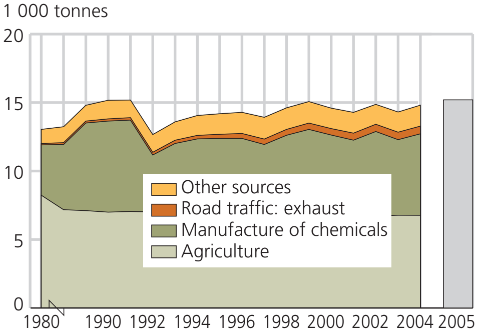
The satellite model has been improved in a number of ways, including changes in the underlying assumptions on the composition of the landfill gas formed and the proportion of the waste that is biodegradable.

In 2005, Statistics Norway took over the responsibility for the model used to calculate methane emissions from landfills from the Norwegian Pollution Control Authority. In this connection, Statistics Norway has reviewed the figures for waste quantities from 1945 to the present, and has found that some changes are necessary. The degradation rates for certain waste types have been adjusted in consultation with the Pollution Control Authority.

These changes and other changes that were made in 2004 have resulted in considerably lower figures for methane emissions from landfills. In 2004, landfills accounted for less than 3 per cent of Norway's total greenhouse gas emissions.

Documentation: Metanutslipp fra norske avfallsfyllinger. Reviderte beregninger av deponert avfall 1945-2004 (*Methane emissions from Norwegian solid waste disposal sites: revised calculations of waste deposited 1945-2004*) (Skullerud 2006) and *Methane emissions from solid waste disposal sites* (Norwegian Pollution Control Authority 2005).

Figure 9.6. Emissions of N_2O by source. 1980-2005*

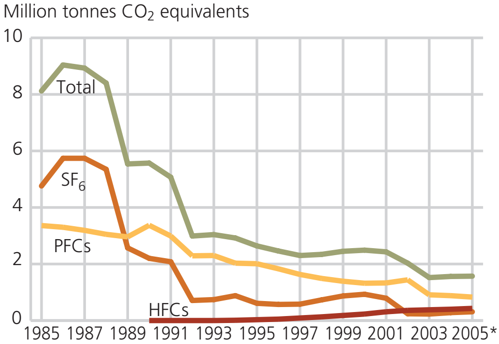


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Nitrous oxide (N_2O)

- In 2005, N_2O accounted for 9 per cent of Norway's aggregate greenhouse gas emissions.
- In 2005, N_2O emissions totalled 15 200 tonnes, which is an increase of 3 per cent from 2004.
- The most important sources of N_2O emissions are agriculture, the manufacture of commercial fertiliser and road traffic. The marked drop in emissions from 1991 to 1992 reflects a cut in emissions from fertiliser manufacturing as a result of technological improvements.
- Emissions from road traffic continued to rise in 2005 because nitrous oxide emissions are higher from cars with catalytic converters than from those without, and because of the growing volume of traffic.

Figure 9.7. Total emissions of other greenhouse gases (HFCs, PFCs and SF_6). 1985-2005*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Other greenhouse gases

- The most important sources of SF_6 and PFC emissions are the process industry (magnesium and aluminium production). The most important source of HFC emissions is leakages from cooling equipment.
- In 2005, emissions of sulphur hexafluoride (SF_6) totalled 13 tonnes, equivalent to 300 000 tonnes CO_2 equivalents, which is a rise of 13 per cent from the year before. In 2002, emissions of SF_6 were reduced by two thirds as a result of discontinuation of primary production of magnesium.
- Emissions of perfluorocarbons (PFCs) dropped by 6 per cent from 2004 to 2005, and now equal about 800 000 tonnes CO_2 equivalents. Emissions of hydrofluorocarbons (HFCs) increased by 7 per cent in the same period, and totalled 430 000 tonnes CO_2 equivalents in 2005.
- Measured in CO_2 equivalents, these pollutants together accounted for almost 3 per cent of Norway's aggregate greenhouse gas emissions in 2005.

Box 9.8. Improved calculations of HFC and SF_6 emissions

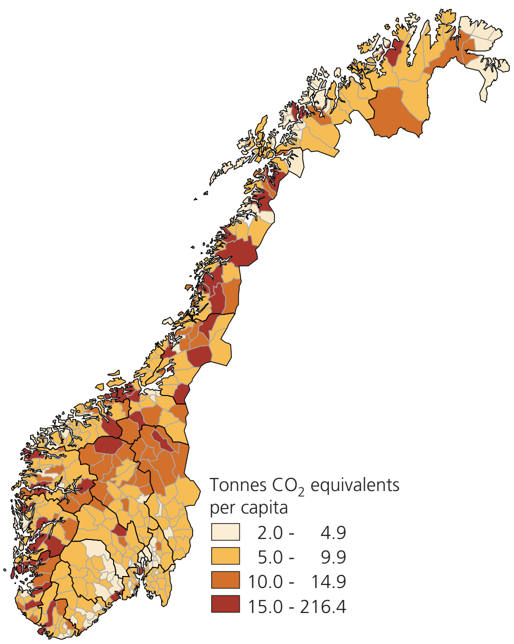
In the period 2002-2004, measures were initiated to reduce emissions of the fluorinated greenhouse gases SF_6, HFCs and PFCs. In 2002, a voluntary agreement was reached between the Ministry of the Environment and the electricity sector on the reduction of SF_6 emissions from electrical components and switches, and in 2003 a tax on imports and production of HFCs and PFCs was introduced. This was supplemented with a refund scheme for destruction of these gases the following year.

The introduction of these measures made it necessary to update the method used for calculating emissions to reflect the current situation. The measures have also made new sources of data available. The work of updating the methodology and surveying the new sources of data has been started.

In connection with the agreement on SF_6 emissions from electrical components, the industry has drawn up a detailed inventory of stocks and leakages from equipment. This has now been included in the emission calculations.

Another element of this work has been to consider how data from the Directorate of Customs and Excise and data from destruction facilities can be used in calculating emissions of HFCs and PFCs. In addition, the emission factors used in the model will be analysed more closely.

Figure 9.8. Per capita emissions of greenhouse gases. Tonnes CO_2 equivalents by municipality. 2004



Map data: Norwegian Mapping Authority.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Greenhouse gas emissions at local level

- CO_2 is the most important greenhouse gas in all counties.
- Manufacturing, road traffic, agriculture and landfills are the largest sources of greenhouse gas emissions in most municipalities.
- About 63 per cent of Norway's CO_2 emissions can be allocated to household and industrial activities in the municipalities. The rest, 37 per cent in 2004, take place at sea and in Norwegian airspace, and are generated mainly by the oil and gas industry, domestic shipping and inland air traffic.

Box 9.9. Analysis of uncertainty in estimates of greenhouse gas emissions

In 2006, Statistics Norway carried out an analysis of uncertainty in the Norwegian greenhouse gas inventory in a project that also received funding from the Norwegian Pollution Control Authority. The uncertainty in the 1990 figures was estimated at ±7 per cent. In a similar analysis carried out in 2000, the level of uncertainty in the 1990 figures was estimated at ± 21 per cent (Rypdal and Zhang 2000). This reduction in the level of uncertainty is explained partly by new, lower estimates of uncertainty, and partly by the new and improved methodology used in the emission inventory. Thus, the level of uncertainty has been reduced both by methodological improvements and by improvement of the underlying data used for recalculation of emissions. Some of the methods that were considered to be good enough in the 1990s were no longer adequate and have therefore been changed. This is a result of a continual process of improvement.

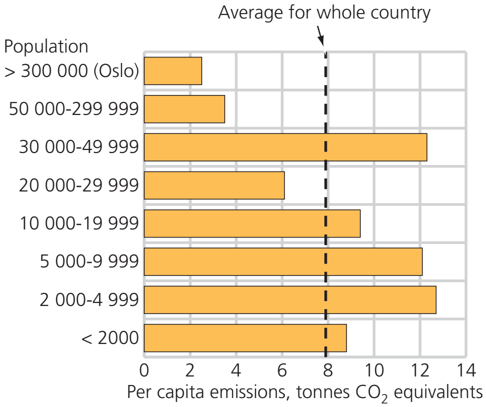
Greenhouse gases. Shares of total emissions and calculated uncertainty in emission figures. 1990 and 2004

	1990			2004	
	Share of total emissions (CO_2 eq.)	Uncertainty (per cent)		Share of total emissions (CO_2 eq.)	Uncertainty (per cent)
Total	1	±7	Total	1	±6
CO_2	0.69	±3	CO_2	0.80	±3
CH_4	0.10	±15	CH_4	0.09	±14
N_2O	0.10	±57	N_2O	0.09	±59
HFCs	0.00	±49	HFCs	0.01	±51
PFCs	0.07	±21	PFCs	0.02	±20
SF_6	0.04	±2	SF_6	0.005	±15

The uncertainty in the input data for the emission inventory was assessed on the basis of available data and expert assessments. Finally, level and trend uncertainties were estimated using Monte Carlo simulation. The analyses were made both excluding and including the LULUCF sector (land use, land-use change and forestry).

For documentation, see Hoem, B.: *The Norwegian Emission Inventory 2006. Documentation of methodologies for estimating emissions of greenhouse gases and long-range transboundary air pollutants*. Reports 06/30, Statistics Norway.

Figure 9.9. Average per capita greenhouse gas emissions in Norway, from municipalities grouped by population size. 2004. Tonnes CO_2 equivalents



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority

- Per capita greenhouse gas emissions are lower in the municipalities with the highest populations than in those with smaller populations. In Oslo, per capita greenhouse gas emissions were 2.5 tonnes in 2004. The corresponding figure for the 11 other municipalities with populations of over 50 000 was 3.5 tonnes, while it was 12.3 tonnes in municipalities with a population of 30 000-50 000. In the average municipality, per capita greenhouse gas emissions were 7.9 tonnes.
- There are several reasons why per capita emissions are below average in the municipalities with the highest population. CO_2 emissions from the process industry are high in Norway, and most plants in this sector are located outside the largest towns. There is little room for agriculture in the largest urban areas, so that major sources of methane and nitrous oxide emissions are more or less absent.
- Landfills generate substantial emissions in many municipalities. In several of the largest towns, however, most waste is incinerated, thus generating considerably lower greenhouse gas emissions. In a city like Oslo, car use is much lower than the average for Norway. This is partly because distances are shorter and public transport is better than in municipalities with a smaller population. In addition, there is less need for heating in densely built-up areas, which results in lower emissions.

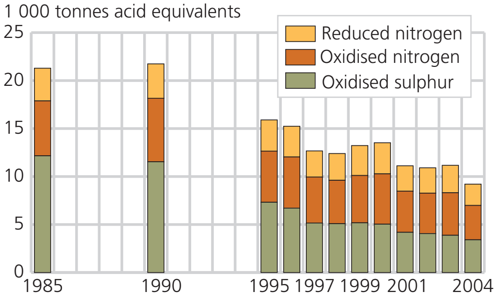
National targets - Long-range air pollutants

1. Annual emissions of sulphur dioxide (SO_2) shall not exceed 22 000 tonnes from 2010 onwards.
2. Annual emissions of nitrogen oxides (NO_x) shall not exceed 156 000 tonnes from 2010 onwards, and annual emissions in the period up to 2010 shall not exceed the 1987 level (230 000 tonnes).
3. Annual emissions of volatile organic compounds (VOCs) shall not exceed 195 000 tonnes from 2010 onwards. In the period up to 2010, annual emissions shall not exceed the 1988 level (252 000 tonnes), and annual emissions from the entire mainland and the Economic Zone of Norway south of 62^0 N shall not exceed 70 per cent of the 1989 level (191 000 tonnes).
4. Emissions of ammonia (NH_3) shall not exceed 23 000 tonnes from 2010 onwards.

Source: Report No. 21 (2004-2005) to the Storting, The Government's environmental policy and the state of the environment in Norway.

9.2. Acidification

Figure 9.10. Deposition of acidifying substances in Norway. 1985-2004



Source: Norwegian Meteorological Institute and EMEP.

Deposition of acidifying substances in Norway

- Acidification of the Norwegian environment is being reduced. Sulphur emissions have been cut elsewhere in Europe, thus reducing the deposition of pollutants over Norway. Reductions in nitrogen emissions have been much smaller, so that the relative importance of nitrogen deposition is increasing.
- Although total deposition has been reduced, critical loads are still being exceeded in large parts of the southern half of Norway.
- Emissions from Norway are largely deposited in Norway or over the sea (EMEP/MSC-W 2005). A certain proportion of the Norwegian emissions is also deposited in Sweden.
- The UK, Germany and Poland are the countries outside Norway that make the largest contributions to the total deposition of acidifying substances in Norway.

Table 9.1. Emissions and emission targets under the Gothenburg Protocol for SO_2 og NO_x. 1 000 tonnes

	SO_2			NO_X		
	Emissions		Target	Emissions		Target
Country:	1 990	2004	2010	1990	2004	2010
UK	3 699	833	625	2 933	1 621	1 181
Germany	5 289	559	550	2 878	1 554	1 081
Russia[1]	4 671	2 130[2]	2 470	3 600	2 566[2]	2 500
Sweden	117	47	67	306	197	148
Denmark	178	24	50	273	181	127
Norway	53	25	22	224	215	156

[1] Figures according to "Expert Emissions used in EMEP models". The figures apply to the European part, within the EMEP area.
[2] Emissions in 2003.
Source: EMEP (2006).

Box 9.10. Acidifying substances. Sources and harmful effects

Substance	Important sources[1]	Effects
Ammonia (NH_3)	Agriculture	Contributes to acidification of water and soils.
Nitrogen oxides (NO_x)	Combustion (industry, road traffic)	Increase the risk of respiratory disease (particularly NO_2). Contribute to acidification, corrosion and formation of ground-level ozone.
Sulphur dioxide (SO_2)	Combustion, metal production	Increases the risk of respiratory complaints. Acidifies soil and water and causes corrosion.

[1] The table indicates important anthropogenic sources.

Box 9.11. Acidification: a brief explanation of causes and effects

The term acid rain means inputs of pollutants that have acidifying effects in the environment with rain and snow. Such pollutants can also be deposited directly in the form of gases or particles (dry deposition), and direct deposition is normally also included in the definition of acid rain. Acid rain is caused mainly by emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_x) from the combustion of fossil fuels. In addition, ammonia and ammonium ions (NH_x) contribute to acidification through various chemical processes that take place in soil and water. Air pollutants are often transported for long distances, for example from central Europe or Britain, before ending up as acid rain in Norway. Most of the deposition of acidifying substances in Norway originates from emissions in other countries.

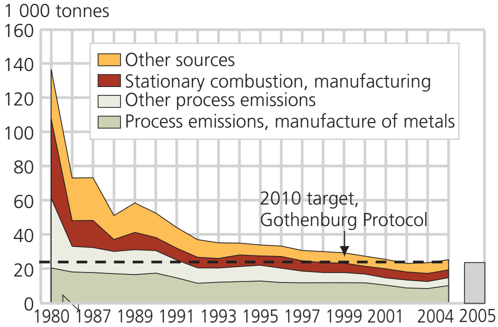
Acid rain has had serious impacts on life in rivers and lakes: for example, formerly abundant fish stocks have been lost from river systems across large parts of the southern half of Norway. Acidification of soils results in leaching of nutrients and metals. In addition to its impact on the flora and fauna, acid rain results in corrosion damage to buildings and cultural monuments.

There has been little change in emissions of nitrogen compounds. The problems related to emissions of these compounds are more complicated than for sulphur, because nitrogen has a fertilising effect and can therefore result in changes in the species composition of the vegetation. Species that can make use of an extra nitrogen supply benefit at the expense of other species. Nitrogen has an acidifying effect if inputs are larger than the amount the vegetation can absorb.

In recent years, clear improvements have been observed in water chemistry and in the content of acidifying substances in precipitation. In its annual report for 2004 on monitoring of long-range transport of pollutants, the Norwegian Institute for Air Research (2005b) noted that the concentration of sulphur in air has never been lower since measurements started in 1973. According to the 2005 report (Norwegian Institute for Air Research 2006a), concentrations of strong acid, sulphate, nitrate and ammonium in precipitation in 2005 were somewhat higher than in 2004, but the same as or lower than in 2003.

The Norwegian Pollution Control Authority's report summarising the results of all the monitoring programmes for long-range transport of pollutants (Norwegian Pollution Control Authority 2006) confirms the impression of the past few years that concentrations of acidifying substances are beginning to level off. Although concentrations of these substances in fresh water are lower than they have ever been since the monitoring programmes were started in 1980, there is less improvement from one year to the next than before.

Figure 9.11. Emissions of SO_2 by source. 1980-2005*

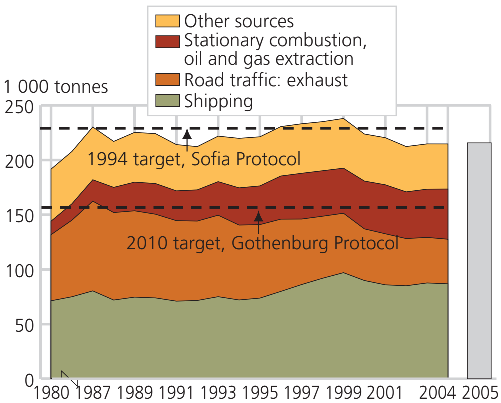


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority

Sulphur dioxide (SO_2)

- Sulphur emissions had been decreasing steadily since the mid-1980s, but rose again in 2003 and 2004. In 2005, SO_2 emissions totalled 23 800 tonnes, a drop of 5.5 per cent from 2004. Since 1990, emissions have been reduced by more than half through measures to reduce industrial emissions, a change-over from fossil fuels to electricity, and reduction of the sulphur content of oil products and raw materials.
- The recent fluctuations in sulphur emissions are explained by variations in emissions from the manufacture of iron, steel and ferro alloys, carbide production and shipping. Domestic shipping and fishing vessels accounted for 15 per cent of total emissions in 2005.
- The Gothenburg Protocol entered into force on 17 May 2005. Under this agreement, Norway has undertaken to reduce its annual SO_2 emissions to 22 000 tonnes by 2010. This means that emissions must be reduced by 8 per cent from the current level.

Figure 9.12. Emissions of NO_x by source. 1980-2005*

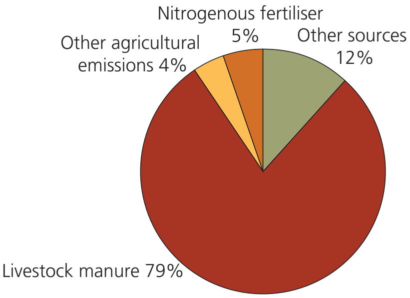


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Nitrogen oxides (NO_x)

- In 2005, NO_x emissions totalled 215 700 tonnes, which is about the same level as the year before. From 1990, emissions have been reduced by 4 per cent.
- The largest sources of NO_x emissions are shipping and fisheries (40 per cent), stationary combustion in the oil and gas industry (21 per cent) and road traffic (19 per cent). The only reduction since 1990 has been in emissions from road traffic. This is explained by lower emissions from petrol vehicles as a result of limits on exhaust emissions. Emissions from diesel vehicles have risen in recent years despite the limits on exhaust emissions, because the number of diesel vehicles has risen.
- Total emissions must be reduced to 156 000 tonnes if Norway is to meet its commitment under the Gothenburg Protocol. This means a reduction of 28 per cent by 2010.

Figure 9.13. Emissions of ammonia by source. 2004*. Per cent

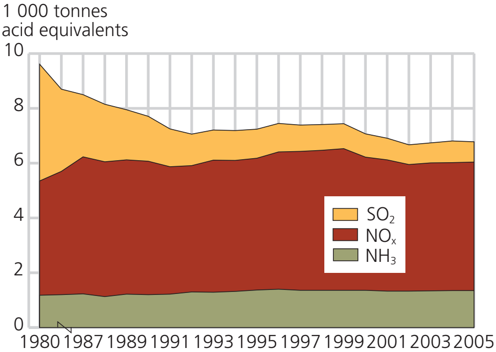


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Ammonia (NH_3)

- In 2005, NH_3 emissions were almost unchanged from the year before at 22 900 tonnes. Under the Gothenburg Protocol, Norway has undertaken to meet an emission ceiling of 23 000 tonnes NH_3 in 2010.
- Agriculture generated 88 per cent of Norwegian emissions of ammonia in 2004. The main sources are livestock, the use of commercial fertiliser and treatment of straw with ammonia. Other sources are petrol vehicles (9 per cent) and manufacturing processes (2 per cent).

Figure 9.14. Emissions of acidifying substances in Norway. 1987-2005*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Aggregate emissions of acidifying substances

- In 2005, Norway's aggregate emissions of acidifying substances, expressed as acid equivalents, amounted to 6 780 tonnes. NO_X accounts for 69 per cent of the total.
- Emissions expressed as acid equivalents showed only a slight decrease from 2004 to 2005.
- The dispersal potential of SO_2 and NO_X emissions is greater than that of NH_3 emissions.

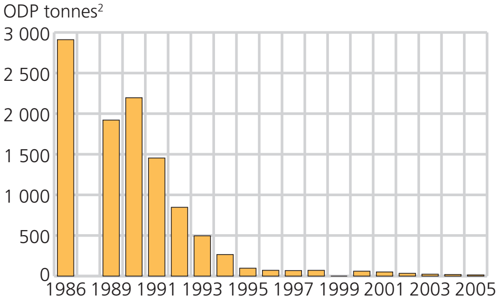
National targets - Depletion of the ozone layer

1. Consumption of halons, all types of chlorofluorocarbons (CFCs), tetrachloromethane, methyl chloroform and hydrobromofluorocarbons (HBFCs) shall be eliminated.
2. Consumption of methyl bromide shall be stabilised in 1995 and phased out by 2005.
3. Consumption of hydrochlorofluorocarbons (HCFCs) shall be stabilised in 1995 and phased out by 2010.

Source: Report No. 21 (2004-2005) to the Storting, The Government's environmental policy and the state of the environment in Norway.

9.3. Depletion of the ozone layer

Figure 9.15. Imports of ozone-depleting substances to Norway[1]. 1986-2005



[1] In addition, one firm has imported carbon tetrachloride (CCl_4) as feedstock in a production process. CCl_4 is converted to other compounds during production, and according to the Norwegian Pollution Control Authority, any emissions are insignificant.
[2] The ozone-depleting potential (ODP) varies from one substance to another, and the figures are totals weighted according to the ODP of each substance (ODP factors).
Source: Norwegian Pollution Control Authority.

- Measured in ODP tonnes, Norway's consumption of ozone-depleting substances has been reduced by more than 99 per cent since 1986. Norway has met all its commitments under the Montreal Protocol and EU targets for ozone-depleting substances.
- Norway imported a total of 15 ODP tonnes of ozone-depleting substances in 2005. This is a drop of 24 per cent since 2004.
- Various HCFCs still dominate imports of ozone-depleting substances to Norway, and accounted for 99.95 per cent of the total (expressed as ODP tonnes) in 2005.
- It has been calculated that the thickness of the ozone layer above Oslo has been reduced by an average of 0.16 per cent per year since 1979 (Norwegian Institute for Air Research 2006b).

Box 9.12. The ozone layer and ozone-depleting substances

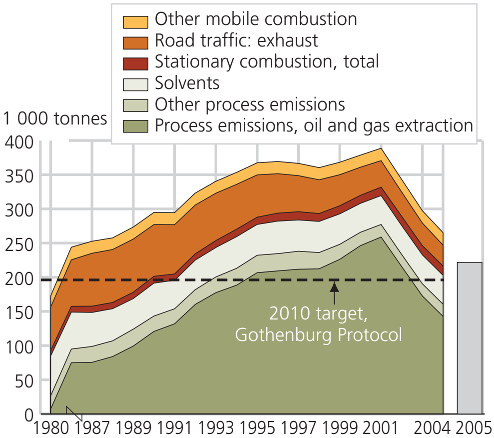
Substances that deplete the ozone layer include hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs) and other gases containing chlorine and bromine. Such gases have been used as cooling agents, propellants in aerosols and in the production of foam plastic. In new products, they are being replaced with hydrofluorocarbons (HFCs), which are greenhouse gases, but not ozone-depleting.

In accordance with the Montreal Protocol, the consumption of ozone-depleting substances in Norway has dropped steeply since the mid-1980s. Emissions take place largely during use of equipment containing these gases, not during production, and only small amounts are collected and destroyed. In accordance with the revised Montreal Protocol, Norway has eliminated imports of newly-produced halons, and there is a general prohibition against imports of CFCs (small quantities of CFCs are imported for necessary purposes such as laboratory analyses). In addition, Norway has undertaken to keep to a timetable for reductions in consumption or prohibitions against the use of several other substances that deplete the ozone layer.

The largest decreases in ozone concentrations have been observed over Antarctica. An annual cycle of significant ozone reduction occurs from September to November. In this so-called ozone hole, up to 60 per cent of the total ozone is lost. After a couple of months, new ozone is produced from oxygen under the influence of solar UV radiation, and the ozone layer regenerates until the next cycle starts. This phenomenon was first registered in the 1980s (Norwegian Pollution Control Authority 2006).

9.4. Formation of ground-level ozone

Figure 9.16. Emissions of NMVOCs by source. 1980-2005*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

NMVOCs

- In 2005, Norway's NMVOC emissions totalled 221 800 tonnes, which corresponds to a reduction of 16 per cent from 2004 and more than 40 per cent from 2001, when these emissions were at their highest level.
- This reduction is mainly a result of measures to reduce emissions during loading and storage of crude oil offshore. Emissions in 2005 were also reduced by recovery of oil vapour at onshore loading facilities, lower sales of petrol and an increase in the number of cars fitted with catalytic converters.
- Under the Gothenburg Protocol, Norway has undertaken to meet an emission ceiling of 195 000 tonnes NMVOCs in 2010. This means an average annual reduction of 12 per cent in the period up to 2010. The target appears to be within reach.

Box 9.13. Ground-level ozone and emissions that contribute to its formation. Sources and harmful effects

Substance	Important sources[1]	Effects
Carbon monoxide (CO)	Combustion (fuelwood, road traffic)	Increases risk of heart problems in people with cardiovascular diseases and contributes to formation of ground-level ozone
Ground-level ozone (O_3)	Formed by oxidation of CH_4, CO, NO_x and NMVOCs (in sunlight)	Increases the risk of respiratory complaints and damages vegetation
Methane (CH_4)	Agriculture, landfills, production, transport and use of fossil fuels	Enhances the greenhouse effect and contributes to formation of ground-level ozone.
Nitrogen oxides (NO_x)	Combustion (industry, road traffic)	Increase the risk of respiratory disease (particularly NO_2). Contribute to acidification, corrosion and formation of ground-level ozone.
Non-methane volatile organic compounds (NMVOCs)	Oil and gas industry, road traffic, solvents	May include carcinogenic substances. Contribute to formation of ground-level ozone.

[1] The table indicates important anthropogenic sources.

Box 9.14. Ozone precursors

Ground-level or tropospheric ozone is formed by the oxidation of CH_4, CO, NO_X and NMVOCs in the presence of sunlight. A weighting factor is defined for each of these precursors according to how much ground-level ozone it forms during a specific period of time. These are known as TOFP (Tropospheric Ozone-Forming Potential) factors, and NMVOCs are used as the reference component.

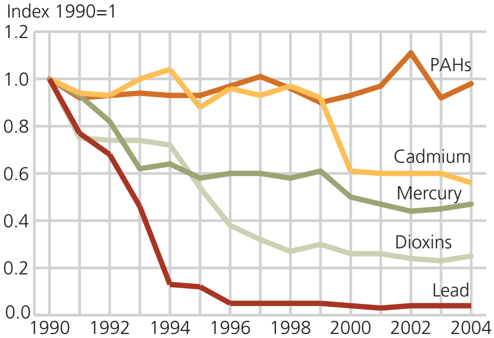
Substance:	**TOFP factor (de Leeuw 2002):**
NO_X	1.22
NMVOCs	1
CO	0.11
CH_4	0.014

Aggregating Norwegian emissions of these gases, weighted with the appropriate factors, we find that total TOFP emissions have dropped by 19 per cent in the period 1990-2005.

9.5. Hazardous substances

Norway has taken on international commitments to reduce emissions to air of selected hazardous substances in relation to 1990 levels. The Storting has adopted the substantial reduction of releases of certain substances (categorised as ecological toxins) by 2010 in relation to 1995 levels as a national target (Report No. 21 (2004-2005) to the Storting). Releases to air, water and soil are all to be reduced. The figures presented here are only for emissions to air.

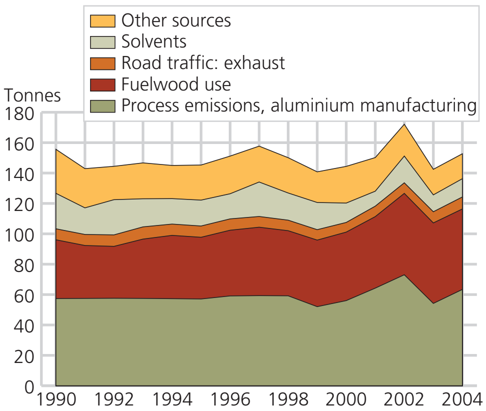
Figure 9.17. Changes in emissions of lead, cadmium, mercury, total PAH and dioxins in Norway. Index 1990=1. 1990-2004*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

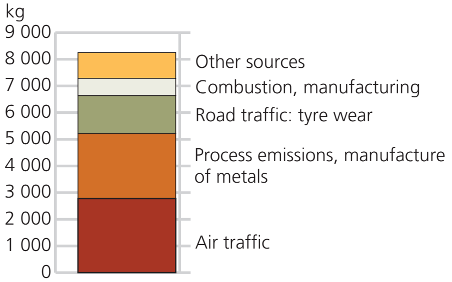
- Emissions of hazardous substances (heavy metals and several persistent organic pollutants) to air were substantially lower in 2004 than in 1990. Lead emissions from road traffic dropped steeply from 1990 to 1997 as leaded petrol was phased out. Other important reasons for reductions in emissions of these substances, especially after 1995, are the installation of equipment to control emissions and improvements in its operation, and the closure of plants in the chemical and metallurgical industry.
- However, releases of certain substances have risen to some extent in the last few years. Two of the reasons for this are a rise in metal production and fuelwood use.
- As a result of better measurements and changes in emission factors, emission figures for some substances are now higher for the whole period than those published previously.

Figure 9.18. Emissions of total PAH to air by source. 1990-2004*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Figure 9.19. Emissions of lead to air by source. 2004*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

PAHs

- In 2004, Norway's emissions of "total PAH" were 153 tonnes, an increase of 7 per cent from 2003. PAH-4, which is the component regulated by the POPs Protocol under the LRTAP Convention, accounted for 15 tonnes of this, an increase of 11 per cent from 2003.
- The largest sources of PAH emissions are fuelwood use in households and process emissions from aluminium production. These two sources accounted for 42 and 35 per cent respectively of the total in 2004. Process emissions accounted for 63 per cent of total PAH-4 emissions.
- The rise in PAH emissions in the past year is a result of higher emissions from aluminium production. Emissions from fuelwood use have been rising for several years. PAH emissions are now 5 per cent higher than in 1995 and at the same level as in 1990.

Lead (Pb)

- Lead emissions were reduced by 96 per cent in the period 1990 to 2004. This was mainly a result of the changeover to unleaded petrol. Since 1995, there has also been a drop in emissions from manufacturing as a result of lower activity and the closure of some plants. Emissions in 2004 totalled 8.3 tonnes. This corresponds to a rise of 13 per cent from 2003, mainly as a result of higher metal production and problems with equipment to control emissions at one plant.
- Leaded petrol is still used in light aircraft, which are now the most important source of emissions. Domestic air transport generates 34 per cent of total lead emissions. The second most important source is metal production processes (29 per cent), while tyre wear accounts for 17 per cent.

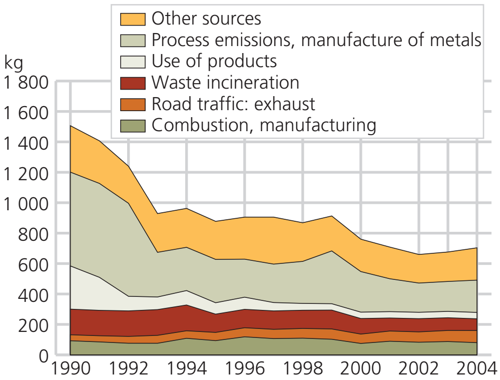
Box 9.15. Harmful effects and sources of emissions for heavy metals, particulate matter, benzene, dioxins and PAHs

Substance	Important sources[1]	Effects
Arsenic (As)	Chemical industry, pulp and paper industry, metal production and road traffic	Inorganic arsenic compounds (arsenates) are very toxic to most organisms (acute and chronic effects), carcinogenic even at low concentrations. Organic compounds are much less toxic.
Benzene (C_6H_6)	Combustion and evaporation of petrol and diesel, fuelwood use	Carcinogenic, toxic effects on acute exposure to high concentrations.
Cadmium (Cd)	Pulp and paper industry, mineral production, metal production, fuelwood use	Liable to bioaccumulate. Delayed effects such as pulmonary emphysema, cancer, reduced fertility in men and kidney damage.
Copper (Cu)	Road traffic and process industry	Liable to bioaccumulate. Some copper compounds are acutely toxic or irritant in mammals.
Chromium (Cr)	Ferro-alloy industry and combustion in industry	Liable to bioaccumulate. Hexavalent compounds (Cr^{6+}) are carcinogenic and sensitising. May cause kidney and liver damage.
Dioxins	Metal production, pulp and paper industry, fuelwood use, shipping and waste incineration	Become concentrated in organisms and food chains. Carcinogenic.
Lead (Pb)	Air traffic, waste incineration mineral production	Environmentally hazardous. No damage to health at concentrations currently found in air in Norway, but because lead accumulates in living organisms, formerly high emissions still constitute a health hazard.
Mercury (Hg)	Pulp and paper industry, mineral production, metal production, fuelwood use, crematoria	Becomes concentrated in organisms and food chains. Causes kidney damage and harms nervous system. May cause cellular changes.
Particulate matter ($PM_{2,5}$ and PM_{10}) [2]	Road traffic and fuelwood use	Increase the risk of respiratory complaints.
Polycyclic aromatic hydrocarbons (PAHs)	All incomplete combustion of organic material and fossil fuels, solvents, aluminium production	Several are carcinogenic.

[1] The table indicates important anthropogenic sources.

[2] PM_{10}; particles measuring less than 10 µm in diameter. $PM_{2,5:}$ particles measuring less than 2.5 µm in diameter.

Figure 9.20. Emissions of mercury to air by source. 1990-2004*

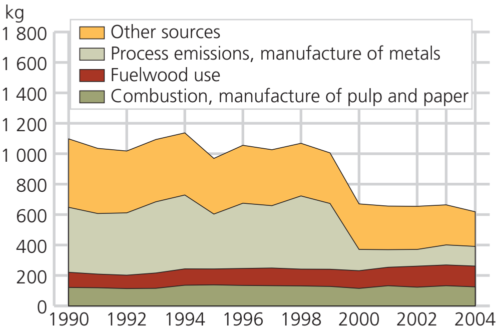


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Mercury (Hg)

- In 2004, mercury emissions totalled 700 kg, an increase of 4 per cent from the year before.
- The main explanation for this is a rise in emissions from metal production as a result of higher production and variations in the mercury content of metal ore, and because equipment to control emissions was out of service for a period at one plant. Emissions from road traffic rose by 10 per cent, mainly as a result of greater use of diesel vehicles.
- The drop in emissions since 1990 is mainly explained by a reduction in emissions from the manufacture of ferro-alloys and better control of emissions from waste incineration, but emissions from the use of products (e.g. mercury thermometers) have also been substantially reduced.
- Metal production processes are the largest single source of mercury emissions, and accounted for 30 per cent of the total in 2004.

Figure 9.21. Emissions of cadmium to air by source. 1990-2004*

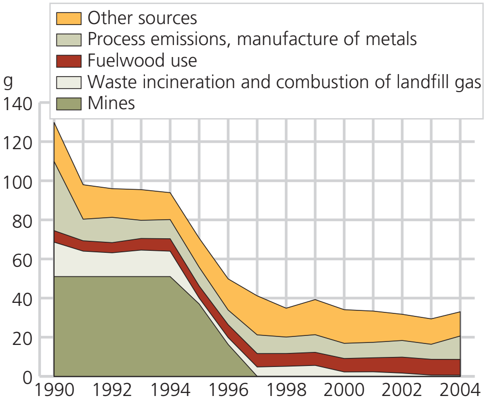


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Cadmium (Cd)

- In 2004, cadmium emissions totalled about 600 kg. These emissions have been stable in the last few years, but are about 44 per cent lower than in 1990 and have been reduced by about 36 per cent since 1995. Most of the reduction is in metal production.
- The most important sources of cadmium emissions today are fuelwood use by households, process emissions from metal production and wood processing.

Figure 9.22. Emissions of dioxins to air by source. 1990-2004*

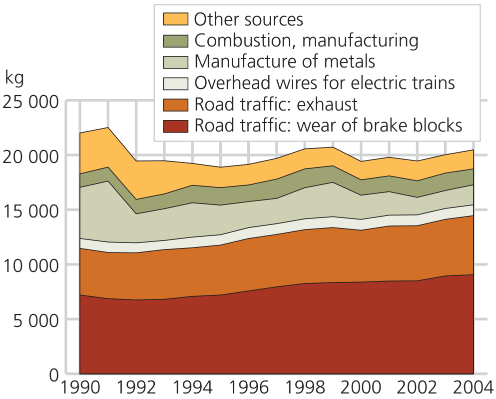


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Dioxins

- In 2004, emissions of dioxins totalled 33 g, an increase of 12 per cent since 2003. This rise is a result of higher metal production. Emissions from this source accounted for more than one third of total dioxin emissions in 2004.
- Fuelwood use by households was the next most important source of dioxin emissions, and accounted for about one fourth of the total. There was a certain reduction in emissions from this source because there were fewer house and car fires in 2004 than in 2003.
- Dioxin emissions have been reduced by 75 per cent since 1990 and by about 50 per cent from the 1995 level. This reduction is largely explained by the closure of industrial plants, stricter emission standards and improvements in technology for controlling emissions.

Figure 9.23. Emissions of copper to air by source. 1990-2004*

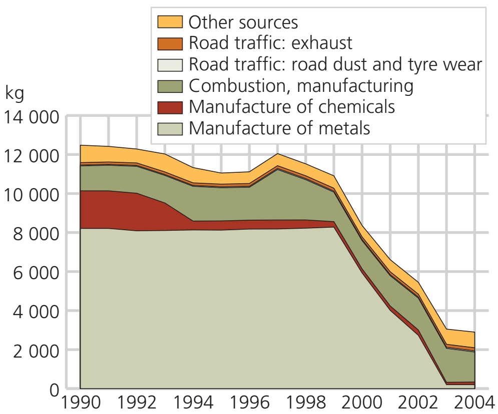


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Copper (Cu)

- In 2004, emissions of copper to air totalled 20 tonnes, the same level as the year before. Road traffic is by far the largest source of emissions. Wear of brake blocks accounted for 44 per cent of copper emissions in 2004, and exhaust emissions from petrol and diesel vehicles for 26 per cent. Emissions of copper from road traffic (wear of brake blocks included) rose by 2 per cent from 2003 to 2004.
- Copper emissions are 7 per cent lower than in 1990, but 8 per cent higher than in 1995. In the period 1995-2004 emissions from road traffic (wear of brake blocks included) have increased by 23 per cent. In the same period, copper emissions from metal production have decreased.

Figure 9.24. Emissions of chromium to air by source. 1990-2004*

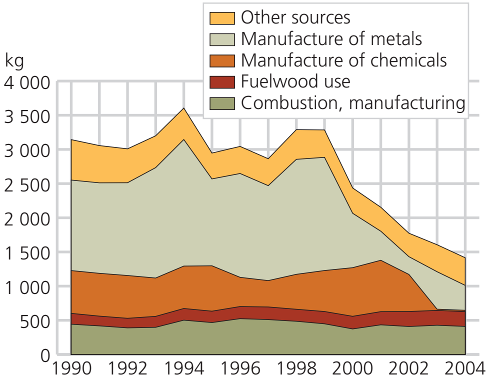


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Chromium (Cr)

- In 2004, emissions of chromium to air totalled about 3 tonnes, a decrease of 5 per cent from 2003. Combustion in the wood processing industry is the most important source, and accounted for 30 per cent of total emissions in 2004.
- From 1990 to 1995, chromium emissions from processes in the chemical industry were greatly reduced. Since then, chromium emissions have dropped by 74 per cent relative to the 1995 level. The reduction in this period is mainly due to a 98 per cent reduction in process emissions from the manufacture of ferro alloys. The closure of a ferro-chromium plant gave some reduction in emissions, but the most important reason for this reduction is the installation of equipment to control emissions.

Figure 9.25. Emissions of arsenic to air by source. 1990-2004*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Arsenic (As)

- In 2004, arsenic emissions totalled 1.4 tonnes, which is a drop of 12 per cent since 2003. This is explained by a lower arsenic content in the coke used in metal production.
- Emissions have been reduced by more than half since 1990, and most of the reduction has taken place after 1995. In this period, emissions of arsenic from metal and carbide production have dropped by more than 1 500 kg. Before 2000, the ferro-alloy industry was the dominant source of emissions. Emissions from this source dropped by 85 per cent from 1999 to 2002 because one sintering plant was closed for most of this period.
- Other important sources of arsenic emissions are combustion in the pulp and paper industry and fuelwood use by households.

9.6. Emissions of substances that particularly affect local air quality

Particulate matter, carbon monoxide (CO) and nitrogen oxides (NO_x) are the pollutants that are most important for local air quality in towns and urban settlements.

National targets - Local air quality

1. The 24-hour mean concentration of particulate matter (PM_{10}) shall not exceed 50 µg/m^3 on more than 25 days per year by 2005 and 7 days per year by 2010.
2. By 2010, the hourly mean concentration of nitrogen dioxide (NO_2) shall not exceed 150 µg/m^3 for more than 8 hours per year.
3. By 2005, the 24-hour mean concentration of sulphur dioxide (SO_2) shall not exceed 90 µg/m^3.
4. By 2010, the annual mean concentration of benzene shall not exceed 2 µg/m^3, measured as urban background concentration.

Source: Report No. 21 (2004-2005) to the Storting, The Government's environmental policy and the state of the environment in Norway.

Box 9.16. Emissions to air from fuelwood use

Emissions from fuelwood use are an important source of Norwegian emissions of pollutants including particulate matter, heavy metals, PAHs and dioxins. Statistics Norway's figures for emissions to air show that fuelwood use accounts for about two thirds of all emissions of particulate matter (PM_{10}) in Norway. Fuelwood use accounts for such a large proportion of these emissions because most of the wood is still burned in old wood-burning stoves, which are estimated to emit five times as much particulate matter as new stoves.

Figures for energy use by households are of key importance for the energy accounts, the emission inventory and analyses carried out by Statistics Norway's Research Department.

In 2005, two quarterly questionnaire-based surveys were carried out on household fuelwood consumption, the type of stove or fireplace used and its age. These have provided better and more up-to-date figures for fuelwood consumption in households. They have also made figures for emissions from fuelwood use for use in the emission inventory available two years earlier than would otherwise be the case. Good, up-to-date figures for these emissions are particularly important because, together with road traffic, fuelwood use is one of the most important sources of emissions that result in pollution concentrations exceeding the levels set in the national target for local air quality (particulate matter) in towns and built-up areas.

On the basis of the surveys, fuelwood use and energy quantities have been calculated for different types of stoves and fireplaces. The effects on emissions of particulate matter and energy efficiency of replacing old stoves with new ones have also been estimated.

Statistics Norway continued the quarterly surveys in 2006 and also plans to do so in 2007, when it will be possible to include wood consumption in holiday homes and the consumption of other energy commodities such as heating kerosene and fuel oil.

The figures for total fuelwood consumption are still uncertain. They are based on the comprehensive survey of consumer expenditure, and there is a long delay before the figures are ready for use in the emission model.

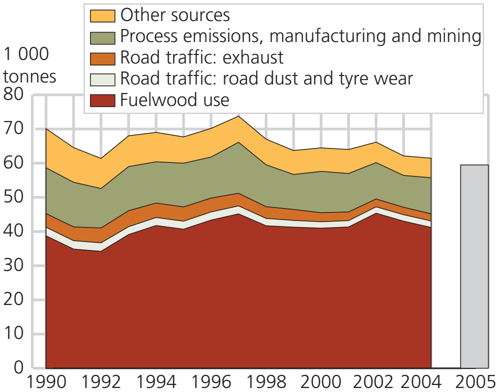
Read more in: Haakonsen, G. and E. Kvingedal (2001): *Utslipp til luft fra vedfyring i Norge. Utslippsfaktorer, ildstedsbestand og fyringsvaner* (Emissions to air from fuelwood use in Norway. Emission factors, numbers of wood-burning stoves and open fireplaces, and heating habits). Reports 2001/36. Statistics Norway.

Finstad, A. et al. (2004): *Vedforbruk, fyringsvaner og svevestøv. Resultater fra Folke- og boligtellingen 2001, Levekårsundersøkelsen 2002 og Undersøkelse om vedforbruk og fyringsvaner i Oslo 2002* (Fuelwood consumption, heating habits and particulate matter. Results of the Population and Housing Census 2001, Survey of Living Conditions 2002 and the 2002 survey of fuelwood consumption and heating habits in Oslo). Reports 2004/5, Statistics Norway.

Finstad, A. et al. (2004): *Vedforbruk, fyringsvaner og svevestøv. Undersøkelse om vedforbruk og fyringsvaner i Trondheim og Bergen 2003* (Fuelwood consumption, heating habits and particulate matter. Survey of fuelwood consumption and heating habits in Trondheim and Bergen 2003). Reports 2004/27, Statistics Norway.

New stoves reduce emissions of particulate matter. http://www.ssb.no/english/magazine/art-2005-01-19-02-en.html

Figure 9.26. Emissions of particulate matter (PM_{10}) to air by source in Norway. 1990-2005*

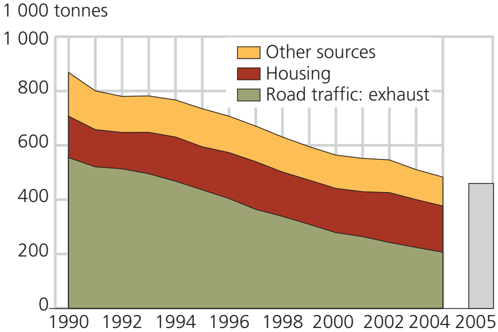


Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Particulate matter

- Three different fractions of particulate matter are distinguished: TSP (total suspended particles), PM_{10}, with a diameter of less than 10 µm and $PM_{2.5}$, with a diameter of less than 2.5 µm. Total emissions of the three fractions in 2005 were 75 600 tonnes, 59 500 tonnes and 53 400 tonnes respectively.
- Emissions from fuelwood use are the largest source of particulate matter, and accounted for 67 and 75 per cent respectively of emissions of PM_{10} and $PM_{2.5}$ in 2004. For these two fractions, the next most important source of emissions is metal production.

Figure 9.27. Emissions of carbon monoxide in Norway. 1990-2005*



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Carbon monoxide (CO)

- In 2005, emissions of carbon monoxide to air totalled 460 400 tonnes.
- The largest sources of CO emissions are road traffic and heating of housing, especially with fuelwood, and these accounted for 43 and 35 per cent respectively of the total in 2004.
- Since 1990, emissions of CO have been reduced by 47 per cent. The main reason is reduced emissions from road traffic because more cars are equipped with catalytic converters.

More information: Gisle Haakonsen (gisle.haakonsen@ssb.no) and Lisbet Høgset (lisbet.hogset@ssb.no).

Useful websites

Statistics Norway - Greenhouse gas emissions:
http://www.ssb.no/english/subjects/01/02/
Statistics Norway - Emissions to air: http://www.ssb.no/english/subjects/01/04/10/
Center for International Climate and Environmental Research:
http://www.cicero.uio.no/index_e.asp
Norwegian Meteorological Institute: http://met.no/english/index.html
State of the Environment Norway: http://environment.no/
Norwegian Institute for Air Research: http://www.nilu.no/
Norwegian Pollution Control Authority: http://www.sft.no/english/

References

Brook, E.J. (2005): Tiny bubbles tell all, *Science,* vol. 310, p. 1285-1287, 25 Nov. 2005.

de Leeuw, F.A.A.M. (2002): *A set of emission indicators for long-range transboundary air pollution*. Environmental Science & Policy 5 (2002) 135-145.

EEA (2006): http://reports.eea.europa.eu/technical_report_2006_6/en/EC-GHG-Inventory-2006.pdf

EMEP/MSC-W (2005): *Transboundary air pollution by main pollutants (S, N, O_3) and PM. Norway* MSC-W Data Note 1/2005, Norwegian Meteorological Institute. http://www.emep.int/publ/reports/2005/Country_Reports/report_NO.pdf

EMEP (2005): *http://webdab.emep.int/*

Finstad, A., K. Flugsrud, G. Haakonsen and K. Aasestad (2004): *Vedforbruk, fyringsvaner og svevestøv. Resultater fra Folke- og boligtellingen 2001, Levekårsundersøkelsen 2002 og Undersøkelse om vedforbruk og fyringsvaner i Oslo 2002.* (Fuelwood consumption, heating habits and particulate matter. Results of the Population and Housing Census 2001, Survey of Living Conditions 2002 and the 2002 survey of fuelwood consumption and heating habits in Oslo). Reports 2004/5, Statistics Norway.

Finstad, A., K. Flugsrud, G. Haakonsen and K. Aasestad (2004): *Vedforbruk, fyringsvaner og svevestøv. Undersøkelse om vedforbruk og fyringsvaner i Trondheim og Bergen 2003.* (Fuelwood consumption, heating habits and particulate matter. Survey of fuelwood consumption and heating habits in Trondheim and Bergen 2003). Reports 2004/27, Statistics Norway.

Haakonsen, G. and E. Kvingedal (2001): *Utslipp til luft fra vedfyring i Norge. Utslippsfaktorer, ildstedsbestand og fyringsvaner* (Emissions to air from fuelwood use in Norway.

Emission factors, numbers of wood-burning stoves and open fireplaces, and heating habits). Reports 2001/36, Statistics Norway.

Haakonsen, G. and A. Rosland (2006): *Klimagassregnskapet – et regnskap med holdbarhetsdato.* (*The greenhouse gas emission inventory – an inventory with a use-by date*). Økonomiske analyser (Economic Analyses) 4/2006. Statistics Norway.

Hoem, B. (ed.) (2006): *The Norwegian Emission Inventory. Documentation of methodologies for estimating emissions of greenhouse gases and long-range transboundary air pollutants.* Reports 2006/30, Statistics Norway.

Norwegian Institute for Air Research (2005a): Greenhouse gas monitoring at the Zeppelin station. Annual report 2004. Report 934/2005,OR 33/2005, TA 2110/2005.

Norwegian Institute for Air Research (2005b): *Overvåking av langtransportert forurenset luft og nedbør, Atmosfærisk tilførsel, 2004* (Monitoring of long-range transport of polluted air and precipitation, atmospheric inputs, 2004). Report 929/2005, OR 26/2005, TA2102/2005.

Norwegian Institute for Air Research (2006a): *Overvåking av langtransportert forurenset luft og nedbør, Atmosfærisk tilførsel, 2005* (Monitoring of long-range transport of polluted air and precipitation, atmospheric inputs, 2005). Report 955/2006, OR 67/2006, TA2180/2006.

Norwegian Institute for Air Research (2006b): Monitoring of the atmospheric ozone layer and natural ultraviolet radiation. Annual report 2005. Rapport 965/2006, OR 67/2006, TA-2197/2006.

Norwegian Pollution Control Authority (2006): State of the environment Norway. http://www.environment.no/

Norwegian Pollution Control Authority (2005): *Methane emissions from solid waste disposal sites.* TA-2079/2005.

OECD (2002): *OECD Environmental Data. Compendium 2002,* Paris: Organisation for Economic Co-operation and Development.

OECD (2005): *OECD Environmental Data. Compendium 2004,* Paris: Organisation for Economic Co-operation and Development.

Report No. 1 (2006-2007) to the Storting: Nasjonalbudsjettet 2007 (The National Budget 2007), Ministry of Finance.

Report No. 21 (2004-2005) to the Storting: The Government's environmental policy and the state of the environment in Norway. Ministry of the Environment.

Rypdal, K. and L-C. Zhang (2000): Uncertainties in the Norwegian Greenhouse Gas Emission Inventory, Report 2000/13, Statistics Norway.

Skullerud, H. (2006): Methane emissions from Norwegian landfills. Revised calculations for waste landfilled 1945–2004. Documents 2006/7, Statistics Norway.

SSB/SFT/DN (1994): *Naturmiljøet i tall 1994* (The natural environment in figures 1994). Oslo: Scandinavian University Press.

WHO (2005): http://www.cepis.ops-oms.org/bvsea/fulltext/guidelines05.pdf

10. Noise

Noise is one of the environmental problems that affects the largest number of people in Norway. About 1.7 million Norwegians are exposed to noise levels exceeding 50 dB outside their homes[1], and about half a million of them are annoyed or highly annoyed by noise. The overall level of noise annoyance from transport has increased as a result of a rise in the volume of traffic and in the number of people living in urban areas, despite a reduction in annoyance from certain types of transport. Noise can be harmful to health, and often has the greatest impact on the most vulnerable groups of the population.

There has been growing recognition at international level too that it is necessary to address the problem of noise, and many of the provisions for example in EU directives are also applicable to Norway.

The Norwegian noise annoyance index and most other noise indicators that are in use measure noise annoyance outside people's homes. This is a limited approach, because noise can also cause annoyance and affect people's well-being outside the areas where they live. Schools, day care centres, offices, hospitals and other institutions can all be exposed to noise. In addition, noise affects enjoyment and discourages use of parks, outdoor recreation areas and other public spaces, reduces travel on foot and by bicycle.

According to the Norwegian noise annoyance index, which is an indicator of noise annoyance from a range of sources, about three-quarters of all noise annoyance is caused by road traffic. Industry, construction, air traffic and railways account for 4 per cent each. The latest survey of living conditions carried out by Statistics Norway shows that 5 per cent of the population have sleep problems as a result of noise. For more information on the model for calculating the noise annoyance index, see Box 10.1.

[1] For road traffic noise, only the number of people exposed to noise levels exceeding 55 dB is included.

10.1. Noise and measurement of noise

The Storting has decided that by 2010, noise annoyance in Norway is to be reduced by 25 per cent from the 1999 level. Statistics Norway is developing a model that will make it possible to monitor developments in noise annoyance. The model calculates the number of people exposed to noise from various sources and transforms the figures into a noise annoyance index. The environmental authorities have decided to use the index to monitor progress towards the noise reduction target.

The minimum noise levels used in calculations of the noise index are not the same for all sources. Different levels are used partly to take into account the varying characteristics of noise produced by different sources, which means that the degree of annoyance they cause varies, and partly because the data currently available do not permit calculations using the lowest noise levels. If the same minimum noise level was used for all other sources as for road traffic, the latter would dominate the index even more than it does at present.

- Despite a marked drop in noise annoyance from railways and air traffic, total noise annoyance in Norway rose by two per cent from 1999 to 2003 (see Table 10.1). Noise annoyance caused by road traffic increased during this period because of a rise in the volume of traffic and in the number of people living in areas where there is heavy traffic. Since road traffic is responsible for such a large share of noise annoyance, 78 per cent, the changes resulted in an overall increase in noise annoyance in Norway.
- Railways accounted for four per cent of estimated noise annoyance in 2003. From 1999 to 2003, noise annoyance from this source dropped by 20 per cent. Several factors help to explain this reduction: a reduction in rail traffic, replacement of older trains with new, quieter models, rail grinding and changes in settlement patterns. Rail grinding is the most important of these, and this alone gave a reduction of 10 per cent in noise annoyance.
- Air traffic accounted for four per cent of registered noise annoyance in 2003. The noise annoyance index for air traffic has dropped by 22 per cent from 1999 to 2003. This is related to a considerable drop in the number of landings and take-offs during this period: at civilian airports, the number of flights dropped by 23 per cent.
- The calculations show that manufacturing accounted for four per cent of total noise annoyance. Noise annoyance from this source dropped by six per cent from 1999 to 2003. Noise from "other industry", which accounted for three per cent of total noise annoyance, rose by five per cent in the same period. However, these calculations are uncertain. To take account of the characteristics of industrial noise (which includes impulse noise), the minimum noise level used in calculations of the noise annoyance index for this source is somewhat lower (48 dBA) than for other sources.

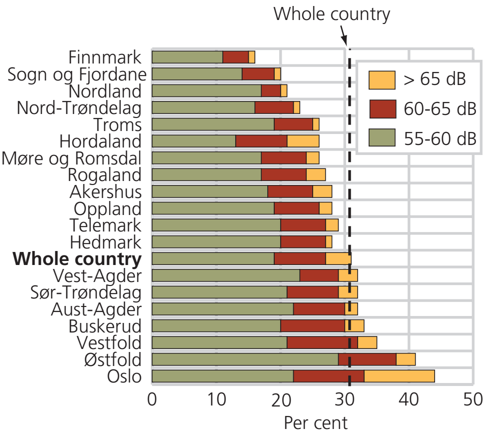
Table 10.1. Noise annoyance index by source of noise[1]. 1999 and 2003

	Index 1999	Index 2003	Percentages 2003	Change 1999-2003, per cent
Total, all sources	563 283	573 547	100	2
Road traffic	423 690	446 862	78	5
Manufacturing	25 845	24 237	4	-6
Other industry	15 339	16 087	3	5
Air traffic	28 595	22 233	4	-22
Railways	31 827	25 542	4	-20
Construction[2]	21 079	21 678	4	3
Firing ranges (military)	..	..	..	..
Shooting ranges[3]	12 060	12 060	2	0
Motor racing tracks[3]	4 848	4 848	1	0
Products used outdoors	..	..	..	..

[1] In general, noise levels exceeding 50 dBA are used in calculating figures for the noise annoyance index. For some sources, a different lower limit is used: 55 dBA for road traffic, 48 dBA for manufacturing and other industry, and 30 dBA (free field) for shooting ranges.
[2] Figures for 1999 are from the report "Mulige tiltak for å redusere støy. Framskrivninger til 2010 og oppsummering på tvers av kilder" (Possible noise abatement measures. Projections and summary for all sources) (Norwegian Pollution Control Authority 2000). Figures for 2003 were calculated on the basis of the 1999 figures and adjusted for changes in the level of activity.
[3] No new index values were calculated. The 1999 value is also being used for 2003 for the moment. Source for the 1999 figure: Norwegian Pollution Control Authority (2000).
Source: Statistics Norway's noise model (Statistics Norway 2005).

10.2. Exposure to road traffic noise

Figure 10.1. Proportion of the population exposed to road traffic noise levels exceeding 55 dBA, by county. 2003*



Source: Statistics Norway's noise model and Directorate of Public Roads.

Distribution of road traffic noise by county

- About 1.4 million people in Norway are exposed to road traffic noise exceeding a 24-hour average of 55 dBA (decibels). In Oslo, almost half the population is exposed to noise exceeding this level.
- About 32 500 people in Norway were exposed to noise levels above 70 dBA in 2003. Almost half of these, 15 000 people, lived in Oslo.
- The proportion of the population exposed to noise levels above 65 dBA is highest in Oslo and Hordaland, at 11 per cent (58 000 people) and 5 per cent (22 500 people) respectively.

Box 10.1. About the noise model

Statistics Norway was commissioned by the Norwegian Pollution Control Authority to develop the model, and has done this in close cooperation with the Directorate of Public Roads, Norwegian Air Traffic and Airport Management, the Norwegian National Rail Administration and the Norwegian Defence Construction Service. A GIS model was developed to calculate and record noise levels outside individual dwellings throughout Norway. The model calculates data for noise exposure from various sources (measured as the number of people exposed to different noise levels, Leq) and noise annoyance (measured using the noise annoyance index) in Norway for 1999 and subsequent years. The model is based on existing noise surveys and additional calculations for dwellings that were not included in earlier surveys.

Changes from 1999 to 2003

The method of calculating railway and road traffic noise has been adjusted to take into account the screening effect of buildings between dwellings and the noise source. The method of calculating industrial noise has also been changed. In addition, the formula for calculating the noise annoyance index has been adjusted for all three of these sources and for air traffic noise. These changes have also resulted in changes in the calculated noise annoyance figures for 1999.

Uncertainty

The calculations are generally uncertain. However, the level of uncertainty varies from source to source. In general terms, it is lowest for areas where noise levels are high and the model is largely based on existing surveys (for example around Oslo airport (Gardermoen) and areas surveyed using the model VSTØY, which is used by the Norwegian Public Roads Administration to calculate road traffic noise). The calculations for industrial noise are more uncertain. For these sources, the model is over-simplified, and the calculations are not based on existing surveys as they are for road traffic and air traffic noise.

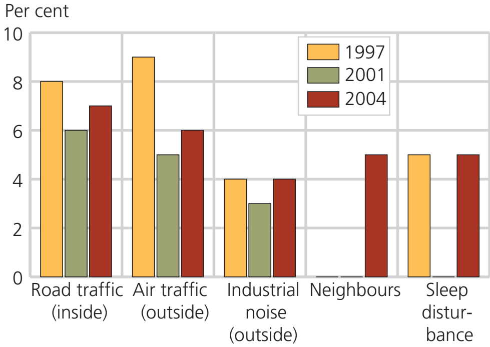
For the largest source of noise annoyance, road traffic, the level of uncertainty is considered to be lower for data taken from the VSTØY model than for data from Statistics Norway's supplementary calculations. Statistics Norway's calculations are considered to be most reliable for the national and county roads for which data on traffic volume is available from the National Road Database. For municipal roads, the figures are mainly calculated on the basis of general assumptions, which results in a higher level of uncertainty.

For more information, see: Støyplage i Norge. 1999-2003: Veitrafikken årsak til økt støyplage. Magazine (Noise annoyance in Norway. 1999-2003: Road traffic causing increased noise annoyance): http://www.ssb.no/vis/magasinet/miljo/art-2005-08-25-01.html (in Norwegian only).

10.3. Perception of noise

The figures for exposure to noise discussed in sections 10.1 and 10.2 are calculated on the basis of map data, data from registers and strictly objective measurements. Statistics Norway's surveys of living conditions, which are based on interviews with a representative sample of the population, have for many years included questions on whether people are exposed to or annoyed by noise inside or outside their homes. This is a way of registering the subjective perception of noise in the residential environment. Answers to this type of question are influenced by other factors than actual noise levels, such as attitudes to the problem, how much attention it is receiving in the media, local campaigns, and people's background and experience.

Figure 10.2. Percentage of population who say they are annoyed by noise from different sources, and percentage who suffer from sleep disturbance. 1997, 2001 and 2004



Source: Statistics Norway, Survey of living conditions.

- In 2004, seven per cent of the population, or more than 300 000 people, stated that they were annoyed by road traffic noise inside their homes, and six per cent that they were annoyed by air traffic noise outside their homes. There has been a marked drop in the proportion of the population who find air traffic noise annoying, probably because in 1998, Oslo Airport was moved from Fornebu to Gardermoen, considerably further away from the city.
- Five per cent of the population, or well over 200 000 people, stated that noise caused sleep disturbance.
- Noise from neighbours is also an important source of noise annoyance.

More information: Erik Engelien (erik.engelien@ssb.no) and Gisle Haakonsen (gisle.haakonsen@ssb.no).

Useful websites
Norwegian Pollution Control Authority, State of the Environment Norway:
http://www.environment.no/templates/themepage____3032.aspx

References
Statistics Norway (2005): Støyplage i Norge. 1999-2003: Veitrafikken årsak til økt støyplage. SSBmagasinet (Noise annoyance in Norway. 1999-2003: Road traffic causing increased noise annoyance). Magazine. http://www.ssb.no/vis/magasinet/miljo/art-2005-08-25-01.html

Other literature
Engelien, E., G. Haakonsen and M. Steinnes (2004): Støyplage i Norge. Resultater fra førstegenerasjons modell for beregning av antall støyutsatte og SPI (Noise annoyance in Norway. Results from a first-generation model for calculating the number of people exposed to noise and the noise annoyance index). Notater 04/43, Statistics Norway.

Haakonsen, G., K. Rypdal, P. Schøning and S.E. Stave (2001): Towards a National Indicator for Noise Exposure and Annoyance. Part I: Building a Model for Traffic Noise Emissions and Exposure. Documents 01/3, Statistics Norway.

11. Waste

The total quantities of waste generated in Norway are rising, and household waste generation is increasing most. Strict emission standards and new technology have resulted in large reductions in many of the emissions associated with waste management, and an increasing proportion of the waste is being recovered to provide new raw materials and energy. One of the national targets for waste management is to recover 75 per cent of all waste by 2010.

Waste consists of anything that is discarded after production and consumption. Norway's waste management legislation is intended to prevent pollution of soil and water, greenhouse gas emissions, health problems and local problems such as littering and unpleasant smells. The authorities set standards for waste management facilities through regulations and the mandatory licensing system. Licences include requirements to collect and control leachate from new landfills and upper limits for permitted emissions from incineration plants. A general prohibition against landfilling of wet organic waste (food waste, slaughterhouse waste, etc.) was introduced on 1 January 2002. A series of voluntary agreements have also been established between various sectors of industry and the authorities to ensure the collection and sound management of selected waste types.

Preliminary figures from the waste accounts show that about 8.7 million tonnes of waste was generated in Norway in 2005. The rise in waste generation was larger for households than for other sectors that generate large quantities of waste. Every Norwegian generated an average of 402 kg waste in 2005. This is 24 kg more than the year before. Calculations show that in 2005, the overall waste recovery rate was 69 per cent, as compared with 66 per cent the year before. This applies to waste for which information on methods of treatment or disposal is available.

Certain types of waste are particularly dangerous to human health and the environment, and special legislation applies to these waste fractions to ensure that they are managed properly and in a way that can be controlled. With few exceptions, the authorities require hazardous waste to be treated at separate, specially designed treatment facilities. In 2004, the total quantity of hazardous waste was at least 900 000 tonnes. Detailed reports on such waste are also required to ensure control of the waste stream. Nevertheless, in 2004 over 20 per cent of the hazardous waste generated may have been dealt with without being reported to the authorities (Skullerud in prep.). Most of this has probably been treated at approved treatment plants, but some may in the worst case have been dumped in the environment.

11.1. Some environmental problems related to waste management

Table 11.1. Emissions from waste incineration and landfills. Percentages of total Norwegian emissions in 2004 and change since 1990

	Percentage of total Norwegian emissions	Percentage change since1990
Incineration plants:		
Quantity of waste incinerated	.	+ 86
Sulphur dioxide	0.8	- 42
Nitrogen oxides	0.4	- 22
Carbon dioxide[1]	0.4	+ 78
Particulate matter, PM_{10}	0.0	- 99
Lead	0.3	- 99
Cadmium	0.3	- 98
Mercury	10.9	-54
Arsenic	0.5	- 95
Chromium	0.4	- 96
Copper	0.0	- 96
Total PAH	0.7	-32
Dioxins	1.8	- 97
NMVOCs	0.2	+ 82
Landfills:		
Methane (greenhouse gas)[1]	2.7	-20
Leachate: heavy metals[2]	1	..
Leachate: nitrogen[2]	2	..
Leachate: phosphorus[2]	1	..

[1] Calculated as a percentage of total greenhouse gas emissions in CO_2 equivalents.
[2] Figures from 1996.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority (emissions to air) and Report No. 8 (1999-2000) to the Storting (leachate).

Emissions to air and leachate

- Emissions of particulate matter, heavy metals and organic compounds (PAHs and dioxins) from waste incineration have dropped steeply since 1990, even though significantly more waste is being incinerated.
- Emissions from waste incineration plants account for only relatively small proportions of national emissions.
- Emissions of methane (a greenhouse gas) from rotting waste in landfills make a substantial contribution to Norway's total emissions. In 2004, methane emissions from landfills accounted for 30 per cent of total methane emissions and just under 3 per cent of Norway's aggregate greenhouse gas emissions. The model used to calculate methane emissions from landfills was revised in 2006, and the estimated level of emissions has been substantially reduced.
- Leachate from landfills may contain heavy metals, organic material and plant nutrients such as nitrates and phosphates. These discharges may cause local pollution, but are often small compared with those from other sources. The figures for leachate are uncertain, and recent surveys indicate that discharges of leachate from landfills contain only moderate amounts of hazardous inorganic and organic substances (Norwegian Pollution Control Authority 2005). However, it is difficult to draw firm conclusions, since the statistical basis in this field is still rather weak.

Box 11.1. The impacts of waste and waste management on the environment and natural resources

Waste has a variety of impacts on the environment. Waste generation, management and transport, as well as litter, have direct impacts in the form of pollution released to the air, water and soil. However, waste is also a resource that can be used to provide new products through material recovery or heating through energy recovery.

Methane emissions from landfills account for 3 per cent of Norway's greenhouse gas emissions (measured as CO_2 equivalents) and contribute to global warming (see table 11.1). *Old* landfills generate leachate that contains hazardous substances and nutrients and pollutes the environment (Norwegian Pollution Control Authority 1992). Even though substantial amounts of environmentally hazardous waste are still being landfilled, *newer* landfills are less of a problem because they are required to meet higher standards for the collection of leachate. Locally, landfills can give rise to problems related to unpleasant smells and vermin.

Successful composting is an environmentally sound method of treatment for wet organic waste, including park and garden waste, and generates no harmful emissions (water vapour is not a pollutant, and the carbon dioxide generated is "climate-neutral"). If the process is unsuccessful, on the other hand, it may generate methane emissions, give rise to unpleasant smells (for example from hydrogen sulphide) and produce leachate. Such problems may arise when a new composting system is being started up and before it is operating properly, but are not considered to be a serious health threat (Lystad and Vethe 2002). The content of hazardous substances in Norwegian compost has been investigated and found to be low enough to be safe (Norwegian Pollution Control Authority 1997).

On average, 75 per cent of the heat generated by Norwegian incineration plants was utilised in 2004. This reduces the extraction and use of other energy resources. On the other hand, waste incineration generates emissions to air. Emissions of hazardous substances and acidifying substances from this source are small compared with those from other sources (see Chapter 9). New technology has reduced these emissions, and they will probably be reduced even further as a result of further technological advances and the stricter standards set out in new regulations on waste incineration and landfills.

A marginal but highly visible fraction of our waste ends up as litter in streets and our surroundings otherwise. This is mainly an aesthetic problem rather than a threat to the environment, and generally involves disposable packaging and food waste.

Hazardous waste

Hazardous waste that is not dealt with appropriately may be a serious environmental problem. Some of the more common types of hazardous waste for which it is not possible to document handling at approved facilities are PCBs (polychlorinated biphenyls), waste oil, solvents and brominated flame retardants.

Few *PCBs* are acutely toxic, but chronic exposure, even at relatively low concentrations, can impair reproduction, disturb behavioural patterns, weaken the immune system and cause cancer (Thorsen 2000). PCBs provide very good heat and electrical insulation, are flame-retardant, and improve the resistance of certain materials to wear. They were therefore used in a wide variety of products, particularly in the 1960s and 1970s, but their use was prohibited from 1980 onwards. Today, PCBs can still be found in insulating windows, in capacitors (especially ballasts in light fixtures), in concrete and filling compounds, and in smaller amounts in ships' paints and electricity lead-ins. PCBs break down very slowly in the environment and can be transported over long distances. PCBs are readily absorbed by living organisms and stored in fatty tissue, and thus become concentrated in food chains. In Norway, the authorities have advised people not to eat fish and shellfish from a number of fjords and restricted commercial fishing in certain areas because of the presence of PCBs. PCBs spread through the environment by evaporation and with runoff. Once PCBs have entered the environment, their removal is a very costly process.

Cont.

Cont.

Waste oil contains carcinogenic tars (PAHs) and small quantities of heavy metals. Degradation of waste oil in the environment is fairly rapid if the oil is finely divided, but after major oil spills, it may take many years before the process is completed. Some harbour basins in Norway have become polluted as a result of discharges of oil-contaminated waste over long periods of time.

Organic solvents are highly flammable and it is therefore dangerous to mix them with ordinary waste. In most cases, their acute toxicity is not very high and they are easily broken down in the environment. This means that they are not generally very harmful to the environment. Waste containing solvents includes paints, and may also contain both heavy metals and persistent organic pollutants. Chlorinated solvents are particularly hazardous to health and the environment. They break down slowly in the environment, become concentrated in food chains and have a variety of toxic effects. For example, they may be endocrine disruptors, carcinogenic or impair reproduction (Norwegian Labour Inspection Authority 2002).

Brominated flame retardants are a group of substances that are used to prevent fire, for example in electronic circuit boards, textiles and fittings for vehicles. Some of them are chemically similar to PCBs, but we still have only limited knowledge of the health risks associated with them and the extent to which they become dispersed in the environment. The concentrations of some of these compounds in human breast milk have risen by a factor of 50 in the last 25 years. Some are suspected to be endocrine disruptors and to impair reproduction. The annual global consumption of brominated flame retardants is estimated at 150 000 tonnes (National Institute of Public Health 2003). The brominated flame retardants that are believed to be most dangerous have been included in the new regulations on hazardous waste, which entered into force on 1 January 2004.

Box 11.2. Waste - definition and classification

According to the Pollution Control Act, waste is defined as discarded objects of personal property or substances. Waste water and waste gases are not defined as waste.

Waste can be classified in many ways, for instance according to its origin, composition or environmental impact. The result is a wide variety of terms, some of which have overlapping meanings. Standards Norway has drawn up a new standard for waste classification, NS 9431 (NAS 2000), that classifies the waste by material, sector of origin, method of treatment/disposal and place of origin. The objective is to encourage uniform use of categories when registering and reporting waste quantities. The European *List of Wastes* is the most commonly used waste classification system in Europe. This system classifies waste into about 850 categories according to material characteristics, sector of origin, the pollutants it contains and in some cases the type of product. In addition, the OECD and the Basel Convention have their own waste classification systems.

In the Pollution Control Act, waste was previously divided into three categories: consumer waste, production waste and special waste (including hazardous waste). In 2003, the Act was amended and the terms production waste and consumer waste were replaced by industrial waste and household waste. These amendments entered into force on 1 July 2004. According to the Pollution Control Act, the municipalities are responsible for collection and management of household waste, but are no longer responsible for industrial waste. The term *municipal waste* has been used for waste actually treated or administered in the municipal system. The term municipal waste is now in limited use in Norway, but is still used internationally, for example in various sets of environmental indicators including the EU structural indicators. Industrial waste has generally made up a little over half of all municipal waste. Now that the Pollution Control Act has been amended, it is likely that more of this waste will be dealt with by non-municipal actors.

Often, *waste fractions* consisting of particular materials are discussed separately (paper, glass, metal, etc.). Waste may also be classified according to *product type* (packaging, electrical and electronic equipment, etc.). Both material fractions and product types may belong to any of the above-mentioned categories.

Box 11.3. Waste and waste statistics - terminology

Biogas treatment: Degradation of organic waste by living organisms without access to oxygen (anaerobic biological treatment). Methane gas is formed in the process.

Composting: Controlled degradation of waste by living organisms with access to oxygen (aerobic biological treatment). Often considered to be a form of recovery.

Consumer waste: All waste that is not production waste. Includes both non-hazardous and hazardous waste, and also large items such as fittings and furnishings from private households and commercial undertakings.

EEE waste, or WEEE (waste electrical and electronic equipment): EEE items require an electric current or electromagnetic field to function, and need batteries, transformers, wires, etc. to generate, transmit, distribute and measure the current or field, and parts to cool, warm, protect, etc. the electric and/or electronic components. Means of transport are not included in this definition, and cooling equipment containing CFCs is generally also excluded since a separate waste collection and recovery scheme has been established for such equipment.

Energy recovery: Use of the energy released by waste incineration, for example to heat buildings.

Energy recovery efficiency: describes how much of the waste incinerated is in practice converted to utilisable energy.

Final disposal: Means that the resources in the waste are not utilised: either landfilling or incineration without energy recovery.

Hazardous waste: Waste which cannot appropriately be treated together with municipal waste because it may cause serious pollution or a risk of injury to people and animals. Hazardous waste is governed by separate regulations under the Pollution Control Act. The list of hazardous waste in Norway was expanded from 1 January 2003.

Household waste: Defined in the Pollution Control Act as waste from private households, including large objects such as furniture, etc.

Industrial waste: Defined in the Pollution Control Act as waste from public and private enterprises and institutions. This includes both consumer waste and production waste. In its waste statistics, Statistics Norway further subdivides industrial waste according to the branch of industry from which it originates. The degree of aggregation in the classification varies. Includes all waste that is not defined as household waste.

Landfilling: Final disposal of waste at an approved landfill.

Material recovery (or recycling): Use of the waste in a way that wholly or partly retains the materials of which it consists. One example is the production of writing paper from recycled paper.

Municipal waste: All waste treated or administered in the municipal system, in practice the same as consumer waste. Municipal waste includes all household waste and a large proportion of industrial waste. However, the amendments to the Pollution Control Act (see Box 11.2) mean that the municipalities are now only responsible for household waste. Municipal waste is therefore a little-used term in Norwegian waste statistics, but is used a good deal internationally.

Production waste: Waste from production of goods and services which is significantly different in type or amount from consumer waste. Includes all waste that is not classified as consumer waste.

Re-use: Use of the waste in its original form. For example, discarded clothing may be sold in second-hand shops or sent abroad as emergency relief.

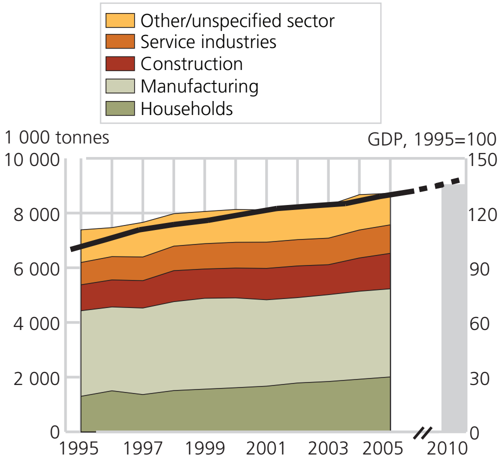
Waste management: Usually defined to include all operations from the moment when an object or substance is discarded until all treatment, recovery and disposal operations are completed. The term **treatment/disposal** is used in the waste accounts to include all waste management processes involving physical change (material recovery, composting, incineration) and all forms of disposal (landfilling, illegal dumping, export, re-use).

Waste recovery: Includes re-use, material recovery, incineration combined with energy use and composting.

Wet organic waste (biodegradable waste): Readily degradable organic waste, e.g. food waste and slaughterhouse waste. Park and garden waste is included in this category in the waste accounts unless otherwise specified.

11.2. Waste accounts for Norway

Figure 11.1. Waste quantities[1] in Norway, by source. 1995-2005* and projection 2010. 1 000 tonnes. GDP 1995-2010, index 1995=100



[1] New revised figures for the waste accounts have been published since the editing of this publication was completed. There are some substantial changes in the figures for both total waste quantities and certain waste fractions. See: http://www.ssb.no/english/subjects/01/05/40/avfregno_en/
Source: Waste accounts and national accounts, Statistics Norway.

Sources of waste

- Preliminary calculations show that from 1995 to 2005, total annual waste generation rose from 7.4 to 8.7 million tonnes, a rise of 18 per cent. In the same period, GDP grew by 32 per cent. Thus, waste generation has increased considerably less than GDP, in accordance with the national targets.
- The quantity of industrial waste rose by 10 per cent in the period, considerably less than GDP.
- In the period 1995-2005, the quantity of household waste rose more rapidly than household consumption, and today this category accounts for about 23 per cent of the total quantity of waste. If this trend continues, the proportion will rise to 26 per cent in 2010.
- Manufacturing waste accounted for 37 per cent of the total in 2005. Of this, about 75 per cent was production waste. The construction industry accounts for 15 per cent of total waste generation, and service industries for 12 per cent.

National targets - waste and waste recovery

1. The growth in the quantity of waste generated shall be considerably lower than the rate of economic growth.
2. The proportion of waste recovered is to be raised to about 75 per cent of the total quantity in 2010 and subsequently to 80 per cent. This is based on the principle that the quantity of waste recovered should be increased to a level that is appropriate in economic and environmental terms.
3. Practically all hazardous waste is to be dealt with in an appropriate way, so that it is either recovered or sufficient treatment capacity is provided within Norway.

Source: Report No. 21 (2004-2005) to the Storting: The Government's environmental policy and the state of the environment in Norway.

Box 11.4. Waste accounts and projections of waste quantities

Waste accounts

The waste accounts are based on traditional principles for natural resource accounting and organised as a material balance between annual waste generation and the quantities treated or disposed of each year. In practice, the accounts are a multidimensional matrix, where the dimensions are represented by four selected characteristics of the waste. These are:

- material type (e.g. paper, glass, metals)
- product type (e.g. food waste, park and garden waste, packaging, EEE waste)
- source (e.g. agriculture, manufacturing industries)
- form of treatment/disposal (e.g. material recovery, incineration)

As a general principle, existing data sources such as statistics on external trade, production and waste have been used wherever possible. Where no such sources exist, Statistics Norway has carried out its own surveys, for example for waste from manufacturing, mining and quarrying, waste from services and households, and waste management.

Two different methods are used to estimate waste quantities. One is called the "supply of goods method", and is a theoretical method of estimating waste quantities. It is based on the assumption that waste quantities are equal to the supply of goods after correction for the lifetime of the products. The supply of goods is calculated from statistics on import, export and production of goods. The second method is called the "waste statistics method": existing waste statistics are collected and harmonised, and waste quantities are estimated in cases where the existing statistics are inadequate.

The two methods give an estimate of waste quantities at two different points in the waste stream. The supply of goods method estimates the quantities of waste that are generated, while the waste statistics method shows the quantities delivered for various types of treatment. There may be a real difference between these quantities, for example if not all the waste generated is registered as delivered for treatment or disposal.

Projections of waste quantities

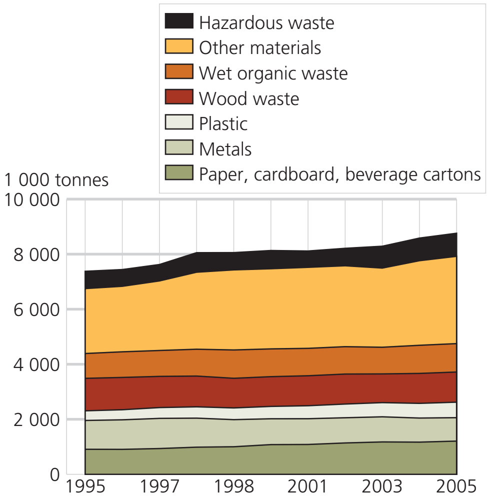
Statistics Norway has made projections of waste quantities in Norway several times previously, on the basis of waste statistics and economic projections in the macroeconomic models MSG (see Bruvoll and Spurkland 1995, Bruvoll and Ibenholt 1999, and Ibenholt 1999) and MODAG (Bruvoll and Skullerud 2004). The calculations based on the macroeconomic model MODAG are updated at regular intervals, using figures from the waste accounts. The calculation method used was described in *Natural Resources and the Environment 2003*.

The results show that we can expect waste quantities to grow by about 9 per cent from 2003 to 2010. It is estimated that a rise in household waste generation will account for about 70 per cent of the overall increase. The quantity of household waste is estimated to increase by 28 per cent. Industrial waste is expected to increase by 3 per cent. The largest increases for specific materials are expected for plastics, concrete and brick, and textiles. These projections are based on the assumption that the relationship between production and waste generation will be the same up to 2010 as it has been in the period 1995-2003.

The projections have been carried out without taking into account already implemented or future changes in definitions or the introduction of policy instruments that will influence the relationship between production and waste quantities. In other words, it has been assumed that the factors influencing waste quantities will remain unchanged up to 2010.

For more information, see: http://www.ssb.no/english/subjects/01/05/40/avfregno_en/

Figure 11.2. Waste quantities in Norway, 1995-2005*. By material. 1 000 tonnes

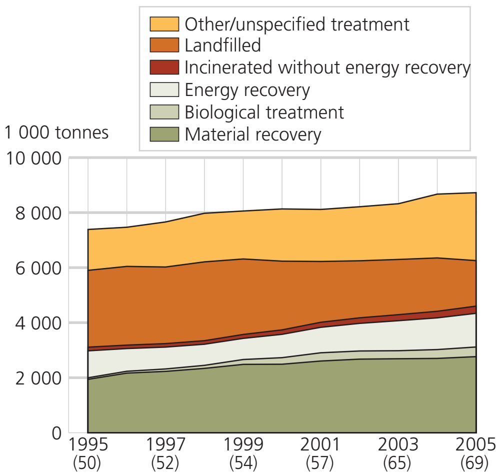


Source: Waste statistics, Statistics Norway.

Materials in waste

- The most rapidly-growing fractions are plastics, wet organic waste and textiles, which are largely found in household waste.
- All materials except wood waste and metals are expected to increase in the period up to 2010.
- The category "other materials" includes concrete and brick, organic and inorganic sludge, slag, rubber, glass, china and ceramics, and dust. Unpolluted stone, gravel, etc. are not included in the statistics.

Figure 11.3. Waste quantities in Norway, 1995-2005*. By treatment/disposal[1]. 1 000 tonnes



[1] The figures in brackets below the years on the x axis indicate the overall recovery percentage (excluding waste for which the treatment/disposal method is unknown or unspecified).
Source: Waste statistics, Statistics Norway.

Treatment/disposal

- The waste accounts have been revised and back-calculated since *Natural Resources and the Environment 2005* was published, and this has resulted in some changes in the figures presented this year. Changes have been introduced to make the methodology more consistent, and the new figures indicate that Norway is somewhat further from achieving its target for waste recovery than previously estimated, but that the percentage of waste recovered is rising faster than was thought to be the case.
- In 2005, 32 per cent of all waste generated was recycled, 14 per cent was incinerated with energy recovery and 19 per cent was landfilled.

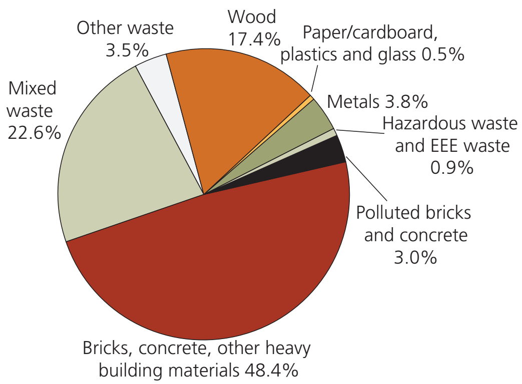
- In 2005, treatment/disposal was unknown for 28 per cent of all waste generated, and the percentage is increasing. A large proportion of this consists of discarded products that are left where they were used, for example oil and other pipelines and underground cables. In addition, it is reasonable to assume that a growing proportion of waste is being dealt with outside waste treatment and disposal plants, for example delivered directly for use as new raw materials for industrial and energy purposes.
- The quantity of waste for which we have information on the form of treatment or disposal has been almost unchanged since 1998.

11.3. Construction and demolition waste

Preliminary estimates show that 1.24 million tonnes of construction and demolition waste was generated in 2004, corresponding to about 14 per cent of the total quantity of waste generated in Norway. Most of this waste consists of materials such as bricks and concrete that are relatively uncontaminated and that can be landfilled or re-used without taking special environmental considerations into account. Some building materials do however contain hazardous substances, which must be properly treated.

Of the total quantity of construction waste generated in 2004, 44 per cent (0.54 million tonnes) was from rehabilitation activities, 36 per cent (0.45 million tonnes) from demolition and the remaining 20 per cent (0.24 million tonnes) from construction.

Figure 11.4. Construction waste[1] split by type. Per cent. Preliminary figures, 2004



[1] Includes construction, rehabilitation and demolition waste. More information: http://www.ssb.no/english/subjects/01/05/avfbygganl_en/
Source: Waste statistics, Statistics Norway

- About half the construction waste generated in 2004 consisted of heavy building materials, mainly bricks and concrete. This included 37 000 tonnes of polluted materials.
- Some of the waste registered as polluted heavy building materials should probably have been classified as hazardous waste, for example if it contained PCBs or other dangerous substances. However, most of this waste consists of oil-contaminated bricks and concrete, and is not considered to be hazardous waste.
- Slightly more than 7 000 tonnes of hazardous construction waste was generated in 2004. This is a conservative estimate, and the real quantity may be higher.

- There is reason to believe that the fractions plastics, paper and glass are also underestimated in the statistics. The quantities of these fractions were estimated at 2 400, 2 900 and 1 300 tonnes, respectively. These figures correspond more or less to the amounts separated at construction sites. However, the category mixed waste also includes a certain proportion of these materials.
- Mixed waste accounted for 23 per cent of all construction waste in 2004.

Box 11.5. Hazardous waste management in Norway

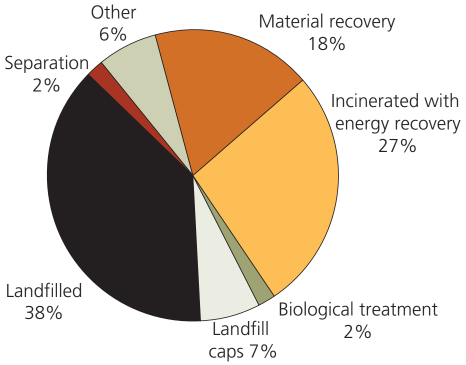
Normally, anyone who has hazardous waste is required to deliver it to an approved municipal facility. Waste is collected from such facilities, and transferred to a firm that specialises in preliminary treatment, or directly to a firm that can carry out final treatment. On the other hand, companies that generate large amounts of hazardous waste often have special agreements with transport firms that collect the waste directly from the site.

Some industrial plants that generate large quantities of hazardous waste can document sound management of the waste on site. They may be granted permits to dispose of their own hazardous waste. This applies mainly to landfilling of slag containing heavy metals.

Some companies, especially in the petroleum extraction and manufacturing sectors, hold permits to export hazardous waste.

If hazardous waste is not reported to the authorities or to Statistics Norway, it is included in the category "no information available on treatment or disposal". A good deal of this is probably treated at approved facilities but not reported, or stored until better treatment methods are available or in anticipation of changes in the legislation. However, a proportion of this waste may be disposed of in ways that cause environmental damage.

Figure 11.5. Treatment and disposal of construction waste delivered to waste treatment and disposal plants. Percentages. Preliminary figures, 2004



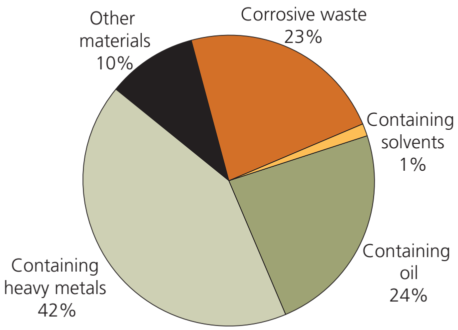
Source: Waste statistics, Statistics Norway.

Treatment and disposal of construction waste

- In 2004, 60 per cent of all construction waste generated was delivered to waste treatment and disposal plants.
- Of the waste delivered to such plants, 38 per cent was used for material or energy recovery.
- The same proportion was landfilled, and a further 7 per cent was used in landfill caps.
- Similar estimates for 2001 carried out by Statistics Norway showed that 27 per cent of construction waste delivered to waste treatment and disposal plants in that year was used for material and energy recovery, while 49 per cent was landfilled.
- The remaining 40 per cent of the waste, which consisted mainly of heavy building materials, wood and metals, was disposed of in other ways, a large proportion at building sites. In addition, a proportion of the waste, mainly wood and metals, was delivered directly for recycling or to industrial plants, and this was not recorded in the surveys and data on which these statistics are based. There is also reason to believe that some of the waste that is not delivered to waste treatment and disposal plants is dealt with illegally.

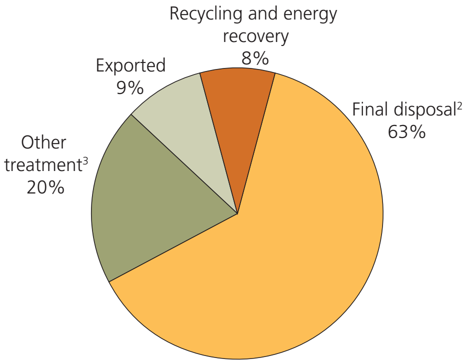
11.4. Hazardous waste

Figure 11.6. Hazardous waste handled at approved facilities, by material. 2004. Per cent



Source: Waste statistics, Statistics Norway.

Figure 11.7. Hazardous waste handled at approved facilities, by type of treatment. 2004. Per cent[1]



[1] Includes secondary hazardous waste (treatment products that are still classified as hazardous waste and that require further treatment), corresponding to 1.2 per cent of the total.
[2] Includes all types of landfilling, permanent storage, incineration without energy recovery and treatment that results only in non-hazardous products.
[3] Also includes pretreatment.
Source: Waste statistics, Statistics Norway.

Origin and materials

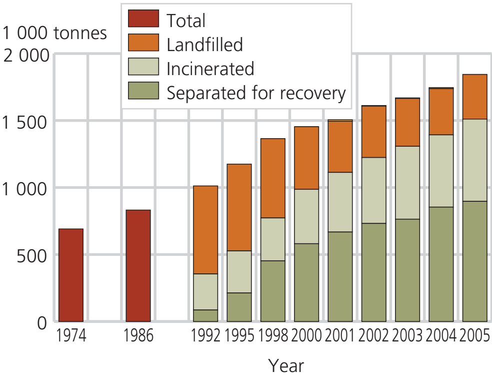
- In 2004, a total quantity of 908 000 tonnes of hazardous waste was handled at approved facilities. Of this, 793 000 tonnes was registered with the authorities.
- About two-thirds of all hazardous waste is generated by manufacturing industries. This includes almost all corrosive waste, most waste containing heavy metals and substantial proportions of other types of hazardous waste.
- Oil-contaminated waste is generated mainly by petroleum extraction, but manufacturing and service industries (especially wholesale and retail trade and transport) also account for substantial amounts.

Treatment/disposal of hazardous waste

- Most of the hazardous waste delivered for final disposal is deposited at special landfills for hazardous waste, generally after being stabilised by means of chemical reactions. Most hazardous waste consists of materials such as slag, blasting agents and acid sludge and other waste components that are not suitable for material or energy recovery.
- Some hazardous waste is exported either for final disposal or for material recovery. Exports for final disposal are only permitted if the waste cannot be properly dealt with in Norway.
- In 2004, no information on disposal or treatment was available for about 80 000 tonnes of hazardous waste. A large proportion of this was probably dealt with at approved facilities but not reported to the authorities. However, some of it may have been treated or disposed of illegally and may have been dumped in the environment.

11.5. Household waste

Figure 11.8. Household waste by method of recovery or disposal. 1974-2005



Source: Waste statistics, Statistics Norway.

Quantities and methods of disposal

- In 2005, per capita generation of household waste was 402 kg, 167 kg more than in 1992 and 24 kg more than in 2004.
- In 2005, 906 000 tonnes of household waste, or 49 per cent of the total, was separated for recovery.
- A 3 per cent decrease in the quantity of household waste landfilled was registered from 2004 to 2005. In 2005, 333 000 tonnes of household waste was landfilled.
- In 2005, 732 000 tonnes (40 per cent) of household waste was incinerated.

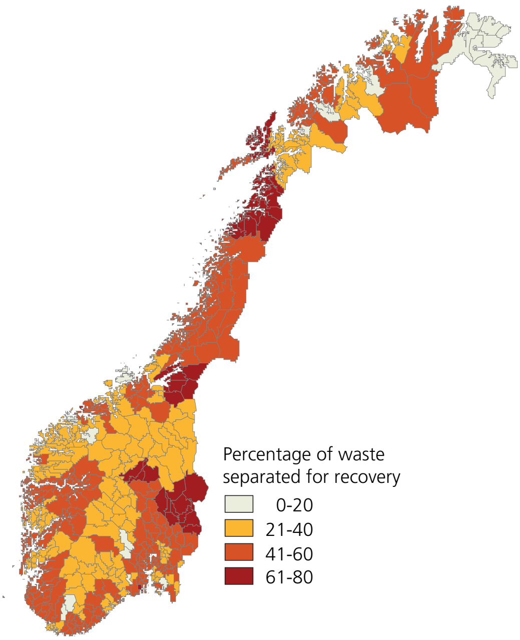
Box 11.6. Legislation relating to waste management in Norway

Act of 13 March 1981 No. 6 relating to protection against pollution and to waste (Pollution Control Act)

Regulations of 1 June 2004 No. 930 relating to the recovery and treatment of waste

Regulations of 1 June 2004 No. 931 relating to pollution control

Figure 11.9. Percentage of household waste separated for recovery, by municipality. 2005



Source: Waste statistics, Statistics Norway.

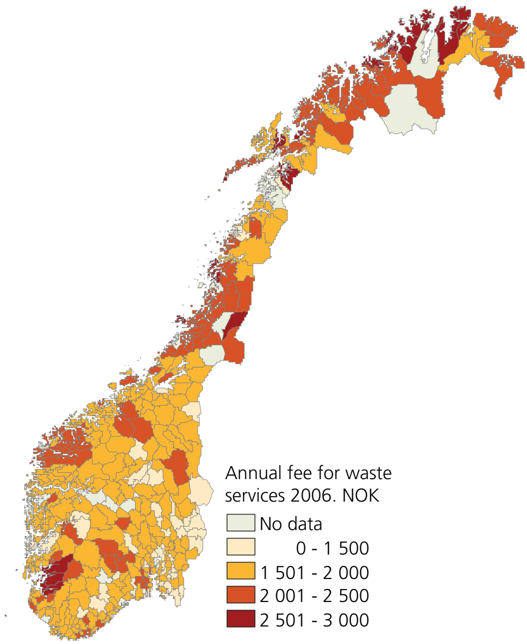
Waste recovery

- In 2005, each person in Norway separated 198 kg of household waste for recovery, 13 kg more than in 2004. The proportion of household waste delivered for final disposal (incineration without energy recovery and landfilling) in 2005 was 29 per cent.
- The highest proportions of household waste were separated in Hedmark and Nord-Trøndelag counties, 68 and 65 per cent respectively.
- The proportion of waste recovered was highest in Vestfold, at 84 per cent. This figure takes into account the fact that 75 per cent of the waste incinerated is used for energy recovery.
- Both material recovery and incineration of waste rose by 13 per cent from 2004 to 2005, and 732 000 tonnes of waste was incinerated. Of this, 118 000 tonnes had previously been through a separation process. A total of 727 000 tonnes was recycled. From 2004 to 2005, the proportion of waste separated rose most for hazardous waste and textiles (by 45 and 24 per cent respectively). The quantity of waste separated rose most for paper and cardboard (by 27 000 tonnes to about 300 000 tonnes); this was also the largest single waste fraction separated for recovery.

11.6. Fees in the municipal waste management system

Under the Pollution Control Act, municipalities are required to take responsibility for collection of all household waste, and households are required to pay fees for this service. These fees must follow the principle of full costing, which means that they are set to cover all the costs associated with household waste management, but the municipalities may not charge households more than the actual costs of collecting and treating household waste.

Figure 11.10. Annual fee for waste management services. Municipalities. 2006



Source: Waste statistics, Statistics Norway.

- A large proportion of waste management services at municipal level in Norway are provided by entities other than the municipalities themselves: intermunicipal companies, municipal limited companies or private companies. However, in most cases the municipalities collect the fees.
- The average annual fee per subscriber for household waste was NOK 1 882 in 2006, an increase of 3 per cent from 2005. The annual fee varies between municipalities. The highest average annual fee in a municipality was NOK 2 775, and the lowest NOK 1 016.
- The very highest fees are in municipalities where settlement is scattered, but apart from this there is no clear relationship between settlement patterns and the size of the fees in different municipalities.
- It is also difficult to identify any other geographical features of the municipalities that can explain the variation in the size of the fees.

More information: Eva Vinju (eva.vinju@ssb.no), Håkon Skullerud (hakon.skullerud@ssb.no) and Gisle Berge (gisle.berge@ssb.no).

Useful websites

Norwegian Pollution Control Authority: http://www.sft.no/english/
Norwegian Resource Centre for Waste Management and Recycling: http://www.norsas.no/norsas/main.nsf
State of the Environment Norway: http://www.environment.no/
Statistics Norway - waste statistics: http://www.ssb.no/english/subjects/01/05/

References

Bruvoll, A. and G. Spurkland (1995): Avfall i Noreg fram til 2010 (Waste in Norway up to 2010). Reports 1995/8, Statistics Norway.

Bruvoll, A. and K. Ibenholt (1999): *Framskrivning av avfallsmengder og miljøbelastninger knyttet til sluttbehandling av avfall* (Projections of waste quantities and environmental pressures related to final treatment of waste). Reports 1999/32, Statistics Norway.

Bruvoll, A. and Ø. Skullerud (2004): Framskrivninger av organisk avfall for 2001-2020 (Projections of quantities of organic waste 2001-2020). Notater 2004/38, Statistics Norway.

Ibenholt, K. (1999): *Framskrivning av avfall og tilhørende utslipp ved bruk av MSG6. Teknisk dokumentasjon,* (Projections of waste quantities and accompanying emissions using MSG6. Technical documentation) Notater 1999/72, Statistics Norway.

Lystad, H. and Ø. Vethe (2002): *Fakta om biologisk avfallsbehandling - kompostering* (Biological waste treatment: composting), Report 43/02. Norwegian Centre for Soil and Environmental Research (Jordforsk).

NAS (2000): *Klassifisering av avfall.* Norsk standard NS 9431. 1. utgave november 2000 (Classification of waste. Norwegian standard NS 9431, 1st edition November 2000), Norwegian Standards Association.

National Institute of Public Health (2003): Tema: Miljøforurensninger. Bromerte flammerhemmere. (Brominated flame retardants) http://www.fhi.no/artikler/?id=28367. 15/8-2005.

Norwegian Labour Inspection Authority (2002): Arbeidsmiljø – HMS: Faktaside om løsemidler (*Fact sheet on organic solvents*). http://www.arbeidstilsynet.no/info/tema/losemidler.html 15/8-2005.

Norwegian Pollution Control Authority (1997): *Miljøgifter i norsk kompost og husdyrgjødsel* (Hazardous chemicals in Norwegian compost and manure). Report No. 97:26.

Norwegian Pollution Control Authority (2002): Redegjørelse for årlige rapportering fra returselskapene for EE-avfall (Annual reporting on EEE waste by the producer responsibility organisations). Unpublished note.

Norwegian Pollution Control Authority (2005): *Sigevann fra avfallsfyllinger* (Leachate from landfills). http://www.sft.no/nyheter/dbafile12949.html. Last seen: 18.08.2005.

Report No. 8 (1999-2000) to the Storting: *The Government's environmental policy and the state of the environment in Norway.* Ministry of the Environment.

Report No. 15 (2001-2002) to the Storting: Amendment to Report No. 54 to the Storting (2000-2001): *Norwegian Climate Policy.* Ministry of the Environment.

Report No. 21 (2004-2005) to the Storting: *The Government's environmental policy and the state of the environment in Norway.* Ministry of the Environment.

Skullerud, H. (in prep.): Registrering av farlig avfall i Norge som grunnlag for offisiell statistikk: Sammenligning av de sentrale registre for farlig avfall med data fra to uavhengige kilder (Registration of hazardous waste in Norway as a basis for official statistics. Comparison of the central registers for hazardous waste and data from two independent sources.). To be published in the series Notater, Statistics Norway.

Statistics Norway (2002): MODAG - En makroøkonomisk modell for norsk økonomi. (MODAG – a macroeconomic model for the Norwegian economy) Social and Economic Studies 108.

Thorsen, T.A. (2000): *Hva er PCB?* (What are PCBs?) http://www.uio.no/miljoforum/natur/gift/pcb.shtml Miljøforum, University of Oslo. 01 October 2003.

Other literature

Barkman, A., C. Askham, L. Lundahl and E. Økstad (2000): *Investigating the life-cycle environmental profile of liquid food packaging systems.* Eastern Norway Research Institute.

Bruvoll, A. and T. Bye (2002): *En vurdering av avfallspolitikkens bidrag til løsning av miljø- og ressursproblemer* (*An assessment of the contribution of waste management policy to solving environmental and natural resource problems*), Notater 2002/36, Statistics Norway.

Bystrøm, S. and L. Lønnstedt (1997): Paper recycling: Environmental and economic impact. *Resources, conservation and recycling* **21**, 109-27.

DeLong, J.V. (1994): *Wasting away. Mismanaging municipal solid waste,* Environmental studies program, Competitive Enterprise Institute, Washington D.C.

Heie, Aa. (1998): *Sorteringsanalyser - Kommunalt avfall* (Analyses of sorting of municipal waste). Report 97/248, Interconsult.

Hu, S.W. and C.M. Shy (2001): Health effects of waste incineration: a review of epidemiologic studies. *Journal of the Air & Waste Management Association* 2001; 51(7): 1100–9.

IPCC (1996): *Revised 1996 Guidelines for Greenhouse Gas Inventories*: Reference Manual, chapter 6: Waste. Intergovernmental Panel on Climate Change.

Norwegian Pollution Control Authority (1999): Evaluering av refusjonsordningen for spillolje, 1998 (Evaluation of the refund scheme for waste oil, 1998).

Norwegian Pollution Control Authority (2000): *Hva gjør miljøvernmyndighetene for å stanse nye utslipp fra PCB i produkter?* (What are the environmental authorities doing to stop further emissions of PCBs from products?) SFT Fakta, TA 1704, February 2000.

Sandgren, J., Aa. Heie and T. Sverud (1996): Utslipp ved håndtering av kommunalt avfall (Emissions from municipal waste management). Report No. 96:16. Norwegian Pollution Control Authority.

12. Water pollution and waste water

There has been more focus on water quality in Norwegian inland and coastal waters since the first North Sea Agreement was signed in 1990, and more recently because of the implementation of the EU Water Framework Directive, which lays down standards for water quality that also apply to Norwegian water bodies. The petroleum sector is an important source of pollution, and is considered to be the largest source of acute pollution in Norwegian coastal waters today. As water resources are used in almost all forms of economic activity and are vulnerable to exploitation and pollution, it is important to monitor their state and environmental trends. This provides a basis for dealing with any problems related to conflicting user interests and water quality.

Discharges of phosphorus and nitrogen from the waste water treatment sector have been a matter of concern for many years, because these plant nutrients play an important role in the eutrophication of rivers, lakes and coastal areas. Eutrophication causes excessive growth of algae and oxygen depletion. Agriculture, aquaculture and manufacturing industry are also important sources of large nutrient inputs to inland waters and coastal areas.

In recent years, both Norway and other countries that drain to the Skagerrak and the North Sea basin have invested substantial resources in waste water treatment. The main reason has been that the pollution load in these waters has resulted in eutrophication and periodical algal blooms. In addition, Norway has signed the North Sea Agreements and the OSPAR Convention, thereby undertaking to halve inputs of phosphorus and nitrogen compared with the 1985 levels.

During the past 20 years, Norway has achieved a satisfactory level of treatment efficiency for phosphorus, mainly by building waste water treatment plants providing chemical or chemical-biological treatment. Nitrogen removal measures have been given priority over the last few years in areas where discharges from Norway have a major impact on eutrophication (as defined in the EU directive concerning urban waste water treatment and the directive concerning protection against pollution caused by nitrate from agricultural sources), i.e. areas from the border with Sweden to Strømtangen lighthouse near Fredrikstad (Hvaler/Singlefjorden in Eastern Norway) and in the Inner

Oslofjord. Discharges of nitrogen and phosphorus from Norway are relatively modest in comparison with discharges from the other countries bordering the North Sea and the Baltic Sea. As is the case in many other contexts, cooperation across national borders is important to achieve the objective of reducing pollution in these marine areas.

Oil and gas activities have put pressure on the seabed environment near offshore installations, particularly as a result of discharges of oil-contaminated drill cuttings. Although these discharges have been prohibited since 1992, it will take many years before the environment is restored to its original condition. Releases of hazardous chemicals from the oil and gas industry have been reduced in the last few years, and now only account for about one per cent of Norway's total releases. (Norwegian Pollution Control Authority 2006).

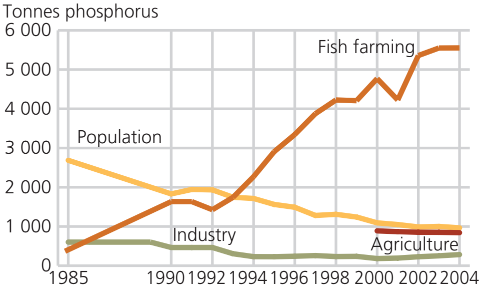
National targets - eutrophication and oil pollution

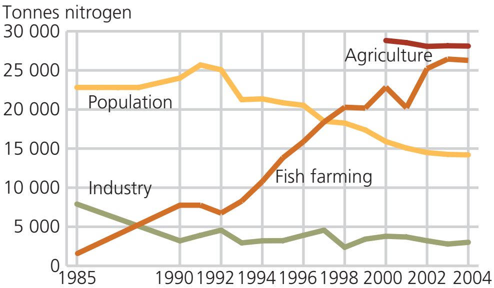
1. Inputs of the nutrients phosphorus and nitrogen to parts of the North Sea that are adversely affected by eutrophication shall be reduced by about 50 per cent by 2005, using 1985 as the base year.
2. Operational discharges of oil shall not result in unacceptable injury to health or environmental damage. The risk of environmental damage and other adverse effects of acute pollution shall be acceptable.

Source: Report No. 21 (2004-2005) to the Storting: The Government's environmental policy and the state of the environment in Norway.

12.1. Inputs of nutrients to coastal areas

Figure 12.1. Inputs[1] of phosphorus and nitrogen to the Norwegian coast, by households and important industries. 1985-2004





[1] Inputs from agriculture have not been modelled for data sets prior to 2000.
Source: Selvik et al. (2005).

The Norwegian coast

- In the period 2000-2004, total anthropogenic inputs of phosphorus to the coast increased by an estimated 10 per cent. Nitrogen inputs were relatively constant in the same period.
- Due to the development of the fish farming industry along the coast from the county of Rogaland and northwards, the discharges from this industry have increased substantially since 1985. In 2004, phosphorus discharges were 5 200 tonnes higher and nitrogen discharges 26 400 tonnes higher than in 1985. Today, this industry accounts for 73 per cent of phosphorus inputs and 37 per cent of nitrogen inputs to coastal areas.
- In 2004, agriculture was the largest source of nitrogen run-off to the Norwegian coast, and accounted for 39 per cent of the anthropogenic inputs.

Box 12.1. International agreements and concepts related to nutrient inputs to coastal areas and inland waters

North Sea Agreements and the OSPAR Convention

- The North Sea Agreements are the joint declarations made by the countries round the North Sea to reduce inputs of nutrients to the North Sea. One of the targets was to halve the total inputs of nitrogen and phosphorus during the period 1985 to 1995. Since Norway had not reached the nitrogen target by the end of 1995, the national time limit was extended to 2005.

- A key agreement is the OSPAR Convention for the protection of the marine environment of the North-East Atlantic. The Convention was opened for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris on 22 September 1992. The following countries have ratified the Convention: Belgium, Denmark, Finland, France, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Spain, UK, Sweden, Switzerland and Germany. The Convention entered into force on 25 March 1998.

Source: *http://www.ospar.org/eng/html/welcome.html*

The North Sea counties or North Sea region

In principle, the North Sea Agreements apply to the areas south of 62° N. In Norway, the targets for reducing inputs of nutrients apply to the counties from the border with Sweden to Lindesnes. Thus, the North Sea counties or North Sea region means the following counties: Østfold, Akershus, Oslo, Hedmark, Oppland, Buskerud, Vestfold, Telemark, Aust-Agder and Vest-Agder. Virtually all land in these counties drains into the Skagerrak or the North Sea.

Trophic status and eutrophication

The trophic status describes the plant nutrient and biological production conditions in water bodies. Water bodies that are rich in nutrients and very productive biologically are called eutrophic, while those that are poor in nutrients and relatively unproductive are termed oligotrophic. Water bodies of intermediate status are termed mesotrophic. In fresh water, eutrophication is usually caused primarily by phosphorus inputs, although nitrogen and other substances also play a role.

Eutrophication is a natural process in which inputs of organic matter containing plant nutrients alter biological production conditions in water bodies towards an environment rich in nutrients and high plant production. Excessive inputs of phosphorus, nitrogen and organic matter, often anthropogenic, cause increased eutrophication of inland waters and coastal areas. Important anthropogenic sources include agriculture, waste water from households, industry, fish farms and nitrous gases in air pollution. The effects of eutrophication include cloudy, discoloured water, overgrown bottom and shore and vigorous vegetation. Excessive algal production may lead to anaerobic decomposition. This may cause fish mortality, the destruction of spawning areas, a sludge layer on the bottom and toxic, sulphuric bottom water.

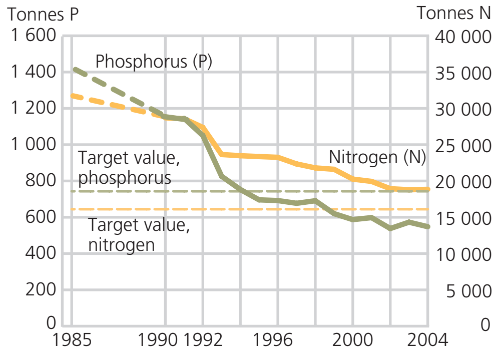
The sensitive area for phosphorus

The area that drains to the coast from the border with Sweden to Lindesnes is particularly sensitive to phosphorus inputs.

The sensitive area for nitrogen

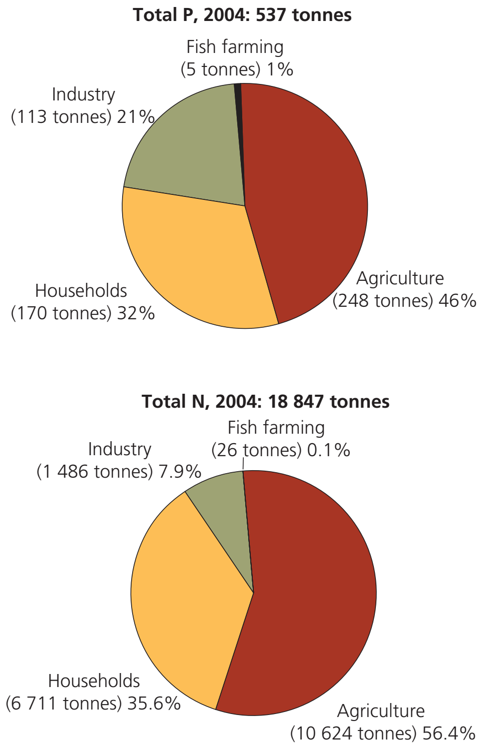
The inner Oslofjord, the area Hvaler-Singlefjorden (around the estuary of the river Glomma) and the catchment areas of the Glomma and Halden watercourses are regarded as particularly sensitive to nitrogen inputs. In these areas, the authorities have issued instructions for nitrogen removal at six waste water treatment plants.

Figure 12.2. Inputs of phosphorus and nitrogen to the North Sea region. 1985-2004



Source: Selvik et al. (2005).

Figure 12.3. Inputs of phosphorus and nitrogen to the North Sea region, by households and important industries. 2004



Source: Selvik et al. (2005).

The North Sea area

- In order to achieve the targets of the North Sea Agreements, substantial sums have been invested in new high-grade waste water treatment plants and upgrading of older plants in the North Sea region. Measures have also been implemented in fish farming and the agricultural sector.
- Phosphorus and nitrogen inputs to the sensitive North Sea region (from the border with Sweden to Lindesnes) were reduced by 66 and 42 per cent respectively from 1985 to 2004.
- This means that the target set for phosphorus in the North Sea Agreements has already been achieved, but that the nitrogen target has not yet been reached (see box 12.1).
- Phosphorus inputs from municipal waste water treatment plants (mainly from households) have been reduced by 758 tonnes (82 per cent) since 1985 and nitrogen inputs by 5 218 tonnes (44 per cent).
- Phosphorus inputs from agriculture have been reduced by around 38 per cent and nitrogen inputs by 27 per cent since 1985.
- Phosphorus and nitrogen inputs from manufacturing industry have been reduced by 15 and 74 per cent respectively.
- In 1997, open fish farming facilities were prohibited in the North Sea region, and inputs from this industry have thus been considerably reduced.

Box 12.2. The Urban Waste Water Treatment Directive and new Norwegian legislation

The objective of the Urban Waste Water Treatment Directive (EU Council Directive of 21 May 1991 concerning urban waste water treatment, 91/271/EEC, amended by Directive 98/15/EEC) is to protect people and the environment from the adverse effects of waste water discharges. Waste water from human activities contains nitrogen, phosphorus, organic substances, micro-organisms and small amounts of hazardous substances. If waste water treatment is inadequate, this may result in various kinds of pollution in Norwegian coastal areas and watercourses.

The directive therefore focuses on the collection, treatment and discharge of urban waste water, and treatment and discharges of biodegradable waste water from the food industry. Specific time limits and treatment requirements for urban waste water in agglomerations with a population equivalent (p.e.) of more than 2 000 for discharges to inland water bodies and river estuaries and more than 10 000 p.e. for discharges to coastal waters.

The Urban Waste Water Treatment Directive sets out a general requirement for secondary treatment, but it is assumed that many treatment plants along the coast between Lindesnes and Grense-Jakobselv on the Russian border only need to carry out primary treatment (see box 12.3) under an exception provision in the directive. This presupposes, however, that municipalities carry out thorough investigations to document that the discharges will not adversely affect the environment.

The treatment requirements will, however, depend somewhat on the area to which waste water is discharged. Particularly stringent treatment is required before waste water is discharged to "sensitive areas" with respect to pollution. The identification of "sensitive areas" will be reviewed every four years.

The Ministry of the Environment has laid down new legislation to ensure coordinated and more effective regulation of waste water. The new provisions apply to all discharges of sanitary waste water and municipal waste water, and are entering into force over a period of time.

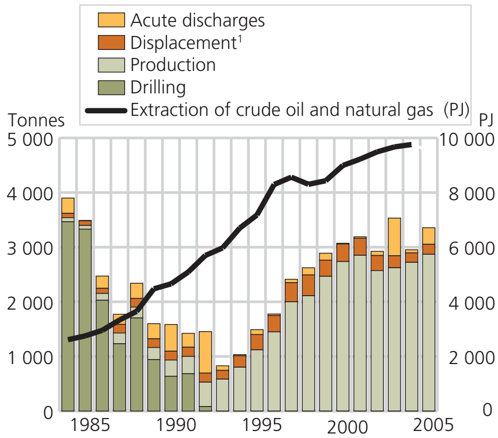
The county governors are responsible for enforcing new treatment requirements and requirements relating to inspection and control for waste water treatment plants in larger urban areas. The municipalities have similar responsibility for waste water treatment plants in smaller urban areas, and more authority than previously.

Source: Norwegian Pollution Control Authority and the Urban Waste Water Treatment Directive.

12.2. Oil pollution

Discharges of oil and chemicals from shipping, petroleum activities and onshore activities can damage organisms and ecosystems in the open sea, on the sea floor, in the littoral zone and on land. Pollution of coastal areas also reduces their value as recreation areas and for other purposes. The authorities have adequate data on discharges of oil from petroleum activities, but the figures for discharges from onshore sources and shipping are incomplete, particularly as regards illegal discharges.

Figure 12.4. Discharges of oil from petroleum activities. Tonnes. Production of crude oil, natural gas and other petroleum products. PJ. 1984-2005



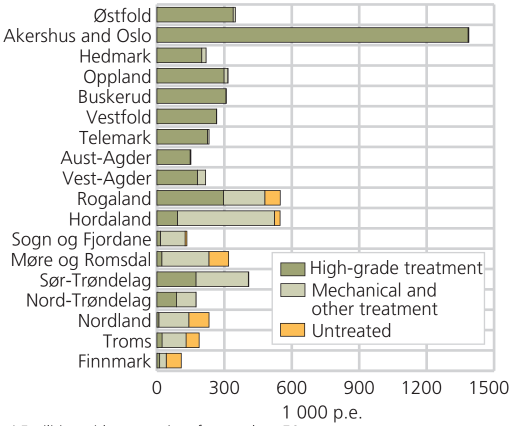
[1] Oil-contaminated ballast water in storage cells on production platforms, displaced when the cells are filled with produced oil.
Source: Norwegian Pollution Control Authority and Energy Statistics, Statistics Norway.

Oil discharges

- Oil production results in both uncontrolled (acute) discharges and legal, licensed (operational) discharges.
- Operational discharges are the largest category. They have risen considerably since 1992, but have been relatively stable in the last few years, even though a weak increasing trend has been observed since 2003. The largest source of oil discharges from the oil and gas industry today is produced water, i.e. water associated with the reservoirs that is produced along with the oil or gas. It contains residues of oil and other chemicals.
- Acute discharges from oil production and other activities have varied widely in the period 1984-2005. The level was high in 2003 as a result of a large spill on the Draugen field. In 2005, the largest discharge was a spill of 286 tonnes from the Norne field.

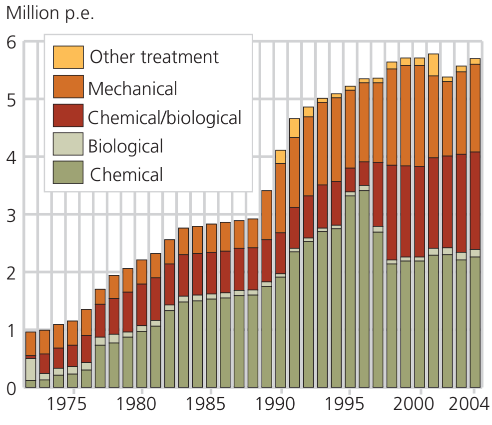
12.3. Municipal waste water treatment

Figure 12.5. Hydraulic capacity of waste water treatment plants[1], by treatment method. By county. 2005



[1] Facilities with a capacity of more than 50 p.e.
Source: Waste water treatment statistics, Statistics Norway.

Figure 12.6. Trend in treatment capacity[1]. Whole country. 1972-2004



[1] Facilities with a capacity of more than 50 p.e.
Source: Waste water treatment statistics, Statistics Norway.

Treatment capacity at waste water treatment facilities

- In 2004, total waste water treatment capacity in Norway was 5.70 million population equivalents (p.e.), 72 per cent of which was high-grade treatment. In addition, systems with direct discharges of untreated sewage had a total capacity of 0.41 million p.e.
- High-grade treatment methods account for over 97 per cent of treatment capacity in the North Sea counties, but only 32 per cent of the total in the rest of the country.
- High-grade treatment capacity in the North Sea region totals 1.31 p.e. per inhabitant, while the equivalent figure for the rest of the country is 0.35 p.e. This is about the same level as in 2003. See also Appendix, table I2.
- The trends in treatment capacity reflect investments made in the 1970s in chemical treatment processes for the removal of phosphorus and the upgrading of some large treatment facilities in the inner Oslofjord to chemical-biological treatment facilities since the mid-1990s.
- The substantial increase in mechanical treatment capacity, particularly since 1988, is largely because this is when registration of strainers and sludge separators in mechanical treatment facilities was introduced.
- The category "other treatment" includes natural purification processes. In 2001, the capacity of this category increased substantially, but has since then been reduced. The changes in this category are probably to a large degree attributable to modified reporting routines, rather than real changes in capacity.

Box 12.3. Terms, municipal waste water treatment

Waste water means domestic and industrial waste water and run-off rain water (storm water).

Sewage sludge is sludge from treatment of domestic and municipal waste water, except screenings.

Municipal waste water means domestic waste water and waste water consisting of a mixture of domestic waste water and industrial waste water and/or run-off rain water. Waste water consisting of less than 5 per cent domestic waste water is not regarded as municipal waste water.

Domestic waste water is waste water that predominantly originates from the human metabolism and household activities, including waste water from toilets, kitchens, bathrooms, utility rooms and the like.

Storm water is water at surface level. It is mainly a result of precipitation (see also the definition of overflow).

An **overflow** (weir) is a technical device to conduct water out of the sewer system in the event of an overload in the system. The water is diverted away via other systems (ditches, etc.), bypassing any treatment devices.

A **sewer system** is any of several drainage systems for carrying surface water and sewage for disposal.

The **public sewer system** is a sewer system to which connection is permitted for the general public.

A **private sewer system** is a sewer system to which connection is not permitted for the general public.

A **sewerage system** is any installation for handling of waste water that includes one or more of the following main components: sewer system, pumping stations, treatment plants and discharge pipe.

Waste water treatment plants are generally divided into three main groups according to the type of treatment they provide: mechanical, biological or chemical. Some plants operate combinations of these basic types.

Mechanical waste water treatment plants include sludge separators, screens, strainers, sand traps and sedimentation plants. They remove only the largest particles from the waste water.

High-grade waste water treatment plants are those that provide a biological and/or chemical treatment phase. Biological treatment mainly removes readily degradable organic material using microorganisms. The chemical phase involves the addition of various chemicals to remove phosphorus. High-grade plants reduce the amounts of phosphorus and other pollutants in the effluent more effectively than mechanical plants.

Natural purification processes include facilities where the waste water is treated for example using wetland filters (constructed wetlands). In these and other facilities using a similar system, micro-organisms decompose the organic material in the waste water and plants utilise the nutrients.

Primary treatment means treatment of waste water by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD5 of the incoming waste water is reduced by at least 20 per cent before discharge and the total suspended solids of the incoming waste water are reduced by at least 50 per cent.

Secondary treatment means further reduction of organic material in relation to primary treatment requirements (see above). The requirements may be met by means of a treatment efficiency requirement (minimum percentage reduction) or a concentration requirement (maximum concentration of organic material).

Tertiary treatment means the strictest requirements as to treatment methods and the reduction of phosphorus and nitrogen in the waste water before discharge to the recipient.

One **population equivalent (p.e.)** is the organic biodegradable load having a five-day biochemical oxygen demand (BOD5) of 60 g of oxygen per day. The number of population equivalents in an area is given by the sum of the number of permanent residents and all waste water from industry, institutions, etc. converted to the number of people who would produce the same amount of waste water.

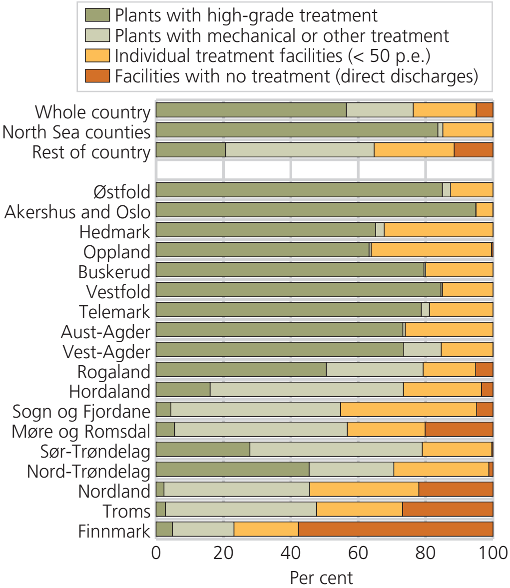
The **hydraulic capacity** (treatment capacity) of a treatment plant is the amount of waste water it is designed to treat.

The **hydraulic load** is the amount of waste water a treatment plant actually treats.

Individual waste water treatment facilities are designed to receive waste water equivalent in amount or composition up to 50 p.e. (generally, private plants in areas with scattered settlement).

Source: Norwegian Pollution Control Authority.

Figure 12.7. Percentage of population connected to various types of treatment plants. By county. 2004



Source: Waste water treatment statistics, Statistics Norway.

Connection to waste water treatment plants

- In 2004, about 80 per cent of the population of Norway was connected to waste water treatment plants with a capacity greater than 50 p.e. and to municipal sewer systems. The remaining 20 per cent were connected to smaller, individual treatment facilities.
- Just below 56 per cent of the population were connected to high-grade treatment plants in 2004. In the North Sea counties, this proportion was over 85 per cent, while the figure for the rest of the country was 20 per cent.

Discharges of plant nutrients from waste water treatment plants

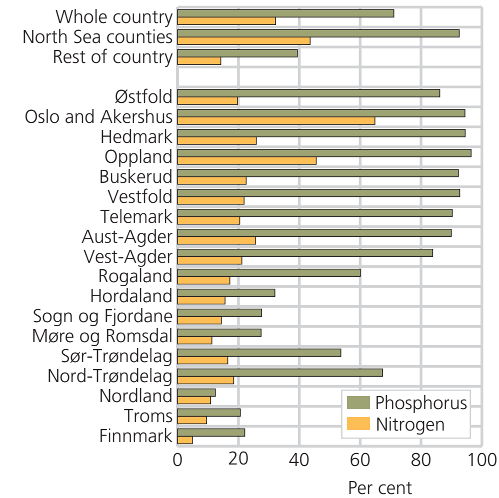
- Discharges of phosphorus and nitrogen from the waste water treatment sector in 2004 totalled 1 170 and 15 500 tonnes respectively. This includes leakages from sewers and discharges from individual treatment facilities (< 50 p.e.).
- Plants in the North Sea counties accounted for 26 per cent of the phosphorus discharges and 50 per cent of the nitrogen discharges. This corresponds to a discharge of 0.12 kg phosphorus and 2.97 kg nitrogen per capita per year. Per capita discharges of both phosphorus and nitrogen decreased by 0.01 kg compared with 2003.
- The equivalent figures for the rest of the country were 0.44 kg phosphorus and 3.97 kg nitrogen. These are about the same as the 2004 levels.

Table 12.1. Total discharges of phosphorus and nitrogen from sewerage systems. 2000-2004. By county. 2004

	Phosphorus					Nitrogen				
	Total	Discharges from municipal treatment plants	Leakages from sewers[1]	Discharges from individual treatment facilities	Discharges per inhabitant	Total	Discharges from municipal treatment plants	Leakages from sewers[1]	Discharges from individual treatment facilities	Discharges per inhabitant
	Tonnes				kg	Tonnes				kg
Total 2000	**1 296**	**825**	**124**	**346**	**0.29**	**17 374**	**13 191**	**912**	**3 270**	**3.88**
Total 2001	**1 280**	**795**	**123**	**362**	**0.28**	**16 723**	**12 303**	**860**	**3 560**	**3.71**
Total 2002	**1 186**	**725**	**120**	**347**	**0.26**	**15 802**	**11 785**	**830**	**3 246**	**3.49**
Total 2003	**1 228**	**756**	**121**	**351**	**0.27**	**15 599**	**11 426**	**835**	**3 338**	**3.41**
Total 2004	**1 170**	**708**	**122**	**340**	**0.26**	**15 501**	**11 494**	**800**	**3 207**	**3.40**
North Sea counties (01-10)	303	108	73	122	0.12	7 709	5 863	481	1 365	2.97
Other counties (11-20)	867	599	49	218	0.44	7 792	5 631	319	1 842	3.97
01 Østfold	35	17	6	12	0.13	1 000	850	53	97	3.78
02-03 Akershus and Oslo	92	38	35	19	0.09	2 135	1 708	243	184	2.06
04 Hedmark	27	5	4	18	0.13	720	456	31	233	3.51
05 Oppland	28	4	5	20	0.15	658	368	34	257	3.44
06 Buskerud	28	9	6	13	0.12	702	513	33	156	3.04
07 Vestfold	29	8	6	15	0.13	876	718	36	122	3.97
08 Telemark	23	8	4	12	0.13	640	490	22	128	3.60
09 Aust-Agder	18	7	3	7	0.17	375	263	14	98	3.54
10 Vest-Agder	23	13	4	6	0.14	602	497	15	90	3.77
11 Rogaland	103	71	9	23	0.29	1 359	1 092	66	202	3.85
12 Hordaland	180	130	10	40	0.42	1 616	1 188	70	358	3.78
14 Sogn og Fjordane	55	33	2	19	0.51	415	237	14	163	3.90
15 Møre og Romsdal	121	86	6	29	0.48	981	696	39	246	3.88
16 Sør-Trøndelag	123	86	9	28	0.50	1 028	739	44	245	4.17
17 Nord-Trøndelag	38	19	3	16	0.30	485	328	20	136	3.83
18 Nordland	116	74	4	38	0.54	875	554	31	290	4.06
19 Troms Romsa	87	66	4	17	0.56	692	534	21	138	4.41
20 Finnmark Finnmárku	44	34	2	8	0.56	340	263	14	64	4.36

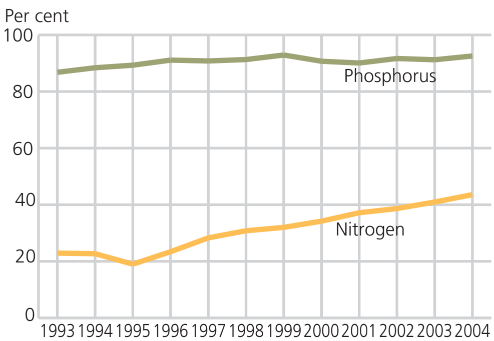
[1] Estimated at 5 per cent of the content of phosphorus and nitrogen in waste water before treatment.
Source: Waste water treatment statistics, Statistics Norway.

Figure 12.8. Estimated treatment effect for phosphorus and nitrogen. By county. 2004



Source: Waste water treatment statistics, Statistics Norway.

Figure 12.9. Trend in treatment effect for phosphorus and nitrogen in the North Sea region. 1993-2004. Per cent

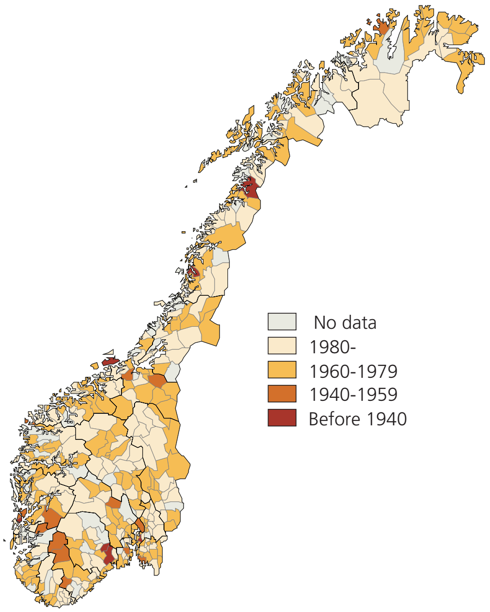


Source: Waste water treatment statistics, Statistics Norway.

Treatment efficiency

- In 2004, waste water treatment plants in the North Sea counties removed on average 93 per cent of the phosphorus and 44 per cent of the nitrogen load processed by the plants. In the rest of the country, treatment efficiency for these nutrients was 39 and 14 per cent respectively.
- In Oslo and Akershus, treatment efficiency for nitrogen is 65 per cent, and this plays an important role in ensuring a level of over 40 per cent for the North Sea region as a whole. In Oppland county, the treatment efficiency is 46 per cent, while it is considerably lower in the other counties.
- In the North Sea region, treatment efficiency rose by three percentage points for nitrogen and one percentage point for phosphorus from 2003 to 2004. Actual efficiency will vary somewhat from year to year, partly because unusual incidents (operational failure, overload, etc.) at the larger plants can have a substantial effect on the figures.
- Since 1995, treatment efficiency for nitrogen has been improved from about 20 per cent to about 44 per cent due to the construction of nitrogen removal plants in the Oslofjord area. Since 1995, treatment efficiency for nitrogen in this area has risen steadily from about 20 per cent to just under 44 per cent in 2004. The treatment efficiency for phosphorus in the same period has been relatively stable at around 90 per cent.

Figure 12.10. Average age of municipal sewer systems. 2005

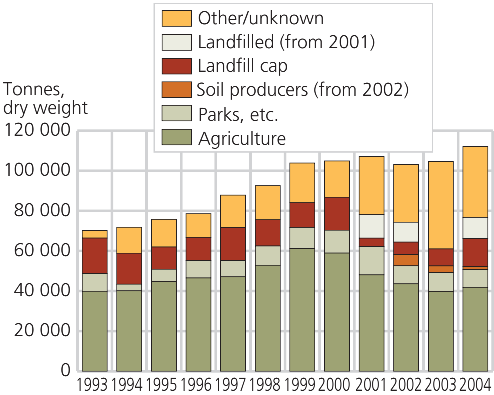


Map data: Norwegian Mapping Authority.
Source: KOSTRA, Statistics Norway.

Sewer systems

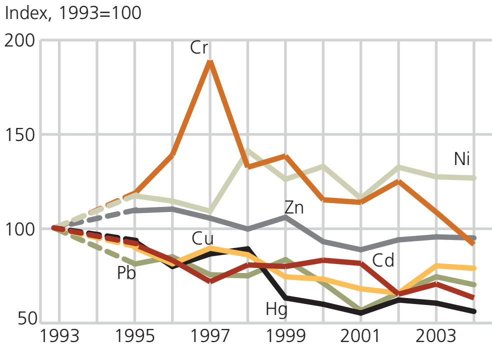
- There is a total of 34 410 km of municipal sewage pipelines in Norway. This corresponds to 4/5 of the earth's circumference at the equator.
- Renewal of the sewer system is essential to prevent damage to buildings and inadvertent environmental pollution as a result of damaged pipes or leaks. Damaged pipes can also contribute to higher treatment costs due to surface water and groundwater draining into the sewer system.
- The average rate of renewal for sewer systems in Norwegian municipalities in 2005 is estimated at 0.56 per cent per year. This corresponds to a pipeline life of about 180 years, assuming that the rate of renewal remains the same.
- The average regional rate of renewal is 0.53 per cent for the counties in the North Sea region (from Østfold to Vest-Agder) and 0.62 per cent for the rest of the country.
- The sewer system, however, is more extensive in the southeastern part of the country, so that the length of pipeline renewed in the North Sea region is nevertheless greater (about 100 kilometres) than in the rest of the country (about 85 kilometres).
- The average age of the sewers is estimated to be 28 years. About 11 per cent of the pipelines were laid before 1940, 9 per cent in the period 1940-1959, 34 per cent in 1960-1980, and the remainder after 1980.

Figure 12.11. Quantities of sewage sludge used for different purposes[1]. Whole country. 1993-2004



[1] The category "landfilled" was not reported separately in 2003, and is assumed to be included in "other/unknown".
Source: Waste water treatment statistics, Statistics Norway.

Figure 12.12. Trends for content of heavy metals in sludge. 1993-2004[1]. Whole country. Index, 1993=100



[1] Figures for 1994 are not available.
Source: Norwegian Pollution Control Authority (SESAM) and Waste water treatment statistics, Statistics Norway.

Sewage sludge

- Sludge is a residual product of the waste water treatment process, but also a potential resource in integrated plant nutrient management in agricultural areas and parks and other green spaces. Nutrients and organic matter are separated from the waste water, and the sludge is stabilised and hygienised to remove odours and harmful bacteria before utilisation or disposal in landfills.
- In 2004, 112 000 tonnes of sludge, expressed as dry weight, was used for various purposes, an increase of 7 per cent compared with 2003. Since 2002, the municipalities have reported the amount of sludge used by soil producers. It is assumed that this was previously included in other categories. The same applies to landfilled sludge, which has been reported as a separate category since 2001.
- In all, 46 per cent of the sludge was used for integrated plant nutrient management or in parks and green spaces, or was delivered to soil producers.
- If the content of heavy metals exceeds the limit values, the sludge cannot be used in integrated plant nutrient management.

- The concentration of heavy metals varies over time. However, the main trend in Norway has been a decrease in the content of heavy metals in sludge. Nickel is an exception, however, maintaining a persistently high level since 1993.
- The content of heavy metals varies, sometimes substantially, from one plant to another. This is because the composition of waste water varies (depending on factors such as the amount of waste water from households, and the proportion of industrial waste water and of rain/melt water).

Table 12.2. Content of heavy metals in sludge. 2004

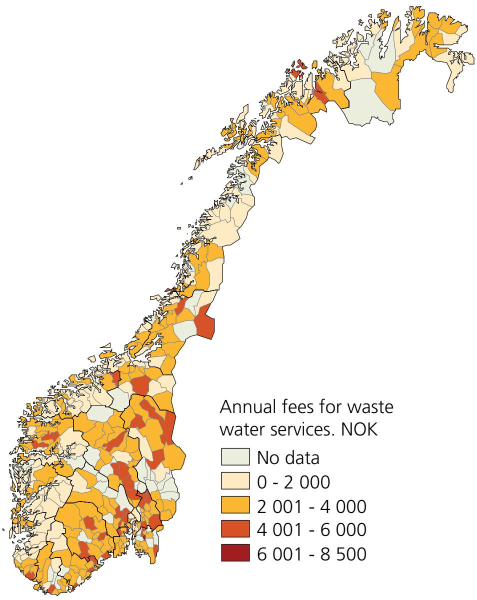
Heavy metals	Mean value	Average of maximum values	Limit value agriculture (quality class II)	Limit value parks, etc. (quality class II)	Change in mean value 2003-2004
	Milligrams per kg expressed as dry weight				Per cent
Cadmium (Cd)	0.8	1.3	2	5	-10.3
Chromium (Cr)	19.7	37.5	100	150	-15.7
Copper (Cu)	263.3	361.0	650	1 000	-1.6
Mercury (Hg)	0.8	2.2	3	5	-7.3
Nickel (Ni)	13.9	25.7	50	80	-0.5
Lead (Pb)	20.4	29.7	80	200	-5.6
Zinc (Zn)	324.1	425.5	800	1 500	-0.6

Source: Waste water treatment statistics, Statistics Norway.

12.4. Fees in the municipal waste water sector

Norwegian legislation lays down that municipal water and waste water fees may not exceed the necessary costs incurred by the municipalities in these sectors. The fees must follow the principle of full costing, and must be based on estimates of the direct and indirect operating, maintenance and capital costs of water and waste water services. The annual fees must be calculated on the basis of measured or stipulated water consumption, or in two parts, one fixed and one variable. For properties where no water meter is installed, water consumption is as a general rule stipulated on the basis of the size of the buildings.

Figure 12.13. Annual fees for waste water services, by municipality. 2006. NOK



Source: KOSTRA, Statistics Norway.

Waste water services

- For the country as a whole, waste water fees showed a decrease of 1.5 per cent in 2005.
- The size of the fee varies significantly between municipalities, from NOK 360 to NOK 8 436.
- In general, fees are highest in Eastern Norway, where requirements for waste water treatment are strictest (partly as a result of the requirements of the North Sea Agreements, see box 12.1).
- Local conditions, such as topography, the need for pumping stations and population density, can also help to explain the large differences in fees between municipalities.

More information: Kari B. Mellem (kbm@ssb.no) (financial data), Gisle Berge (gib@ssb.no) and Jørn Kristian Undelstvedt (jku@ssb.no).

Useful websites

Statistics Norway - Water and waste water statistics:
http://www.ssb.no/english/subjects/01/04/20/
Statistics Norway - Environmental protection expenditure statistics:
http://www.ssb.no/english/subjects/01/06/20/
Norwegian Institute of Public Health: http://www.fhi.no/english/
Norwegian Institute for Water Research: http://www.niva.no/engelsk/welcome.htm
State of the Environment Norway: http://www.environment.no/

References

Norwegian Pollution Control Authority (2006): http://www.miljostatus.no/

Selvik, J.R., T. Tjomsland, S.A. Borgvang and H.O. Eggestad (Centre for Soil and Environmental Research) (2005): Tilførsler av næringssalter til Norges kystområder, beregnet ved tilførselsmodellen TEOTIL2 (Inputs of nutrients to Norwegian coastal areas, calculated using the input model TEOTIL2), Report 5103-2005, Norwegian Institute for Water Research.

13. Hazardous chemicals

Since the 1930s, global production of chemicals has risen from 1 million tonnes a year to more than 400 million tonnes (EC 2006). More than 100 000 new substances have been synthesised, in addition to all those that occur naturally (EEA 2006). Some chemicals are known to cause serious damage to health and the environment, but our knowledge of the vast majority of substances is incomplete. Ensuring safe handling and use of chemicals has therefore become one of the most important challenges for society.

Chemicals have become an essential part of modern life. They are used to give products the desired properties - soft or hard, washable or biodegradable, transparent or colourful. They are used in clothes, furniture, electronic equipment and a range of other products. They are also needed in many different industrial processes. In Norway, the chemical industry employs about 13 000 people, or almost 5 per cent of the industrial labour force. A sustainable chemical industry must produce, use and dispose of chemicals in an environmentally sound way.

The Norwegian authorities have defined the management of chemicals as an important priority area both of environmental policy (see national targets in Box 13.3) and in the action plan for sustainable development (see Chapter 2). A great deal of detailed information exists on the risks associated with the widespread use of chemicals, but it is too fragmented and incomplete to provide a suitable a basis for political decisions and changes of policy. Over the past few years, Statistics Norway has been developing statistics to provide more information on the consumption of chemicals. This process involves the development of statistics on the consumption of hazardous chemicals and of risk indicators (indicators of the risk of damage to health or the environment resulting from the use and releases of chemicals), based so far on information from the Product Register[1]. This work is described in box 13.6. Since the statistics are still being developed, there is a high level of uncertainty in the results. The results presented in this chapter are preliminary and indicate how Statistics Norway envisages the development of the statistics.

[1] The Product Register runs the authorities' central register of dangerous chemicals. See Box 13.5.

Statistics Norway also wishes to develop indicators at other points in the life cycle of chemicals and to include more chemicals than those that are declared to the Product Register. The intention is to develop complete statistics that will provide useful information for use by the authorities, the business sector, environmental organisations and the general public in efforts to limit the harmful effects of the use and releases of chemicals.

Box 13.1. What are chemicals?

«Chemicals» is a generic term for both substances and preparations.
Substances:chemical elements and their compounds in the natural state or obtained by any production process.
Preparations: solutions or solid, liquid or gaseous mixtures composed of two or more substances.

Hazardous chemicals are substances or preparations that may be hazardous to health or the environment. Norway's official List of Substances contains information on about 3 500 substances that are classified as dangerous.

Source: State of the Environment Norway (www.environment.no).

Box 13.2. What kinds of health and environmental damage can chemicals cause?

- The use of chemicals is suspected of being one of the causes of the steadily increasing rates of allergy, asthma, some types of cancer and birth defects and reproductive problems (for example poor sperm quality) in Europe.
- Some chemicals are endocrine disruptors, which can cause sterility and disrupt reproduction in birds, fish, amphibians and molluscs.
- Some chemicals can be transported over long distances in the atmosphere and with ocean currents. Very high levels of dangerous chemicals have for example been found in polar bears and indigenous peoples in Canada. Chemicals can also accumulate in breast milk.
- According to two European studies[1], a third of all recognised occupational skin and respiratory diseases in Europe are related to exposure to chemicals.

[1] «*The impact of REACH on occupational health*», School of Health and Related Research (University of Sheffield, UK), September 2005 and «*Skin sensitisers*», Facts, Issue 40, European Agency for Safety and Health at Work, June 2002.
Source: EC 2006.

Box 13.3. National targets - hazardous substances

1. Releases of certain ecological toxins will be eliminated or substantially reduced by 2000, 2005 or 2010.
2. Releases and use of substances that pose a serious threat to health or the environment will be continuously reduced with a view to eliminating them within one generation (by the year 2020).
3. The risk that releases and use of chemicals will cause injury to health or environmental damage will be minimised.
4. The dispersal of ecological toxins from contaminated soil will be stopped or substantially reduced. Steps to reduce the dispersal of other hazardous substances will be taken on the basis of case-by-case risk assessments.
5. Contamination of sediments with substances that are hazardous to health or the environment will not give rise to serious pollution problems.

Source: Report No. 26 (2006-2007) to the Storting: The Government's environmental policy and the state of the environment in Norway.

Norway categorises chemicals as ecological toxins if they are persistent, bioaccumulative and toxic. In addition to such organic substances, ecological toxins include certain metals such as mercury, chromium and lead, and also endocrine disruptors.

Box 13.4. REACH - the new EU chemicals legislation

The EU is introducing new legislation to ensure a high level of protection of human health and the environment against chemicals and at the same time maintaining a competitive chemicals industry. Under these rules, anyone who manufactures or imports 1 tonne or more of a chemical per year must register this in a central database. Manufacturers and importers will also be required to obtain information on these substances, so that risks can be managed appropriately.

The REACH Regulation enters into force in 2007. REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals.

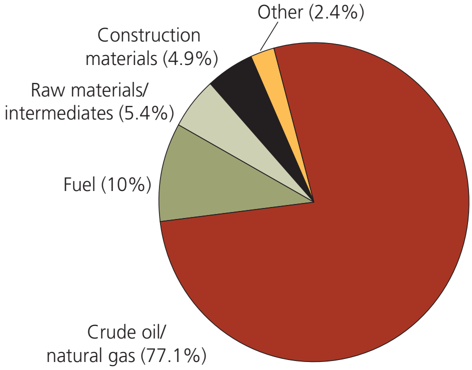
More information on DG Enterprise website http://ec.europa.eu/enterprise/reach/index_en.htm

Box 13.5. The Product Register

All chemical products for which warning labelling is mandatory under the Chemical Labelling Regulations must be declared to the Product Register, which runs the authorities' central register of dangerous chemicals. Companies are required to declare the quantity of each product manufactured, imported, etc., the branches of industry where it is used and its chemical composition. There is a general exemption from the duty to declare for products that are placed on the market in quantities of less than 100 kg per year.

13.1. Consumption of hazardous chemicals in Norway

Figure 13.1. Consumption of hazardous products, by product type. 2004



Source: Product Register 2005.

- More than 43 000[2] different products containing hazardous chemicals were declared to the Product Register in 2004 (see Box 13.5). This is an increase of more than 10 000 products from 2000. However, the increase is partly explained by the introduction of stricter requirements for declaration.
- Consumption of products containing hazardous chemicals totalled more than 100 million tonnes in 2004. Petroleum products such as crude oil, natural gas, fuel oil and autodiesel make up by far the largest category by volume. This category and two others (construction materials such as cement, concrete and mortar; and raw materials and intermediates) account for almost 98 per cent by volume of all products that must be declared to the Product Register. However, people are not exposed to petroleum products and raw materials to any great extent, so that these figures give a somewhat skewed picture of the quantities of hazardous products on the Norwegian market. Neither of these product categories is much used by private consumers.
- However, most of the 43 000 products belong to other product categories. Laboratory chemicals, binding agents and pH-regulating agents are important product categories that are mainly used for industrial purposes, while paints and varnishes and cleaning products are also widely used by private consumers. Other product categories include biocides, cosmetics, leather and textile impregnating agents, closing net proofing and car care products.

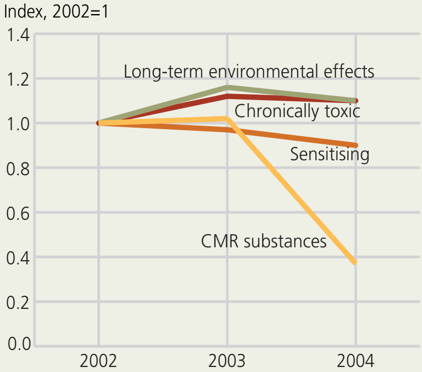
[2] Rough estimate based on the number of declarations registered with the Product Register.

Box 13.6. Consumption of hazardous chemicals. Development of risk indicators

Statistics Norway is developing risk indicators (indicators of the risk of damage to health or the environment resulting from the use and releases of chemicals), based so far on information from the Product Register. There is a high level of uncertainty in the results presented here.

- Consumption of CMR substances was more than halved in the period 2002-2004. This was largely because the consumption of fuel additives dropped sharply as a result of a high level of exports in 2004. For most other product groups, there was an increase in the volume of CMR substances used in the same period. Two product groups that are considered to have a high dispersal potential are paints and varnishes and cleaning products. The volume of CMR substances in these groups has been increasing throughout the period.
- Consumption of substances that are dangerous for the environment and may have long-adverse effects rose by 10 per cent in the period 2002-2004. Important product groups in this category are expanding products, electrolytes, insulating materials and cleaning products. The quantity of substances with long-term environmental effects in cleaning agents was twice as large in 2004 as in 2002.
- Consumption of chronically toxic substances rose by 10 per cent in the period 2002-2004, mainly as a result of higher consumption of hazardous substances in electrolytes. Other important product types are extraction agents, reduction agents and galvano-technical agents. There has been a reduction in the volume of chronically toxic substances in paints and varnishes and in cleaning agents.
- Consumption of sensitising substances has dropped during the period, and was 10 per cent lower in 2002 than in 2004. Large product groups that contain sensitising substances are process regulators, binding agents, biocides, impregnating agents, paints and varnishes, and curing agents.

Index of the consumption[1] of hazardous substances. Four hazard categories[2]: CMR, dangerous for the environment, chronically toxic, sensitising. 2002-2004



[1] Consumption is found by calculating quantity manufactured + import – export. Quality control of the data is not adequate, and the results must therefore be interpreted with caution. Data for crude oil and fuels are not included in the index.
[2] Substances are aggregated into groups according to the risk phrases required on the warning labelling. CMR substances are carcinogenic, mutagenic or toxic for reproduction.
Source: Hansen 2006.

About the calculations

The statistics are based on figures on consumption from the Product Register (see box 13.5), i.e. the quantity manufactured plus the quantity imported minus the quantity exported for each of the selected substances. Three important methodological choices were made:

- Calculations are made for constituent substances, rather than for the whole volume of products, as was done in earlier work by Statistics Norway.
- Each substance is assigned to one or more hazard categories. In earlier work, a hierarchical system of hazard categories was used. Using the new system, the quantity of a particular substance may be found in more than one hazard category, for example both «dangerous for the environment» and «chronically toxic».
- The list of substances included is dynamic: certain harmful effects were selected for inclusion in the indicator, rather than a fixed list of substances. Substances that may have these effects are identified and information is extracted from the Product Register.

Cont.

cont.

Hansen (2006) provides a further description and grounds for these choices. It should be noted that as a result of the choices, the statistics have the following important characteristics:

- They show changes in the quantity of an active substance, i.e. the quantity of a dangerous component in a product. It is this component that must be removed or reduced to reduce the hazards involved in using the product.
- They reduce the importance of incorrect labelling as a source of error, because requirements for labelling substances are laid down by the authorities, whereas products are labelled by suppliers on the basis of subjective evaluation of the legislation.
- If the same substance has several types of harmful effects, they are all apparent, and in particular, environmental effects are made clearer.
- The statistics are based on the most recently available information, since the substances include can be changed if the authorities alter the classification system.
- A focus on sustainability has been added by including substances with long-term effects. The types of adverse effects included in the indicator can also be adjusted.

The method also corrects for the effects of changes in the legislation, and thus ensures consistent time series. This is done by using the warning labelling applicable for the most recent year for all years in the series. It is also possible to back-calculate quantities of substances using expert assessments and estimates from other data sources.

It is important to be aware that there are limitations and weaknesses in the data from the Product Register, and that these can result in errors in the estimated consumption figures.

Recommendations for ways of improving the quality of data in the Product Register have been published, for example in Aasestad et al. (2005).

For more information, see: Hansen, K.L. (2006): Indikatorer på kjemikalieområdet, risiko for skade på helse og miljø grunnet bruk av kjemiske stoffer (Indicators for chemicals: risk of health and environmental damage from the use of chemicals). Notater 2006/25, Statistics Norway.

Development of a risk indicator

The Norwegian Pollution Control Authority, the Product Register and Statistics Norway are developing an indicator for progress in achieving national target 3 of the Government's policy for reducing the risks associated with hazardous substances (see Box 13.3). The statistics presented here are the result of the first phase of this work.

Before the statistics can be used in an indicator, further development is necessary. The second phase of this work is intended to improve the extent to which the figures for consumption reflect the risk of damage to health or the environment:

- A further evaluation is needed of which branches of industry and product types should be heavily weighted in the consumption index and which should be omitted because their use involves little risk. Three product groups have already been omitted from the underlying data for the consumption index - crude oil, fuels, and raw materials and intermediates.

- In the long term, the degree to which dangerous substances are not declared to the Product Register should be assessed, and an evaluation should be made of whether to take the lifetime of substances in the environment into account.

More information: Kathrine Loe Hansen (kathrine.loe.hansen@ssb.no) and Kristin Aasestad (kristin.aasestad@ssb.no).

Useful websites

State of the Environment Norway: http://www.environment.no/
Product Register: http://www.produktregisteret.no/
Norwegian Pollution Control Authority: http://www.sft.no/

References

Aasestad, K., A. Finstad and K.L. Hansen (2005): Bruk av helsefarlige produkter i grafisk industri (Use of chemicals that are hazardous to health in the publishing and printing industry). Notater 2005/33, Statistics Norway.

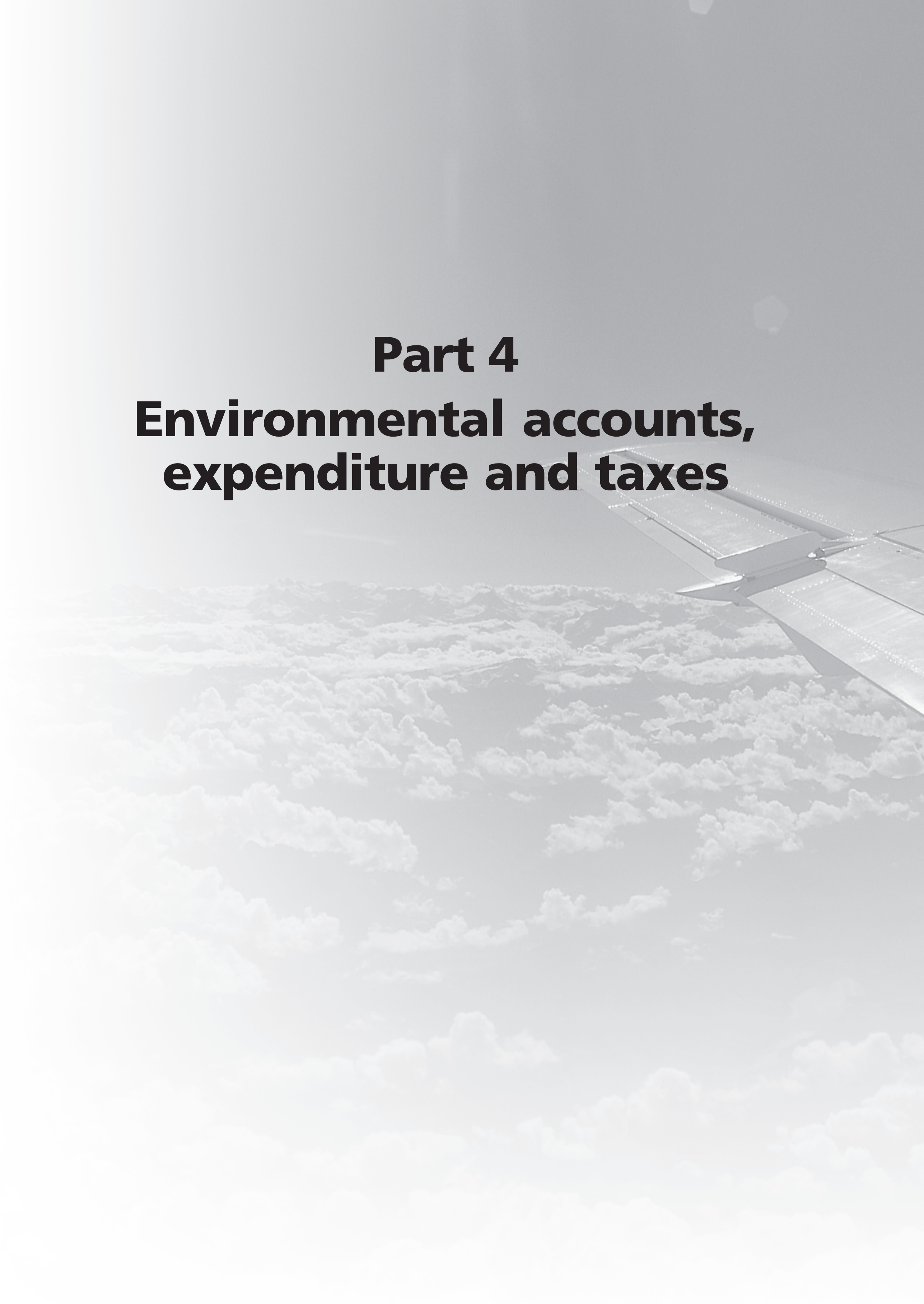
EC (2006): Environment fact sheet: REACH – a new chemicals policy for the EU. European Commission, February 2006.

EEA (2006): Information on chemicals - http://themes.eea.europa.eu/Environmental_issues/chemicals. European Environment Agency.

Hansen, K.L. (2006): Indikatorer på kjemikalieområdet – risiko for skade på helse og miljø grunnet bruk av kjemiske stoffer (Indicators for chemicals: risk of health and environmental damage from the use of chemicals). Notater 2006/25, Statistics Norway.

Product Register (2005): *Tall og figurer for produkter. Rapport 2000-2004.* (Data on products. Report 2000-2004. Norwegian Product Register).

Report No. 26 (2006-2007) to the Storting: *Regjeringens miljøvernpolitikk og rikets miljøtilstand* (The Government's environmental policy and the state of the environment in Norway). Ministry of the Environment.



Part 4
Environmental accounts, expenditure and taxes

14. Links between environment and economy

Environmental pressures are to a large extent caused by the production of goods and services. One goal of environmental policy is therefore to encourage producers and consumers to use resources responsibly and to limit the environmental impact of their consumption and other activities. The authorities can encourage more environmentally friendly behaviour through legislation and by taxation. In addition, it is a principle of international environmental law that the polluter should pay for any environmental damage caused.

National accounts data and emission statistics at the level of specific industries have been linked and used to calculate emission intensities. An industry becomes more emission-efficient if its emission intensity decreases. In 2004, Norway's greenhouse gas emissions and emissions of acidification precursors continued to increase, but the rise in GDP was even larger. This resulted in a decrease in emission intensity for Norway as a whole. The growth in value added has primarily taken place in industries that are less emission-intensive.

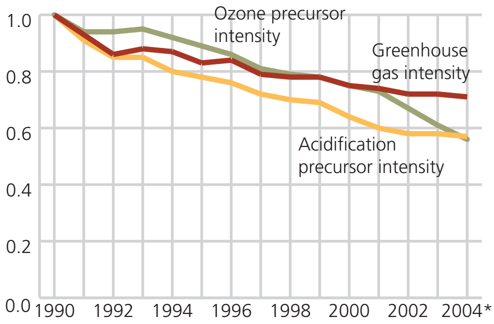
Environmental protection expenditure means the additional expenses an establishment incurs for environmental protection measures. Such measures may either be required by the authorities or voluntary. A sample survey of environmental expenditure in manufacturing industries and mining and quarrying in 2003 showed that their environmental protection expenditure totalled more than NOK 1.6 billion. Expenditure on environmental protection measures is particularly high in four manufacturing industries: basic metals; food products, beverages and tobacco; oil refining and chemicals; and pulp and paper. These accounted for 83 per cent of all reported environmental protection expenditure.

The purpose of environmental taxes is to put a price on environmental impacts and/or costs. In practice, different political priorities have to be weighed against each other, and one result is that various types of exemptions are introduced. Manufacturing industries account for almost 40 per cent of energy use in the Nordic countries, but only pay about 5 per cent of the energy taxes. Energy and transport taxes are the most important environmental taxes in terms of raising revenue. In 2004, these two tax categories accounted for 97 per cent of total environmental tax revenues.

14.1. Trends in emissions and economic growth

National accounts data and emission statistics at the level of specific industries can be linked and used to calculate emission intensities (measured as emissions in tonnes per NOK of value added) using data from the NAMEA system (National Account Matrix including Environmental Accounts). An industry becomes more emission-efficient when its emission intensity decreases.

Figure 14.1. Emission intensities. Norway, excluding ocean transport[1]. 1990-2004*. Index: 1990=1

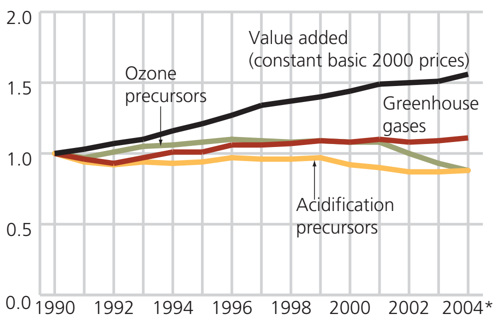


[1] Ocean transport is excluded from the calculations because of uncertainties in the emission calculations
Source: National Accounts and Environment, 1990-2004, Statistics Norway (2006b).

Emission intensities

- Preliminary figures for 2004 show a slight improvement in greenhouse gas intensity and acidification intensity from the previous year. Emissions of greenhouse gases and acidification precursors continued to increase, but economic growth was once again higher than the increase in emissions of these substances.
- For ozone precursors, the positive trend that has been apparent since 2000 continued. The continued reduction in both emissions to air and emission intensity shows that continued economic growth will not necessarily result in rising emissions of ozone precursors to air.

Figure 14.2. Emissions and value added (in constant basic prices). Norway, excluding ocean transport[1]. 1990-2004*. Index: 1990=1



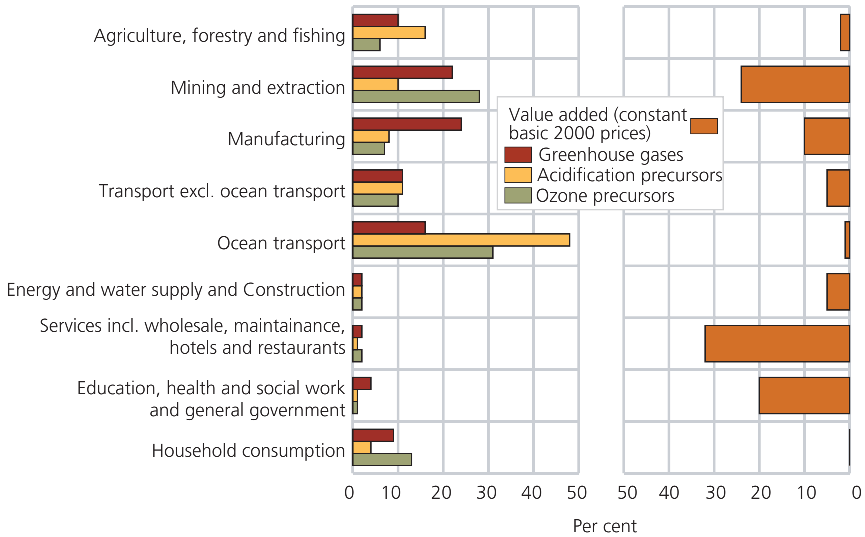
[1] Ocean transport is excluded from the calculations because of uncertainties in the emission calculations.
Source: National Accounts and Environment, 1990-2004, Statistics Norway (2006b).

Emissions and economic growth

- Measured in constant prices, Norway's GDP has grown every year since 1990. Preliminary figures from the national accounts for 2004 show that value added in constant basic prices rose by 2.8 per cent from the previous year.
- During the period 1990 to 2004, Norway has become more emission-efficient with respect to emissions of greenhouse gases, acidification precursors, and ozone precursors.

- This does not necessarily mean that all industries have become more emission-efficient, but that economic growth has taken place particularly in industries that are less emission-intensive.
- Economic growth has been particularly strong in wholesale and retail trade, construction, and other services in recent years. These are industries that make a relatively small contribution to total emissions to air.

Figure 14.3. Emissions to air and value added (constant basic 2000 prices) for industrial sectors and households . 2004*. Per cent

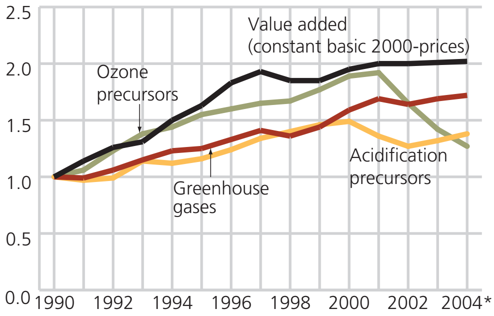


Source: National Accounts and Environment, 1990-2004, Statistics Norway (2006b).

Oil and gas extraction

Although oil and gas extraction including mining accounts for a large proportion of total emissions to air in Norway, this is not one of the most emission-intensive sectors. This is because oil and gas extraction also accounts for a large proportion of total value added (24 per cent in 2004), and because value added includes a considerable economic rent.

Figure 14.4. Value added (constant basic prices) and emissions to air from oil and gas extraction including mining. 1990-2004*. Index: 1990=1



Source: National Accounts and Environment, 1990-2004, Statistics Norway (2006b).

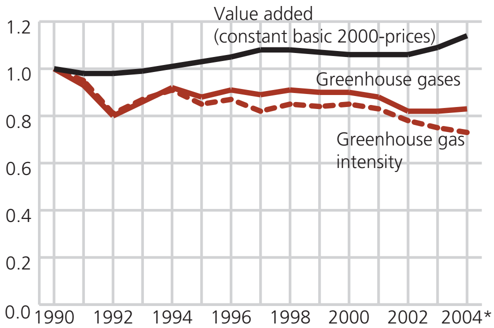
- Since 2001, this sector has become more emission-efficient with respect to ozone precursors. The installation of VOC recovery equipment at offshore facilities just after 2000 is the main reason why total emissions of NMVOCs have been substantially reduced in the last few years. In 2004, NMVOC emissions accounted for 31 per cent of emissions of ozone precursors, and more than half of Norway's NMVOC emissions were generated by oil and gas extraction.

- Greenhouse gas emissions from the continental shelf have increased steadily since 1990. In the early 1990s, the industry was nevertheless becoming more emission-efficient with respect to greenhouse gases, but calculations for the last few years show that this trend is changing. This is primarily because value added has been fairly stable, while emissions of greenhouse gases have continued to rise. Since 2000, there has been a relatively rapid increase in greenhouse gas emissions, which is explained by a rise in energy-intensive production of natural gas relative to oil production. Production of natural gas generates larger greenhouse gas emissions and emissions of acidification precursors per unit produced than oil production. Thus, the emission efficiency of oil and gas extraction with respect to both greenhouse gases and acidification precursors has worsened in the last three years.

Manufacturing

Although manufacturing accounts for a large proportion of total greenhouse gas emissions and a relatively low proportion of total value added, calculations show that these industries have become more emission-efficient since 1996, despite a slight increase in emissions in 2003 and 2004.

Figure 14.5. Value added (constant basic prices), greenhouse gas emissions and greenhouse gas intensity. Manufacturing. 1990-2004*. Index: 1990=1



Source: National accounts and environment, 1990-2004, Statistics Norway (2006b).

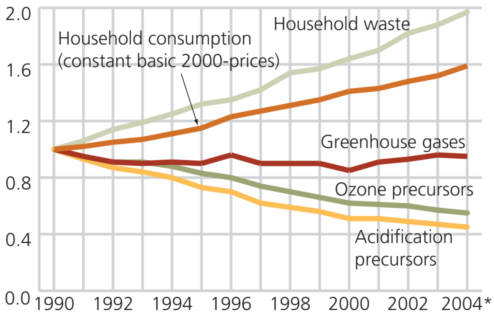
- Not surprisingly, it is manufacturing of basic metals, refined petroleum products, chemicals and mineral products that largely drive trends in greenhouse gas emissions from Norwegian manufacturing.
- In 2003 and 2004, growth was mainly attributable to an increase in value added in two industrial sectors: publishing and printing, and machinery and other equipment.
- In 2003, there was a decrease in the number of manufacturing establishments, and the surviving establishments were the most profitable ones. In some manufacturing industries, for example the basic metals industry, income increased more than costs. This is partly because investments in new equipment resulted in increased production capacity and better utilisation of raw materials.

Households

Household consumption has various impacts on the environment. In 2004, household waste accounted for 22 per cent of total waste generation. Households also accounted for 13 per cent of emissions of ozone precursors and about 10 per cent of the Norwegian greenhouse gas emissions. Household consumption and generation of household waste rose sharply in the period 1990-2004, while emissions of acidifying gases and ozone precursors decreased considerably. Emissions of greenhouse gases are slightly lower than in 1990.

- Both household consumption and the total quantity of household waste increased substantially and at about the same rate from 2003 to 2004. Increased household consumption is due primarily to an increase in consumption of clothes and shoes, purchases of cars and other means of transport, and consumption of other types of goods such as photography and computer equipment, leisure equipment, furniture and household appliances.
- Emissions of acidification precursors and ozone precursors from household activities were lower in 2004 than the previous year. Emissions from privately owned petrol vehicles showed the largest decrease, despite the increase in traffic. NO_x emissions are continuing to drop as older cars without catalytic converters are scrapped and the proportion of cars with catalytic converters rises. However, the number of privately owned diesel vehicles is continuing to increase, and it is expected that this will slow down the reduction in NO_x emissions to some extent. NO_x emissions per kilometre driven are somewhat higher for diesel vehicles than for petrol vehicles with catalytic converters, whereas the opposite is true for CO_2.

Figure 14.6. Consumption (constant basic prices), solid waste and air emissions. Households. Index: 1990=1



Source: National Accounts and Environment, 1990-2004, Statistics Norway (2006).

- After rising steadily for three years, greenhouse gas emissions from households showed a slight decrease in 2004. Greenhouse gas emissions from households can mainly be attributed to fuel consumption by privately owned vehicles and to consumption of fuel oil for heating. Although greenhouse gas emissions from vehicle use by households increased from 2003 to 2004, there was a decrease in CO_2 emissions from heating, resulting in an overall decrease in greenhouse gas emissions from households.

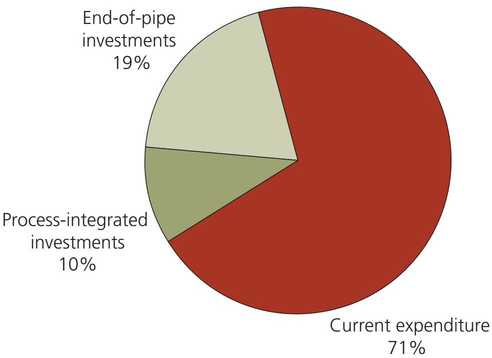
14.2. Environmental protection expenditure in manufacturing industries and mining and quarrying

Manufacturing industries and mining and quarrying excluding the oil and gas industry

A survey of environmental protection expenditure in manufacturing industries and mining and quarrying was carried out in 2003. This survey was linked to the annual industrial statistics, which include all companies classified in the sectors manufacturing and mining and quarrying, but excluding the oil and gas industry. In 2003, 4.7 per cent of investments and 0.4 per cent of current expenditure in the largest manufacturing and mining establishments were related to environmental protection.

- For 2003, establishments in the manufacturing, mining and quarrying industries reported about NOK 1.1 billion in environment-related current expenditure. Examples of such expenditure are wage costs for employees who work on environmental issues, environmental reporting or discharge permits, purchases of external environmental services (consultants' fees, waste management and waste water treatment services) and the operation, maintenance and repair of environmental protection equipment.

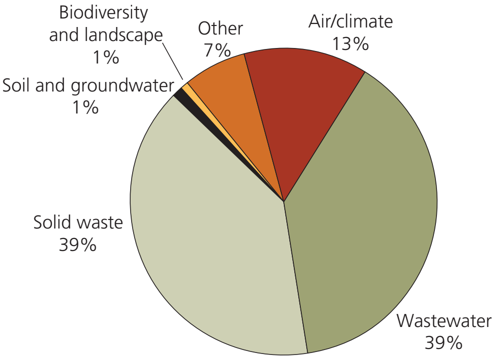
Figure 14.7. Environmental protection expenditure by type. Manufacturing industries and mining and quarrying. 2003. Per cent



[1] The establishments in the survey make up 10.9 per cent of all establishments in the two sectors, but account for about 70 per cent of their total gross investments and 62 per cent of their total current expenditure. Answers were received from 98 per cent of the establishments in the survey.
Source: Environmental protection expenditure statistics, Statistics Norway (2006a).

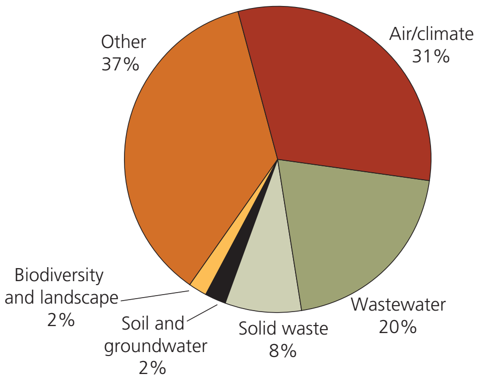
- The largest manufacturing and mining establishments invested a total of NOK 309 million in end-of-pipe equipment. This is equipment to treat, prevent, control or measure pollution. Examples of such equipment are filters, cooling systems, catalytic converters, incinerators, waste compactors, sedimentation tanks and noise barriers.
- In addition, the largest establishments reported that they had invested NOK 165 million in process-integrated technologies, i.e. solutions using cleaner technology in the production process itself. Such investments included waste management and reduction equipment, including production equipment that makes better use of raw materials and equipment for recycling cooling water. Investments of this kind generally improve the efficiency of production and have environmentally beneficial effects at the same time.

Figure 14.8. Current costs for environmental protection, by domain. 2003. Manufacturing industries and mining and quarrying. Per cent



Source: Environmental protection expenditure statistics, Statistics Norway (2006a).

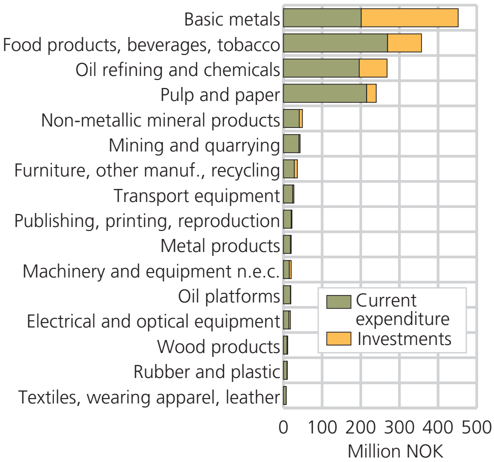
Figure 14.9. Investments in environmental protection, by domain. Manufacturing industries and mining and quarrying. 2003. Per cent



Source: Environmental protection expenditure statistics, Statistics Norway (2006a).

- The largest share of total environmental protection expenditure in 2003 was in the waste water domain, but waste and air/climate were also major sectors (see Appendix, table J1). In all, 83 per cent of environmental protection expenditure in the largest establishments was in these three environmental domains.
- For environment-related current expenditure, the largest categories were the domains waste water and waste. In all, 78 per cent of reported expenditure was in these two domains.
- Activities related to air/climate accounted for the highest share of investments that could be related to a single purpose. One reason why the category "other" was largest may be that one investment may have effects in several environmental domains. This can make it difficult to split the investments between domains.
- The figures show that Norwegian establishments invest more in end-of-pipe equipment than in process-integrated technologies. Of the reported investments, 65 per cent were for end-of-pipe equipment and 35 per cent for process-integrated technologies. However, end-of-pipe investments are easier for firms to identify and quantify, and the actual figures for process-integrated investments may be higher than reported.
- Of investments in end-of-pipe technology, 53 per cent were in the category “other”. The second largest environmental domain for investments of this type was waste water (19 per cent), just ahead of air/climate (16 per cent).
- The domain air/climate accounted for a high proportion of investments in process-integrated technologies (61 per cent). This is because such investments often result in energy savings, which in turn will help to reduce emissions. The domain waste water had the next largest share of such investments (23 per cent).

Figure 14.10. Investments and current expenditure for environmental protection in large establishments, by industry. 2003. NOK million



Source: Environmental protection expenditure statistics, Statistics Norway (2006a).

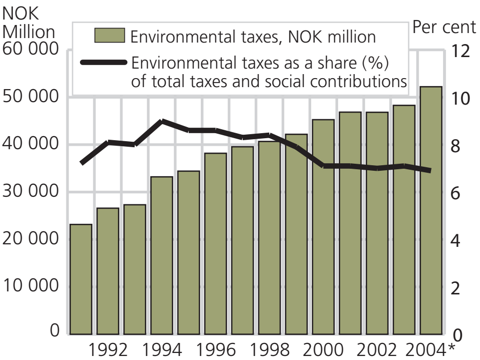
- Environmental protection expenditure is particularly high in four industries: basic metals; food products, beverages and tobacco; oil refining and chemicals; and pulp and paper. Expenditure exceeded NOK 200 million in each of these industries, and their total environmental protection expenditure was NOK 1.3 billion in 2003. This was 83 per cent of all reported environmental protection expenditure.
- Investments were highest in the basic metals industry. This industry accounted for more than 50 per cent of total environmental protection investments.
- The proportion of gross investments used for environmental protection was particularly high in two sectors: "manufacture of pulp, paper and paper products" where such investments accounted for 39 per cent of the total, and "recycling" (38 per cent). In other industries, this type of investment makes up 1 to 7 per cent of total gross investments.

14.3. Environmental taxes

Environmental taxes are calculated on the basis of figures from the national accounts. Statistics Norway uses the Eurostat definition of an environmental tax (Eurostat 2001): "*A tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment*".

In other words, it is what is being taxed and not the explicit motivation for the tax that determines whether or not a tax is considered to be an environmental tax. This means that even if the main purpose of a tax is something else than environmental protection, it may still be classified as an environmental tax (for example, the annual vehicle road tax).

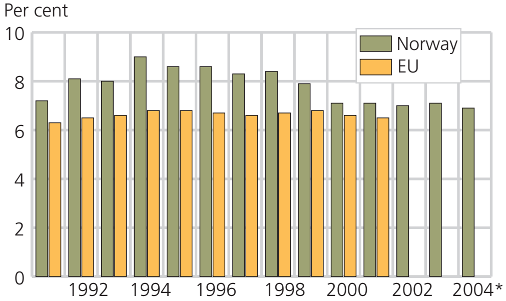
Figure 14.11. Total environmental taxes and environmental taxes as a proportion of total taxes. 1991-2004*. NOK million and per cent



[1] Tax revenues include production taxes, income and property taxes, national insurance contributions and capital income.
Source: National Accounts and Environment Statistics, Statistics Norway (2005).

- The proportion of tax revenues arising from environmental taxes has been decreasing in recent years, despite a steady increase in the revenue from such taxes since 1991.
- In 2004, revenues from environmental taxes amounted to NOK 52 billion and accounted for 6.9 per cent of total tax revenues, approximately the same level as in 1991. In 1994, the proportion of environmental taxes reached 9 per cent, which was the highest level in this period. In 1996, the Green Tax Commission presented its proposals for changing the tax system to encourage environmentally sound behaviour by consumers and businesses (Official Norwegian Report 1996:9). However, after this there was a gradual decrease in the proportion of revenues from environmental taxes. The proportion has remained stable at around 7 per cent for the past few years.

Figure 14.12. Environmental taxes as a proportion of total taxes. Norway and the EU 15. 1991-2004. Per cent



Source: National Accounts and Environment Statistics, Statistics Norway (2005).

Proportion of environmental taxes no longer higher than in the EU

- A comparison of Norway and the EU15 in the period 1991-2001 shows that the proportion of environmental taxes in Norway was well above the EU15 average for most of the period. However, in 2000 and 2001 the difference was only 0.5 per cent. The EU15 average remained around 6 and 7 per cent throughout the period. In Norway, on the other hand, the figure dropped to 7 per cent at the end of the period, from 9 per cent in 1994.

Energy and transport taxes most important

Environmental taxes may be divided into four main categories: energy, transport, pollution and resource taxes.

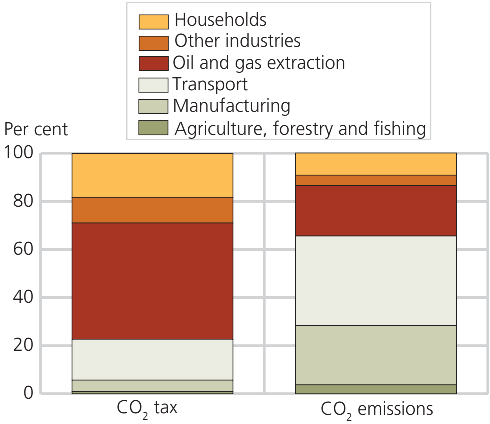
- *Energy and transport taxes* are the most important environmental taxes in terms of revenue. In 2004, each of these two tax categories accounted for almost 49 per cent of total environmental taxes. Since 1991, the proportion of energy taxes has fallen (from 63 to 49 per cent), while at the same time the proportion of transport taxes has increased (from 36 to 49 per cent). Energy taxes include taxes on energy products used for transport and stationary purposes. Transport taxes include taxes on ownership and use of motor vehicles, transport equipment and related transport services.
- *Pollution taxes* accounted for almost 3 per cent of total environmental tax revenues, and thus only play a marginal role in terms of total tax revenues. However, these taxes can be an important tool in efforts to reduce environmental impacts (for example environment-related taxes in agriculture and the tax on beverage containers). Pollution taxes include taxes on measured or estimated emissions to air and water, solid waste treatment and noise.
- *Resource taxes* include taxes on natural resources. Taxes on the extraction of minerals, oil and natural gas, whose purpose is to collect resource rents, are excluded here. Using this definition, there are currently no resource taxes in Norway.

Does the polluter pay?

The Green Tax Commission was appointed to examine how economic instruments could be used to steer the economy in a more environmentally friendly direction. The Commission proposed changes in the taxation system to reduce the tax burden on labour and increase taxes on environmentally harmful consumption. This was to be done without changing the total tax burden. It was also established that the polluter-pays principle should apply.

However, various types of exemptions and refund schemes mean that it is not always the polluter who pays most. The most striking example is manufacturing, which accounts for 50 per cent of energy use in the Nordic countries, but only pays about 5 per cent of the energy taxes. Households, on the other hand, account for about 20 per cent of energy use, but pay 50 per cent of the energy taxes.

Figure 14.13. CO_2 tax and CO_2 emissions, by sectors. 2001. Per cent

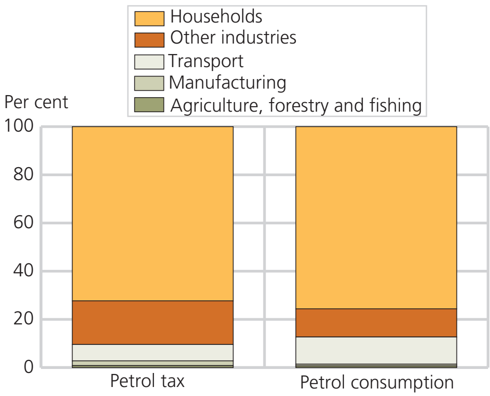


Source: National Accounts and Environment Statistics, Statistics Norway.

CO_2 tax

- There are wide disparities between CO_2 emissions from different sectors and the proportion of the CO_2 tax they pay.
- The oil and gas extraction industry pays a large proportion of the CO_2 tax (48 per cent), but accounts for a much smaller share of the emissions (21 per cent). The manufacturing industry pays a relatively small proportion of the CO_2 tax, but accounts for a larger proportion of the emissions than oil and gas extraction. However, it should be noted that although the oil and gas extraction industry pays CO_2 tax at a higher rate, it also enjoys a higher percentage tax rebate under the petroleum tax regime than does land-based industry.
- The transport industry accounted for 37 per cent of total emissions in 2001, but paid only 17 per cent of the CO_2 tax.

Figure 14.14. Petrol tax and petrol consumption, by sectors. 2001. Per cent



Source: National Accounts and Environment Statistics, Statistics Norway (2005).

Petrol tax

- An analysis of petrol consumption and petrol tax payments show that the polluter-pays principle is being applied to a much larger extent for this tax. This is mainly because there are few exemptions and refund mechanisms for petrol.
- Households account for the largest proportion, over 70 per cent, of both petrol consumption and petrol tax payments.

More information: Julie L. Hass (julie.hass@ssb.no), Kristine E. Kolshus (kristine.kolshus@ssb.no) and Marit Sand (marit.sand@ssb.no).

Useful websites

Statistics Norway - Environmental economics and indicators:
http://www.ssb.no/english/subjects/01/06/
Statistics Norway: National accounts and environment:
http://www.ssb.no/english/subjects/09/01/nrmiljo_en/
Statistics Norway - http://www.ssb.no/english/magazine/

References

Eurostat (2001): Environmental taxes - A statistical guide. Methods and nomenclatures, Theme 2 - Economy and Finance, Eurostat.

Official Norwegian Report (1996:9): Grønne skatter - en politikk for bedre miljø og høy sysselsetting (Green taxes - a policy for a better environment and high employment). Ministry of Finance.

Statistics Norway (2005): Environmental taxes in Norway 1991-2004. Magazine, 17 November 2005. http://www.ssb.no/english/magazine/art-2005-11-17-01-en.html

Statistics Norway (2006a): Environmental protection expenditures in manufacturing, mining and quarrying industries, 2003. NOK 1.6 billion spent on environmental protection. Dagens statistikk (Today's statistics), 11 June 2006.
http://www.ssb.no/english/subjects/01/06/20/miljokostind_en/

Statistics Norway (2006b): National Accounts and Environment, 1990-2004. Economy grew again more than air emissions. Dagens statistikk (Today's statistics), 22 August 2006. http://www.ssb.no/english/subjects/09/01/nrmiljo_en/

Other literature

Bruvoll, A. and T. Fæhn (2005): Økonomisk vekst - medisin mot dårlig miljø? (Economic growth – does it improve the environment?), *Økonomisk Forum* No. 2, 34-43.

Bruvoll, A. and T. Fæhn (2005): Rett i hodet på naboen? Globale miljøvirkninger av norsk økonomisk vekst og miljøpolitikk (Dumping it on the neighbours? Global environmental impacts of Norway's economic growth and environmental policy). Økonomiske analyser (*Economic analyses)* 2/2005. Statistics Norway.

Greaker, M., P. Løkkevik and M. Aasgaard Walle (2005): Utviklingen i den norske nasjonalformuen fra 1985 til 2004. Et eksempel på bærekraftig utvikling? (Norway's national wealth 1985-2004. An example of sustainable development?) Reports 05/13, Statistics Norway.

Part 5
Environmental economic analyses

15. Analyses of selected resource and environmental issues

The relationship between economic activity and environmental impacts is an important area of research for Statistics Norway. There is an extensive body of knowledge on the Norwegian and international economy, which is a good starting point for generating knowledge about the environmental impacts of economic activity. This chapter describes some current research projects in the environmental field, focusing mainly on the links between energy and the environment.

15.1. Introduction

The issue of climate change is receiving a great deal of attention within environmental research. Research on the carbon trading market in Norway and the EU has raised the questions of whether this market has in fact brought about much in the way of emission reductions so far. One important weakness of the current emissions trading schemes is the system of allocating emission allowances free of charge, which weakens incentives to use low-carbon technologies and energy carriers. Calculations for the Norwegian Commission on Low Emissions, which submitted its report in autumn 2006, indicate that emission reductions need not involve exorbitant costs for the country as a whole. Further analyses have been carried out to calculate the difference between the CO_2 emissions associated with consumption in Norway and total emissions from Norwegian production. The difference is largely due to oil production, a large proportion of which is used in other countries.

The next section discusses the effects on emissions and abatement costs of harmonising Norwegian environmental legislation with EU environmental legislation. The Directive concerning integrated pollution prevention and control (IPPC Directive) lays down common rules for granting permits to industrial installations, on the basis of the best available techniques for each industry.

Another study examines the relationship between a firm's profitability and its environmental performance. Increased focus on corporate social responsibility, including environmental responsibility, may provide an incentive to firms to improve their environmental performance and compete with other firms in the same industry, which may boost profitability in the longer term.

Norway is an important player on the EU gas market, where the share of imports continues to increase, with Russia, Norway and Algeria as the leading export countries. One study examines the effects gas price reforms in Russia will have on gas prices in Europe and thereby on profitability for Norwegian gas exports in the future.

In recent years, the power market and electricity prices have been the focus of increasing attention, a result of wide price variations following the deregulation of the power market in the 1990s. One study examines the impact a fall in precipitation levels may have on the power market. Another study reviews the reorganisation of the Norwegian electricity taxation system in 2004. The introduction of a flat tax rate for all electricity consumers will make the taxation system more efficient, although it will also amplify the problems facing energy-intensive manufacturing. Calculations of household energy use show that energy use per household has been relatively stable at around 22 000 kWh since 1980, while electricity consumption per household has been stable at around 18 000 kWh since 1985. Electricity consumption accounted for approximately 35 per cent of energy use in 1960, compared with close to 80 per cent at the beginning of the 2000s. Developments in electricity consumption are affected by a number of factors, which have been discussed in more detail in the article on energy use in Norwegian dwellings.

15.2. The carbon trading market in Norway and the EU

Knut Einar Rosendahl

There is a large carbon trading market in Norway and the EU, which has periodically resulted in relatively high prices for CO_2. Nevertheless, it is doubtful whether the system has reduced emissions to any great extent so far. One important weakness of the system is the rules for allocating emission allowances free of charge. The allocation rules weaken incentives to use low-carbon technologies and energy carriers. The rules for the Kyoto commitment period 2008-2012 are currently being drawn up.

In 2005, both Norway and the EU introduced CO_2 emissions trading schemes. Emissions trading is seen as an important instrument in efforts to reduce greenhouse gas emissions and achieve the goals of the Kyoto Protocol. The first trading period for these schemes lasts until the end of 2007, and there will be some changes in their scope and rules for the Kyoto commitment period 2008-2012. Companies within the EU can trade emission allowances with each other, and so can companies in Norway. Norwegian companies can also buy allowances issued in the EU, but the reverse does not apply at present. Each company must ensure that it has emission allowances that (at least) cover the emissions it generates during the trading period.

In the EU, the emissions trading scheme covers 45 per cent of total CO_2 emissions. The power and heat generation industry is the most important sector covered by the scheme. In addition, it includes certain energy-intensive industrial sectors, but not large emitters such as the aluminium industry and the chemical industry. Other sectors of the economy are also outside its scope at present. Norway's emissions trading scheme currently only covers just over 10 per cent of the country's total greenhouse gas emissions. This is because Norway decided to include the same sectors as the EU, with the exception of emission sources that are subject to the CO_2 tax (e.g. the petroleum sector). Since Norway's power generation is largely CO_2-free, the scope of the Norwegian scheme is limited in this period.

Even though the first period of emissions trading has been referred to as a pilot phase in the EU, it has involved large financial transactions (more than EUR 5 billion in 2005 according to Hasselknippe 2006). The price of emission allowances has varied considerably, and dropped suddenly from EUR 30 to EUR 10 per tonne CO_2 in just a few days at the end of April 2006. This was because reported emissions in 2005 from the installations participating in the scheme were lower than expected, and 3-4 per cent below the total quantity of allowances allocated for the year. Thus, demand for allowances was lower than expected, and the price dropped dramatically. Since then, there has been some variation in the prices of allowances, but they have generally been much higher than expected before the scheme was introduced. One reason for this is that many companies have not sold their surplus allowances, partly because they can be used until the end of 2007. In addition, the emissions trading market is still very immature, and many of the companies involved are not used to trading on markets of this type.

The rules for allocating emission allowances are an important element of the emissions trading system in both Norway and the EU. Economic research has shown that auctioning allowances is preferable to allocating them free of charge, both because auctioning generates public revenue and because allocation free of charge is liable to distort incentives for emissions reductions (see for example Goulder et al. 1999). Nevertheless, the authorities both in Norway and in the EU countries have decided to allocate almost all emission allowances free of charge to the companies that are covered by the emission trading schemes. The EU Commission has decided that a maximum of 5 per cent of the allowances may be auctioned in the current trading period, and most countries, including Norway, have chosen to allocate all allowances free of charge. For the Kyoto commitment period, the EU has decided that up to 10 per cent of the allowances may be auctioned. There is some resistance to auctioning because of the fear that it will weaken the competitiveness of European industry. Free allocation involves a much smaller rise in costs for the companies involved. The problem is that it is difficult to devise a system that both safeguards the competitiveness of emission-intensive sectors and regulates emissions cost-effectively.

The rules for allocating allowances vary from country to country and from sector to sector, and are different for existing and new installations. Existing installations are generally allocated allowances free of charge on the basis of their emissions a few years ago (the base years for Norway are 1998-2001). In some countries, including Norway, the number of allowances allocated is adjusted if there have been substantial changes in the scale of operations since then. One of the problems involved in allocating allowances free of charge on the basis of historical emissions data is that in many cases, it is difficult to determine emission figures for the base years. This applies particularly to smaller companies and companies in the new EU member states. It is clearly in a company's interest to exaggerate the scale of its historical emissions in order to be granted more allowances free of charge. In addition, the authorities in the individual EU countries have not had any strong motive to limit the total number of allowances, since the Kyoto commitments do not apply before 2008. This is probably an important reason why the surplus of allowances was so large in 2005. The surplus was particularly large in manufacturing industries.

New installations, i.e. those that did not generate emissions before 2002, are also allocated allowances free of charge. The number of allowances allocated is based mainly on planned production combined with an emission factor determined by the authorities. The emission factor will depend on the goods that are to be produced and the production technologies that are available. If technologies exist that make it possible to produce the goods with low levels of emissions, the emission factor used should in principle be low.

One important example here is electricity. Some countries (for example Denmark) have chosen to use the same emission factors for different technologies, so that coal- and gas-fired power plants are allocated the same number of allowances per unit of power generated. Other countries (for example Germany) have set different emission factors, so that coal-fired power plants are allocated more emission allowances than gas-fired power plants, because the "cleanest" technology for coal-fired power plants generates larger emissions than the corresponding technology for gas-fired power plants. Thus, coal-based and gas-based power are treated as different products, even though they are really identical. One result is that conditions are more favourable for building coal-fired power plants in Germany than in Denmark, because a plant in Germany will be granted more allowances. It should also be noted that power plants that do not generate CO_2 emissions (for example wind farms) are not allocated allowances free of charge in any of the countries involved. Although this is in accordance with the system as a whole, it means that free allocation offers less incentive to invest in CO_2-free power generation than auctioning of allowances, which means that no power plants receive allowances free of charge.

The carbon trading market naturally influences the power market in Europe, since power plants that use fossil fuel must have emission allowances corresponding to their emissions. However, it is difficult to determine the extent to which the price of emission allowances has influenced electricity prices in Europe, partly because of the rules for allocating allowances. A new coal- or gas-fired power plant is allocated a large quantity of allowances free of charge, so that only a small rise in the price of electricity is needed to make investment in such plants profitable, even given the current price of allowances. According to ECN (2006), the high price of electricity in Northern Europe in autumn 2005 was a result of high fuel costs and market power, while the effect of the price of allowances was more uncertain. Electricity prices in Norway are influenced by a number of other factors as well, including transmission capacity to the continent (cf. Bye and Rosendahl 2005).

The current rules for allocating allowances mean that reductions in CO_2 emissions are not very cost-effective. Companies can to some extent influence how many free allowances they receive through investments and the level of activity, thus violating one of the basic premises for cost-effective reduction of emissions. Auctioning a larger proportion of the allowances might help to rectify this. Better harmonisation between countries would also be an advantage, as would greater predictability as regards the rules that will apply in the future.

It is difficult to evaluate how much the emission trading system has helped to reduce CO_2 emissions in Europe so far. Most experts consider that it has played rather modest role, despite the relatively high prices for allowances. The EU Commission has understood that the rules must be stricter for the second trading period (2008-2012). Individual countries will also have incentives to be more restrictive in this period, since all of them have binding obligations under the Kyoto Protocol to limit their aggregate greenhouse gas emissions. Thus, if the authorities in an EU country (or Norway) allocate large quantities of free allowances to their installations, others will have to pay the costs. This means either that others responsible for domestic emissions (especially households) must pay, or the authorities must buy emission allowances on the international carbon market.

email: ker@ssb.no

References

Bye, T. and K.E. Rosendahl (2005): Betyr egentlig kvotemarkedet noe for kraftprisen? (*Does emissions trading have any real influence on electricity prices?*) *Økonomiske analyser* (Economic Analyses) 5/2005, 3-13, Statistics Norway.
http://www.ssb.no/emner/08/05/10/oa/200505/rosendahl.pdf

ECN (2006): *CO_2 price dynamics: A follow-up analysis of the implications of EU emissions trading for the price of electricity*, ECN-06-015, March 2006, Energy Research Center of the Netherlands (ECN).

Goulder, L.H., I.W.H. Parry, R.C. Williams and D. Burtraw (1999): The cost-effectiveness of alter-native instruments for environmental protection in a second-best setting, *Journal of Public Economics* **72**, 329–360.

Hasselknippe, H. (2006): The Role of the Carbon Market in Future Climate Policy, *Intereconomics. Review of European Economic Policy* **41** (2), 74-77.

15.3. Reduction of greenhouse gas emissions in Norway - calculations for the Low Emission Commission

Turid Åvitsland

Statistics Norway has calculated the macroeconomic effects and effects on industry structure of a policy package drawn up by the Low Emission Commission. Comparison with the baseline scenario showed small effects on gross domestic product (GDP), household consumption and gross real investments. There were larger effects on industry structure. As a result of the introduction of new, cleaner technology required by the policy package, greenhouse gas emissions were calculated at 20 million tonnes CO_2 equivalents in 2050 in the low-emission scenario, as compared with 67 million tonnes in the baseline scenario.

The Low Emission Commission delivered its report on a "climate-friendly Norway" (NOU 2006:18) in October 2006. It was asked to review how Norway could cut its greenhouse gas emissions by 50 to 80 per cent by 2050 relative to its Kyoto commitment level of 50.3 million tonnes CO_2 equivalents. In other words, the Commission was asked to review ways of reducing Norway's greenhouse gas emissions to somewhere between 25 and 10 million tonnes CO_2 equivalents in 2050. The Commission was asked to focus on emissions from Norwegian territory, and assumed that other countries do not implement any new environmental policy instruments. It chiefly considered emission reductions that can be achieved by developing and using new technology.

The Commission drew up a specific policy package and asked Statistics Norway to calculate its macroeconomic effects and the reductions in emissions it would bring about. The policy package consists of 14 measures, together with assumptions on costs, productivity increases and emission reductions, see table 15.1. The assumptions are mainly based on estimates from the Institute for Energy Technology (2006). Another important assumption made by the Commission is that there will be long phase-in periods for the measures in the package (2006 to 2050) so that nobody has to replace capital equipment (buildings, installations, machinery and means of transport) before it has depreciated completely (is worn out). Statistics Norway's calculations were strongly influenced by the Commission's assumptions. It was not part of the project to evaluate how realistic these assumptions were. Thus, Statistics Norway's calculations do not answer the question of how much it will cost to cut Norway's greenhouse gas emissions by 50 to 80 per cent by 2050. They give an indication of the macroeconomic effects of the policy package on the Norwegian economy and its effects on emissions. Further details of the calculations will be found in Åvitsland 2006.

In the macroeconomic model used (MSG-6), GDP growth is mainly determined by growth in the labour supply (exogenous in this case), the growth in capital and the growth in factor productivity (exogenous).

The Commission's assumptions on costs, productivity increases and emission reductions represent the direct effects of introducing new and cleaner technology. In the calculations by Statistics Norway, the costs of the measures, which have a negative effect on GDP, and the productivity increases, which have a positive effect on GDP, are weighed against each other. In addition, the calculations can indicate what effects the measures will have on industry structure and the composition of household consumption. For example, a rise in costs in a pollution-intensive industry will result in a shift of production and employment to other industries. Similarly, increased productivity in an industry will give lower costs and result in a shift of production and employment towards this industry.

Three of the measures stand out because they involve productivity increases that will result in a rise in GDP: these are increased energy efficiency in residential buildings and in non-residential buildings, and increased efficiency of transport. With these measures, less energy is needed to provide heating, run electrical equipment and provide lighting in residential buildings, less energy is needed to heat non-residential buildings, and less transport oil and petrol is needed to transport the same volume of goods and the same number of people as before. Productivity therefore increases for both residential and non-residential buildings. Two measures, increased efficiency of transport and CO_2-neutral heating, stand out because the costs are assumed to be zero.

To provide a basis for comparison with the Commission's policy package, a baseline scenario was simulated for the period 1999-2050, largely based on Ministry of Finance (2004). One important assumption the Commission made in the baseline scenario was that the growth rate in energy-intensive manufacturing (manufacture of pulp and paper, industrial chemicals and metals) will be lower than in other industries. The reasoning behind this was that the favourable energy contracts for these industries will come to an end in the next few years, and no new support measures have been announced. As a result, greenhouse gas emissions in 2050 in the baseline scenario are lower than would have been the case with stronger growth in these industries. Restructuring costs associated with the closure of enterprises are not taken into account in the calculations.

Next, a low-emission scenario was simulated up to 2050, including phase-in of the 14 policy measures. The assumed costs were largely implemented by reducing the productivity of real capital. This means that more real capital is needed per unit produced. An important exception was made for the costs associated with low-emission vehicles and the changeover to biofuels, which were implemented by increasing the import price of cars. The assumptions on productivity increases and emission reductions were implemented by increasing productivity indices and reducing emission coefficients.

The model used was not very suitable for some of the measures in the policy package, particularly CO_2-neutral heating, low-emission vehicles and changeover to biofuels. For these measures, the emission reductions should be brought about by a changeover from fuel oils to biofuels, from transport oils to gas, and from petrol or diesel to electricity and biofuels, respectively. This was not possible, since biofuels, gas-powered ships, hybrid cars and electric cars are not used as variables in the model. Instead, the emission coefficients for fuel oils, petrol, diesel and transport oils were reduced. These limitations of the model

Table 15.1. Measures in the policy package drawn up by the Low Emission Commission, and assumptions on costs, productivity increases, emission reductions and phase-in

Policy measure	Annual marginal cost in NOK/tCO_2 equivalents or NOK/kWh, in 2004 prices	Productivity increase in 2050	Emission reduction in 2050, in $mtCO_2$ equivalents	Timetable for phase-in. Emission reduction ($mtCO_2eq$) compared with baseline scenario unless otherwise specified		
				2020	2035	2050
1. Capture and storage of CO_2 from gas-fired power plants	0.12 NOK/kWh		Capture rate 85%	Fully implemented from first year of production		
2. Construction of wind power plants and small-scale hydropower plants	0.30 NOK/kWh		Clean technology capacity ca. 21 TWh	6.8 TWh	12.6 TWh	21. 3 TWh
3. Electrification of turbines on the continental shelf	Use of 8 TWh electricity in 2050		3.1 $mtCO_2$ eq.	Steady phase-in		
4. Capture and storage of CO_2 from the process industry	270 NOK/tCO_2 eq.		3 $mtCO_2$ eq.	Steady phase-in		
5. Changes in production processes in the process industry	270 NOK/tCO_2 eq.		2 $mtCO_2$ eq.	Steady phase-in		
6. CO_2-neutral heating (biofuel) for industry and households	0 NOK/tCO_2 eq.		3.1 $mtCO_2$ eq.	0.8	2.3	3.1
7. Increased energy efficiency in residential buildings	0.03 NOK/kWh (electricity only, not fuels)	Energy use 30% lower than in baseline scenario in 2050		Steady phase-in		
8. Increased energy efficiency in non-residential buildings	0.03 NOK/kWh (electricity only, not fuels)	Energy use 15-20% lower than in baseline scenario in 2050		Steady phase-in		
9. Low-emission vehicles (hybrid cars and electric cars)	504 NOK/tCO_2 eq.		8 $mtCO_2$ eq.	2	7	8
10. Changeover to biofuels	353 NOK/tCO_2 eq.		5 $mtCO_2$ eq.	1	4	5
11. Increased efficiency of transport	0 NOK/tCO_2 eq.	Consumption of transport oils 5% lower than in baseline scenario in 2050		Steady phase-in		
12. Low-emission vessels (gas-powered)	887 NOK/tCO_2 eq.		2 $mtCO_2$ eq.	1	1.4	2.0
13. Methane recovery from manure pits	50 NOK/tCO_2 eq.		1 $mtCO_2$ eq.	Steady phase-in		
14. Methane recovery from landfills	9 NOK/tCO_2 eq.		0.7 $mtCO_2$ eq.	Steady phase-in		

Source: Low Emission Commission.

will affect the results as regards industry structure, composition of household consumption and effects on GDP and household consumption to some extent. For example, if it is assumed that biofuels are produced in Norway, industry structure will be affected: if, on the other hand, they are imported, the imports will have to be financed by higher exports or lower imports of other goods. Such effects were not taken into account in the simulation.

In the model, increased energy efficiency in residential buildings is only linked to electricity use, not to the use of other fuels). This measure was implemented in a very simplified way in the model, by assuming that less energy measured in physical units is needed to give the same electricity consumption as before measured in fixed prices. As a result, fewer resources are needed in the production of gas power, and the surplus can be used in the production of other goods and services, allowing for higher household consumption.

The Commission's policy package was found to have effects in every year in the period considered. The discussion below focuses on the long-term effects, i.e. in 2050, when all the measures have been phased in fully. In the low-emission scenario, GDP is 0.1 per cent higher in 2050 than in the baseline scenario, measured in fixed 1999 prices. This is explained by the effects of increased energy efficiency in residential and in non-residential buildings and increased efficiency of transport. The positive effects of these measures on GDP outweigh the negative effects of the costs found using the assumptions made by the Commission. If the effect on GDP is calculated without the three measures that give productivity increases, GDP is found to be 0.2 per cent lower in 2050 than in the baseline scenario. These are only small differences.

Higher GDP is largely used for higher gross real investments (higher investments in buildings, installations, machinery and means of transport), which are 0.6 per cent higher in 2050 than in the baseline scenario. In addition, imports are 0.2 per cent lower and exports 0.1 per cent higher in 2050. Household consumption is 0.1 per cent lower. However, if the three measures that give productivity increases are excluded, household consumption is 0.7 per cent lower in 2050 than in the baseline scenario.

The low-emission scenario gives markedly lower gross production in the process industry (defined here as manufacturing of pulp and paper, industrial chemicals, metals, and chemical and mineral products), including oil refining, and in electricity production. For the process industry (including oil refining), lower production (-2.2 per cent) is explained by higher costs as a result of the measures CO_2 capture from the process industry and changes in production processes, and in addition by pay rises. Within the process industry, the largest deviations in production from the baseline scenario are found for manufacturing of industrial chemicals (-7.4 per cent) and metals (-5.7 per cent) and oil refining (-3.2 per cent). Electricity production is 19.2 per cent lower than in the baseline scenario, because the increase in costs associated with CO_2 capture from gas-fired power plants means that gas power production is not profitable in the low-emission scenario. The low-emission scenario includes foreign trade in electricity, and the world market price of electricity is assumed to be approximately equal to the long run marginal costs of Norwegian production of gas power without CO_2 capture. This is a reasonable assumption since the Commission assumed that other countries do not implement any new environmental policy measures.

Demand for electricity is lower in the low-emission scenario as a result of increased energy efficiency in residential and non-residential buildings. However, in 2050 lower demand does not compensate for lower electricity production, and 7.5 TWh of electricity is imported, as compared with 1.5 TWh in the baseline scenario. If the three measures that result in productivity increases are excluded, imports of electricity rise to 45.2 TWh in 2050. However, it should be noted that demand for electricity is underestimated in the model since it was not possible to implement electricity use in cars (for low-emission vehicles).

The largest positive deviations in gross production from the baseline scenario are for road transport (+0.5 per cent) and air transport (+1.1 per cent). Costs in these industries are reduced by increases in productivity. For road transport, this means that lower costs from the two types of productivity increases are not counterbalanced by higher costs resulting from higher import prices for cars, which are caused by the introduction of low-emission vehicles and the changeover to biofuels. In addition, higher import prices for cars increase household demand for road and air transport services, and reduce demand for private cars. A breakdown of household consumption shows a clear reduction in purchases of cars and consumption of petrol and oils and car maintenance services.

In the baseline scenario, total greenhouse gas emissions rise from 53.6 million tonnes CO_2 equivalents in 1999 to 66.9 million tonnes CO_2 equivalents in 2050. In the low-emission scenario, on the other hand, there is a reduction in greenhouse gas emissions, and in the long run (i.e. in 2050) the package of measures results in a reduction to 20 million tonnes CO_2 equivalents. This is 60.2 per cent below Norway's Kyoto commitment of 50.3 million tonnes CO_2 equivalents.

All in all, the effects of the measures in the low-emission scenario on GDP, household consumption and gross real investments are small. The effects on industry structure are larger.

email: tud@ssb.no

References

Ministry of Finance (2004): Report No. 8 (2004-2005) to the Storting. Perspektivmeldingen 2004 - utfordringer og valgmuligheter for norsk økonomi. (Long-term perspectives for the Norwegian economy).

Institutt for energiteknikk (2006): Reduserte klimagassutslipp: teknologiske kiler - innspill til Lavutslippsutvalget (Reducing greenhouse gas emissions: technological measures. Report to the Low Emission Commission), report IFE/KR/F-2006/045.

NOU (2006:18): Et klimavennlig Norge (A climate-friendly Norway), Official Norwegian Report, Ministry of the Environment.
http://www.odin.dep.no/filarkiv/291723/NOU018_06-TS.pdf

Åvitsland, T. (2006): Reductions in greenhouse gas emissions in Norway - calculations for the Low Emission Commission, Reports 2006/44, Statistics Norway.

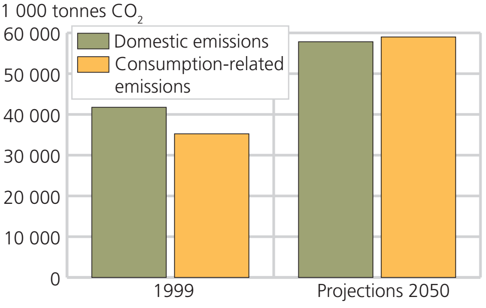
15.4. Norwegian CO_2 emissions and consumer responsibility

Annegrete Bruvoll

There can be a large difference between the emissions actually generated within a country's borders and the emissions associated with total consumption by its population. This section looks at the relationship between these two figures for Norway and how it may change. At the turn of the century, CO_2 emissions associated with consumption in Norway were lower than Norway's total emissions. This is mainly because oil production and energy-intensive manufacturing generate large emissions, while their products are to a large extent exported for consumption in other countries. The difference between the two figures is expected to become smaller because of lower oil extraction and downscaling of the process industry. Introduction of the measures proposed by the Low Emission Commission would reverse this trend: since the measures are assumed to be unilateral, emissions in Norway would be reduced more than those embodied in exports. If measures were also introduced in other countries, the difference between domestic and consumption-related emissions would become smaller.

With the growing internationalisation of environmental policy, the question of who is responsible for greenhouse gas emissions has come into focus. Is it the countries that produce goods and services that are responsible for generating emissions, or the countries that consume these goods and services? In traditional emission inventories, such as those used as a basis for commitments under the Kyoto Protocol, domestic emissions are calculated, i.e. those related to production and consumption within a country's boundaries. Calculations of consumption-related emissions are used to illustrate the large differences there can be between countries in consumption and in the pressure their consumption puts on the global environment, either directly through consumption of their own products, or indirectly through consumption of goods produced in other countries. Thus, calculating Norway's consumption-related emissions takes into account emissions in other countries embodied in goods imported to and consumed in Norway. When consumption-related emissions are calculated, emissions from production for export are subtracted. In connection with implementation of the Kyoto Protocol, it has been discussed whether emission commitments should be more strongly linked to a country's consumption. For example, under the current rules, Denmark is responsible for reducing emissions from coal-fired power production even if the electricity generated is used in Norway.

Figure 15.1. Norway's domestic and consumption-related emissions in 1999 and 2050. 1 000 tonnes CO_2



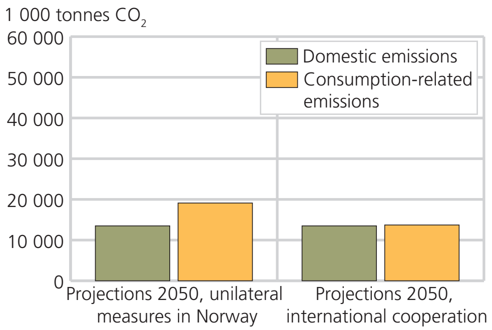
Source: Bruvoll (2006).

Figure 15.1 shows that in 1999, Norway's consumption-related emissions were lower than its domestic emissions. Thus, Norway's export-oriented production was more carbon-intensive than production of goods it imported from other countries. The petroleum sector has for many years been responsible for substantial emissions from oil production for the international market. When consumption-related emissions are calculated, a large proportion of Norway's domestic emissions from this sector is allocated to the consumption of petroleum products abroad. Similarly, parts of Norway's energy-intensive manufacturing sector are carbon-intensive and export-oriented. Up to 2050, the oil sector is expected to be substantially down-scaled, and since the Norwegian economy in general will continue to grow, the oil sector will account for a much smaller share of the total. It is also assumed that conditions will become less favourable for energy-intensive manufacturing industries as their current favourable energy contracts come to an end, so they will account for a smaller share of production and emissions. This means that the share of emissions allocated to consumption outside Norway will decrease and gradually fall below the share of emissions in other countries allocated to Norway's imports. As a result it is estimated that in 2050, Norway's consumption-related emissions will be approximately equal to domestic emissions calculated in the traditional way. In other words, Norway's foreign trade will be almost carbon-neutral, as its imports will be about as carbon-intensive as its exports.

The policy package drawn up by the Low Emission Commission will reduce domestic emissions substantially by 2050, see figure 15.2. The measures chiefly involve technological improvements and target Norwegian production and consumption, for example domestic transport. Introduction of these measures will make production in Norway cleaner. However, they are assumed to have relative small effects on costs, and will therefore have a fairly limited impact on trade and on the Norwegian economy in general. Norway will therefore import about the same quantity of goods as it would if the measures were not introduced. Since imports and exports are required to balance each other in the long run, exports will have to be roughly equal to imports. Since it was assumed that production processes in other countries would not be affected by the policy package, little change is found in the environmental impacts of consumption in Norway on other countries. Norway's consumption-related emissions are therefore found to be higher than its domestic emissions if the policy package from the Low Emission Commission is implemented.

However, it is reasonable to expect that there will be technology transfer between countries - for example, it is not likely that there will be a changeover from petrol to biofuels in Norway without similar developments in neighbouring countries. It is also reasonable to assume that other countries' views on climate change will be similar to Norway's and that they will introduce corresponding measures in the years ahead. To illustrate the possible effects of technology and policy transfer, emissions in other countries have been calculated on the assumption that they will achieve the same reductions in emission coefficients as Norway, see figure 15.2. The calculations show that this would

Figure 15.2. Norway's domestic and consumption-related emissions in 2050, assuming that the policy package from the Low Emission Commission is implemented, with and without reductions in emission coefficients for other countries. 1 000 tonnes CO_2



Source: Bruvoll (2006).

result in substantially lower emissions associated with imports to Norway in 2050. As a result, consumption-related emissions would be about the same as domestic emissions, as they were found to be in 2050 without the policy package from the Low Emission Commission.

If Norway or another country raises the costs of greenhouse gas emissions, for example by introducing a CO_2 tax, this makes it relatively more profitable to increase carbon-intensive production in other countries that do not introduce similar measures. Emissions in other countries may therefore rise, and the overall global effect of the measures introduced will be lower than indicated by the domestic emission inventory. This effect is known as carbon leakage, and has been extensively discussed internationally in connection with climate policy measures. The policy package from the Low Emission Commission could perhaps result in carbon leakage. However, since the Commission assumes that it will not involve any significant rise in costs, the level of carbon leakage will also be low. The global emission reductions are similar to those estimated for Norway.

In general, calculations of consumption-related emissions are of interest because they highlight the differences between the environmental impacts attributable to consumers in rich and poor countries, and the fact that international trade can have greater impacts in countries that do not have satisfactory equipment to control emissions. However, it would be much more complicated to base international climate agreements on consumption-related emissions than on domestic emissions. Their calculation requires detailed allocation of emissions to exports and domestic consumption at all stages of the production chain, and a detailed trade matrix that makes it possible to link imports and exports to the technology in use in different countries. The modelling results presented here are much more simplified. Nor is it necessarily the case that consumers alone should take the moral responsibility for emissions. They enjoy the benefits of consumption, but producers enjoy the profits of sales of emission-intensive products.

If cost-effective instruments are introduced across countries, for example equal climate-related taxes or tradable emission allowances, it will not matter which accounting method is chosen. A shift in technology will be carried out at the lowest possible cost, and the costs of emissions will partly be transferred to product prices, and will be paid by consumers in different countries. This means that the desired outcome of focusing on consumer responsibility will be achieved: cost-effective reduction of emissions according to the polluter-pays principle.

email: agb@ssb.no

References

Bruvoll, A. (2006): Framtidige CO_2-utslepp: Stor vekst i utslepp frå forbruk (Future CO_2 emissions: rapid growth in emissions from consumption), Økonomiske analyser (Economic Analyses) 5, Statistics Norway. http://www.ssb.no/emner/08/05/10/oa/200605/bruvoll.pdf

NOU (2006:18): Et klimavennlig Norge (A climate-friendly Norway). Official Norwegian Report, Ministry of the Environment.

15.5. Harmonisation of Norwegian environmental legislation with EU legislation: consequences for emissions and abatement costs

Jan Larsson and Kjetil Telle

For a long time, economic efficiency has been an important element of Norwegian environmental policy. However, in recent years there seems to have been a shift away from economic efficiency for most pollutants. This is a result of harmonisation of Norwegian environmental legislation with EU environmental directives. In the 1996 IPPC Directive, the EU laid down common rules for granting permits for industrial installations. The conditions in permits must be determined on the basis of the best available techniques for each industry. Larsson and Telle (2006) have used data envelopment analysis to illustrate the effects of the ongoing implementation of the IPPC Directive on emissions and abatement costs.

The purpose of the 1996 Directive on Integrated Pollution Prevention and Control (IPPC Directive) is to reduce emissions from industrial installations. It requires all industrial installations to hold permits to operate. Limit values in permits must be set on the basis of best available techniques (BAT). Through the EEA Agreement, the directive also applies in Norway.

Data envelopment analysis (DEA) is a method for evaluating the efficiency of a number of units, in this case industrial installations, by using the most efficient of them to construct an efficiency frontier. Efficiency is then measured as the distance to the frontier for the other industrial installations. The hypothesis in this study was that installations at the frontier for their industry already operate in accordance with BAT, and that the Norwegian Pollution Control Authority, in accordance with the IPPC Directive, will set the same emission ceiling for all installations within the same industry. This ceiling will thus be in accordance with the input factors, including emissions, used by installations at the frontier[1]. The next step was to calculate how much installations that are not at the frontier need to reduce their emissions. To find an estimate of the costs of emission reductions, it was assumed that the installations can only reduce emissions by reducing production. In practice, companies can normally also reduce emissions by making use of opportunities for substitution or by adjusting investments to regulatory measures that are expected in the future, this method should indicate the upper limit for the costs of reducing emissions[2] . Given this assumption, the value of the loss of production can be used as an expression of the cost of reducing emissions. By assuming in addition that there is a fully flexible labour market and

1 As has been shown by Cropper and Oates (1992) environmental factors can be seen equally as outputs or inputs.

2 Norwegian legislation includes general requirements to take all appropriate measures to prevent pollution, particularly by making use of the best available techniques, and to use energy efficiently (Ministry of the Environment 2004). An emissions trading system has been introduced for greenhouse gas emissions. The price of emission allowances sets the ceiling for costs of emission reductions for CO_2, and emission reductions may also take place outside Norway.

Table 15.2. Average emission reductions in 2000 if all installations were technically efficient. Percentages of total emissions

	Total	Pulp and paper	Inorganic chemicals	Ferro alloys	Primary aluminium
Greenhouse gases	11	12	12	20	2
Acidifying substances	16	6	11	25	1

Table 15.3. Average costs of emission reductions per unit of emissions in 2000. NOK/tonne

	Total	Pulp and paper	Inorganic chemicals	Ferro alloys	Primary aluminium
Greenhouse gases	138	568	97	65	730
Acidifying substances	803	5 353	470	365	46 551

ignoring transitional costs for any workers who lose their jobs, the value of the loss of production can be used to represent the social cost of reducing emissions.

In the study, four of the most energy-intensive manufacturing industries in Norway were analysed using figures from 2000: pulp and paper, inorganic chemicals, ferro-alloys and primary aluminium. The emissions considered were greenhouse gases (aggregate figures for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), measured in 1 000 tonnes CO_2 equivalents), and acidifying substances (aggregate figures for sulphur dioxide (SO_2), nitrogen oxides (NO_x) and ammonia (NH_3), measured in tonnes acid equivalents).

The distance from a particular installation to the frontier was calculated by calculating the emission ceiling if BAT is defined as technical efficiency, i.e. both emissions and all other input factors were included in the comparison between installations[3]. Table 15.2 shows that if all installations were at the efficiency frontier, this would give considerable reductions in emissions from these industries. The overall reductions in emissions from the industries in the analysis were found to be 11 per cent for greenhouse gases and 16 per cent for acidifying substances. However, the reduction differs from one industry to another: the potential for emission reductions was highest for ferro-alloy manufacturing, but low for primary aluminium manufacturing.

Calculating the value of the reduction in production needed to achieve these emission reductions, it was found that the average cost of reducing greenhouse gas emissions was NOK 138 per tonne (see table 15.3). However, there were considerable differences between industries. The average cost for ferro-alloy manufacturing was found to be NOK 65 per tonne, whereas it was NOK 730 per tonne for primary aluminium. Even greater differences between industries were found for acidifying substances. In the case of primary aluminium, almost all the installations were found to be at the frontier, giving little potential for emission reductions. The marginal abatement costs, and thus the emission reduction costs per tonne, are high for this industry.

[3] Larsson and Telle (2006) also includes an analysis in which only emissions are considered in the comparison between installations.

Abatement costs vary not only between industries, but also between installations. For some installations, abatement costs are low, and in some cases, because they operated at a loss in 2000, it may even be profitable to reduce production. On the other hand, reducing emissions will be very costly at some installations. Implementing the use of BAT as a general principle in all installations at a specific time can result in high costs.

In the case of emissions where the location of the emission source has little bearing on the environmental damage caused (e.g. greenhouse gases), economic theory generally indicates that the permitted level of emissions should be set such that the marginal abatement costs are the same for all installations. Conditions such as the IPCC Directive's requirement to use BAT will normally mean that all installations have to meet the same emission standards regardless of the costs this involves. Thus, introducing the BAT principle is not cost-effective. The legislative history of Norway's 1981 Pollution Control Act shows that this was the main reason why it was explicitly rejected in this case (Bugge 1999; Proposition No. 11 (1979-80) to the Odelsting).

Thus, introduction of the BAT principle can result in substantial emission reductions, but also in large differences in abatement costs between installations. As the IPCC Directive is implemented, it will be interesting to see how far the Norwegian Pollution Control Authority takes account of differences between abatement costs for different installations. It will also be interesting to carry out studies to compare the effects of instruments that have traditionally been considered cost-effective (for example taxation) and variants of BAT on technological developments and thus on long-term economic growth.

email: Jan.Larsson@ssb.no and Kjetil.Telle@ssb.no

References

Bugge, H.C. (1999): *Forurensningsansvaret* (Responsibility for pollution), Oslo, Tano Aschenhoug.

Cropper, M. L and W. E. Oates, 1992. Environmental Economics: A survey. *Journal of Economic Literature,* 30, 675-740.

IPPC (1996): *European Integrated Pollution Prevention and Control Directive*, 96/61/EC.

Larsson, J. and K. Telle (2006): *EU-tilpasning av norsk miljølovgivning: Konsekvenser for utslipp og rensekostnader* (Harmonisation of Norwegian environmental legislation with EU legislation: consequences for emissions and abatement costs), Økonomisk Forum, 4, 31-37.

Ministry of the Environment (2004): Forskrift om begrensning av forurensning (Forurensningsforskriften) (Regulations relating to Pollution Control (Pollution Regulations)), FOR 2004-06-01 nr. 931.

Proposition No. 11 (1979-80) to the Odelsting: *Om lov om vern mot forurensninger og om avfall (Forurensningsloven)*. (On an Act relating to protection against pollution and to waste (Pollution Control Act)).

15.6. Environmental objectives and corporate profitability – a source of conflict or potential?

Iulie Aslaksen, Mads Greaker and Terje Synnestvedt

What is the relationship between a firm's profitability and its ability and willingness to be green? From one point of view, environmental requirements are a "necessary evil" that increases a firm's costs. Firms will only meet environmental requirements beyond what is required by law as long as they have clear financial incentives to do so. From the opposite point of view, a proactive approach to green measures can open up new opportunities. Increased focus on corporate social responsibility, including environmental responsibility, may provide an incentive to firms to improve their environmental performance and compete with other firms in the same industry. A proactive approach to environmental issues may thereby boost profitability in the longer term. In practice, the relationship between environmental objectives and profitability will hover somewhere between these two extremes.

Economics, with its emphasis on rational participants who have full access to information at all times and have exploited all the available opportunities, has traditionally been based on the first point of view. Business management literature takes more explicit account of the complexities of firms' profitability concerns and decision structures, and has given greater weight to the influence on companies' strategic decisions of a broad range of stakeholders and differing interests within the organisation. A number of economists are now building a bridge between these two points of view by asserting that the traditional perception of the relationship between ownership interests and profitability is too narrow and must be broadened to include corporate governance and social responsibility by explicitly balancing the interests of the various stakeholders, see e.g. Jean Tirole (2001) and Arild Vatn (2005).

A number of articles written by Harvard professor Michael Porter or by Porter and Claes van der Linde (1995) have questioned whether companies have the knowledge and the motivation to improve their environmental performance. According to Porter and van der Linde, all pollution is a waste of resources. In other words, all pollutants released could be used, whether as a factor input in production or as sales products in their own right. Thus, companies can become more efficient if they are "forced" to control their emissions through stringent environmental regulation. This argument is often termed the Porter hypothesis.

Previous studies

A number of studies have contributed to theoretical and empirical analyses of the relationship between corporate profitability and environmental profile, although no definitive conclusions have been reached. An overview of this literature is to be found in Aslaksen and Synnestvedt (2003) and in Telle (2006). An important incentive to be green seems to be that a proactive approach in environmental performance may reduce a firm's environmental risk, i.e. the risk of income loss as a result of more extensive environmental regulation, or the risk of a loss of reputation due to a poor environmental profile. A proactive approach to environmental performance may also produce direct results in the form of lower insurance premiums and lower capital costs. Another mechanism to link environmental goals with profitability is brand image building and product differentiation, where eco-friendliness in products or production processes is influenced by customers.

A previous survey (Telle 2006) studied the relationship between eco-friendliness and profitability in a number of Norwegian manufacturing firms. The hypothesis underlying the survey was that eco-friendliness can increase a firm's profitability. A simple analysis of the correlation between eco-friendliness and profitability showed a positive co-variation, both for the survey as a whole and when firm size and sector were taken into account. However, a study of correlation cannot give any indication of the causal relationship. Improved profitability is not necessarily caused by being green. The positive correlation may be due to better management or better technology in green companies. If we take into account that important explanatory factors may have been omitted, the positive co-variation between environmental goals and profitability is no longer significant.

The Porter hypothesis has also been examined more closely in two studies (Greaker 2003 and 2006). Both of these studies retained the assumption that firms have full access to information and have exploited all the available opportunities, and instead examined whether other factors, such as imperfect competition, may encourage a country to introduce more stringent environmental regulation than in other countries. In Greaker (2006) the study is based on a small, open economy with a pollution-intensive export sector. Research and development of new pollution abatement technology is the result of new firms starting up and offering their services to this pollution-intensive sector. How large and attractive the market for new technology in this field will be is therefore determined by environmental policy. If environmental policy is more relaxed, new firms will not start up, competition will be weak and the price of new pollution abatement technology high. Stringent environmental policy, on the other hand, results in a larger number of start-ups, strong competition and low prices for new pollution abatement technology. In this case, environmental policy should be particularly stringent, even if export firms encounter competition from firms in other countries that are not subject to particularly stringent environmental regulation. In some case, exports may increase as a result of stringent environmental regulation.

The OECD (2006) has, in collaboration with BI Norwegian School of Management, conducted a postal survey of Norwegian manufacturing firms in order to establish whether there is any relationship between environmental performance and profitability. One conclusion from this survey is that there is no substantial difference in profitability between firms that lead the field and those that trail behind in terms of environmental performance. Any differences between the two - although these are not pronounced - may be due to a number of factors: different methods of data collection, differences in analytical angle of approach, non-overlapping population, observations in the manufacturing sector survey are somewhat older. Both surveys may however indicate that there are no strong links in either direction. In a coming new survey, selected firms will be interviewed to investigate the driving forces behind and the barriers to any links between environmental goals and profitability.

Interviewing firms

In order to understand the motivation behind a firm's environmental performance, it is important to conduct surveys that use different methodological approaches. In a survey financed by the Ministry of the Environment, Statistics Norway will be conducting interviews at a number of manufacturing firms. In order to illuminate various hypotheses, firms will be chosen on the basis of several criteria: sector, size, type and scope of environmental problem, location and environmental behaviour. One hypothesis might be that firms that have a substantial impact on the environment also have a strong incentive to employ a proactive approach in order to prevent regulation. Another hypothesis is that firms that are interested in achieving "best in class" positioning within their sector, also have strong incentives to employ a proactive approach. Environmental reporting is increasingly being used as a method of communicating firms' environmental performance and relative position within their sector (Synnestvedt 1999). The survey examined to what extent firms have systematic and quantitative indicators for evaluating the pressure they put on the environment and their environmental performance, and to what extent this is an integral part of the firm's environmental reporting system.

The following main themes will be in focus in the survey:

- The firm's environmental performance, and if relevant the use of an environmental management system. The relationship between the environmental management system and general management tools. To what extent has environmental management been integrated and mainstreamed in the firm's executive management? Are environmental management systems a key element in strengthening and anchoring a firm's environmental performance? How is the effect and profitability of introducing environmental management systems quantified?
- Pressure on the environment/energy use/waste management.
- The type of environmental regulation applicable to the firm. How has the firm adapted its activities to environmental policy instruments and the uncertainty surrounding these instruments? The firm's own perception of the way the policy is formulated and the various aspects of environmental regulations? To what extent may the regulations make it more difficult for potential newcomers in the sector?
- The impact of environmental regulation on a firm's choice of product design, production methods and factor inputs.
- Measures implemented by the firm to reduce environmental impact. Obligatory and proactive.
- Challenges associated with estimating the costs and benefits of environmental measures. To what extent does the firm identify and quantify environmentally related costs and income? How environmental measures contribute to the bottom line.
- Any application of quantitative environmental indicators, releases in total and per unit of production, and in comparison with competitors in the sector.
- Environmental reporting and corporate social responsibility reporting. What is the firm's experience of environmental reporting and corporate social responsibility reporting?

- Customers, competitive conditions and competitive parameters. In order to gain a picture of the degree to which the firm's stakeholders provide environmental performance incentives, the focus will be on the customer categories and markets the firm targets, and on competitive conditions in the sector. To what extent are customers willing to pay more for products with a positive environmental profile?
- To what extent stakeholders provide incentives to improve the firm's environmental profile. What incentives and obstacles to environmental measures does the firm encounter from various stakeholders? To what extent are concrete environmental measures a result of requirements from the authorities or pressure from consumers, other customers, suppliers, organisations and the local community. To what extent are the employees interested in the firm's environmental profile? To what extent has work on environmental improvements contributed to improving cooperation across the various functions in the firm? Have activities to implement environmental improvements had a positive impact on other activities in the firm?
- Environmental profile and reputation. To what extent is there a relationship between the firm's reputation and profitability?

Conclusion

In the course of a few years, business and industry has shown a marked change in attitude with regard to the environment and, from a broader perspective, corporate social responsibility. To a great extent, the focus has moved from environmental requirements as a "necessary evil" to environmental performance as a market opportunity. The challenge for researchers and decision-makers is to acquire in-depth knowledge about relationships and motivation. The challenge for politicians is to find the right balance between different instruments. The challenge from the point of view of society is to find ways of developing the profitability perspective to include long-term profitability. It is therefore very important to acquire empirical knowledge that can elucidate this theoretical discussion.

email: iulie.aslaksen@ssb.no, mads.greaker@ssb.no, terje.synnestvedt@bi.no

References

Aslaksen, I. and T. Synnestvedt (2003): Ethical investment and the incentives for corporate environmental protection and social responsibility. *Corporate Social Responsibility and Environmental Management* **10**, 212-223.

Greaker, M. (2006): Spillovers in the Development of New, Pollution Abatement Technology: A New Look at the Porter Hypothesis, *Journal of Environmental Economics and Management* **52**, p. 411-420.

Greaker, M. (2003): Strategic Environmental Policy: Eco-dumping or a Green Strategy?, *Journal of Environmental Economics and Management* **45**, p. 692-707.

OECD (2006): *Environmental Policy Tools and Firm-level Management Practices: Does Environmental Performance Predict a Facility's Financial Performance?* Organisation for Economic Co-operation and Development.

Porter, M.E. and C. van der Linde (1995): Green and Competitive, *Harvard Business Review*, September-October.

Synnestvedt, T. (1999): Corporate Environmental Reporting. Unpublished paper, BI Norwegian School of Management.

Telle, K. (2006): "It pays to be green" - A Premature Conclusion? *Environmental & Resource Economics* (2006) **35**:195-220. Springer.

Tirole, J. (2001): Corporate Governance. *Econometrica* **69**, 1-35.

Vatn, A. (2005): *Institutions and the Environment*, Edward Elgar.

15.7. The value of Norwegian natural gas in Europe: consequences of reforms in the Russian gas industry

Marina Tsygankova and Eirik Lund Sagen

The EU gas market will in the foreseeable future be characterised by a growing share of imports, with Russia, Norway and Algeria as the leading export countries. For the EU, the discussion on the reliability of supplies from these countries, and perhaps primarily from Russia, currently Europe's largest supplier by far, will be increasingly important. Developments in the Russian gas industry stand to have a substantial impact on both prices and competitive conditions in the European gas market. A study has been conducted to examine the effects price reforms in Russia will have on the distribution between Russian exports and sales to the Russian domestic market. The results show that the level of Russian gas prices may have a decisive impact on Russia's leading gas producer, Gazprom, with regard to its export possibilities and willingness to export. This may in turn affect prices for gas in Europe and thereby the profitability of Norwegian gas exports in the future.

The current liberalisation of the European gas market through various EU directives has the clear objective of increasing competition between suppliers of gas to Europe. While Norway was previously obliged to discontinue its coordination of gas exports through its Gas Negotiation Committee, Russia, by far the largest gas supplier and Norway's most important competitor in Northern and Central Europe, is still marketing all its gas through one state-controlled agent. The Russian gas industry is one of the few sectors that have not been subject to substantial structural changes since Russia introduced its market reforms in the 1990s. Today, most of production and all of the Russian gas transport system is controlled by the state-controlled gas company Gazprom. Gazprom also has the sole right to all export of gas from Russia (Stern 2005).

In the former Soviet Union, low energy prices were considered very important to the economy. Gas prices to households, manufacturing and power production were therefore regulated to a very low level, and the state-controlled gas company had an obligation to serve the domestic market. This regulatory policy has by no means been discontinued, the price of gas in Russia is still considerably below European market prices and the obligation to serve the domestic market still exists. Recently, the risk of high inflation and social instability as a result of payment problems has perhaps been the most important argument against rapid price increases. However, low Russian gas prices, in combination with economic and political dominance by one market player, have generated a number of problems for the Russian gas industry. Investment in maintenance and upgrading of the production and transport systems has suffered, resulting in considerable uncertainty with regard to the future level of Russian gas production. In addition, low prices have given small producers with no obligation to serve the domestic market little incentive to increase production.

The need for higher gas prices and extensive structural reform of the Russian gas industry has therefore been a subject of discussion for many years. This has resulted in a government strategy to raise Russian gas prices gradually towards international levels, which may have a considerable impact on Gazprom's total export potential and its willingness to export. Since Russia is the largest supplier of gas to Europe, the aggregate level of Russian gas exports may also have an effect both on Norwegian gas prices and Norwegian market shares.

Consequences of a Russian gas price reform

A previous study (Sagen and Tsygankova 2006) modelled the situation in 2015 and examined the effect future Russian gas prices and total Russian production capacity might have on the allocation of Russian gas production between the domestic and export markets. The study showed that higher prices in the Russian domestic market improve export opportunities for Gazprom as a result of lower demand in Russia and increased supply from smaller, often privately owned producers. The level of export, however, depends on total Russian production capacity since there is always a demand in the domestic market for a certain share of total production.

The study also found that Russian gas prices will have to be raised from the current level if Russia is to achieve its export targets for 2015. If the current low price policy is maintained, Gazprom will not be able to meet its export commitments under existing long-term contracts, even if the production level is assumed to be very high.

However, if Russian gas prices are set high enough, sales to the domestic market may become more profitable than exports, if the cost of transport to Europe is deducted. This will prompt Gazprom to exploit its control over the Russian gas transport system, reduce small independent producers' access to the market and obtain larger shares of the domestic market itself. The result may be stagnation or a reduction in Russian gas exports, to which Gazprom currently holds the sole right by law. Export commitments under existing long-term contracts and Gazprom's market share in a future European market with a number of short-term contracts are important factors indicating how high Russian gas prices must be for Gazprom to give the domestic market priority on the basis of profitability. An important element here is that European gas prices are more sensitive to changes in the supply of gas when the proportion of short-term contracts in the European gas market is large. The more market influence Russia has in the European gas market, the more incentives Gazprom has to hold back its exports in order to keep export prices high. With its large share of long-term export contracts, however, Gazprom is less flexible and must honour these contracts irrespective of

Table 15.4. Valuation of Norwegian gas given different levels of Russian prices, production capacity and numbers of long-term contracts

	Low Russian capacity		High Russian capacity	
	Few long-term contract	Many long-term contract	Few long-term contract	Many long-term contractr
Low Russian prices	High	High	Medium	Medium
High Russian prices	Medium	Medium	Medium	Low

profitability in the Russian domestic market. Given the current structure of the Russian gas industry, with Gazprom as the controlling player, both the future market share and price of Norwegian gas may be directly influenced by Russian price reforms.

Table 15.4 shows how the value of one unit of Norwegian gas varies with changes in Russian production capacity, Russian gas prices and Russian export commitments under long-term contracts.

The table shows that low Russian gas prices combined with low Russian production capacity results in the highest value for Norwegian gas exports. In this case, the highest European gas prices are achieved as a result of low Russian gas exports. The lowest gas prices in Europe and thereby the lowest value of Norwegian gas results in a situation where Russian exports are high due to high Russian gas prices, high Russian production capacity and a large share of long-term export contracts.

email: martina.tsygankova@ssb.no, eirik.sagen@ssb.no

References

Sagen, E.L., and M. Tsygankova (2006): Russian Natural Gas Exports to Europe: Effects of Russian gas market reforms and the rising market power of Gazprom, Discussion Papers no. 445, Statistics Norway. http://www.ssb.no/publikasjoner/DP/pdf/dp445.pdf

Stern, J.P. (2005): The Future of Russian Gas and Gazprom, Oxford University Press for the Oxford Institute for Energy Studies.

15.8. What will happen to energy prices if precipitation levels are very low?

Torstein Bye and Annegrete Bruvoll

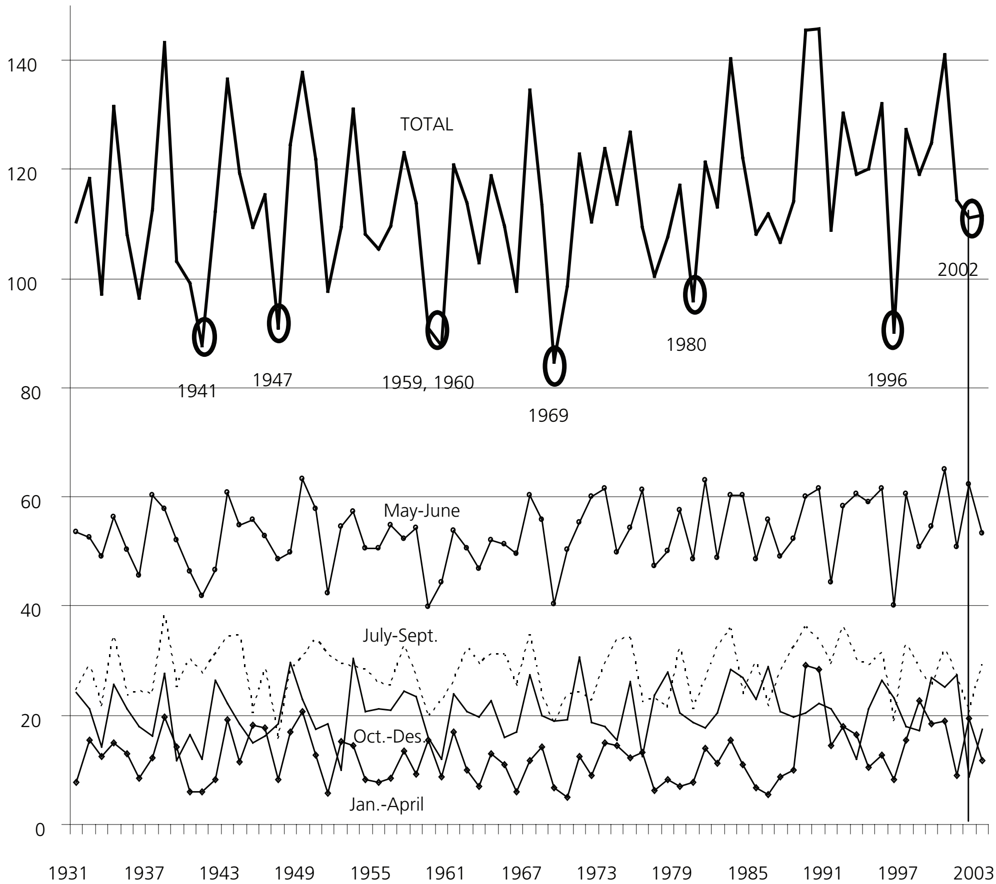
In recent years, the power market and electricity prices have been the focus of increasing attention, a result of wide price variations following the deregulation of the power market in the 1990s. Since almost all electricity production in Norway is based on hydropower, prices are strongly influenced by the weather. Precipitation levels vary widely over time and substantial price fluctuations, up and down, must be expected in the years ahead. It is, however, high prices that cause most concern and are most in focus. In the following, we discuss how low levels of precipitation, which are likely to be far lower than in autumn 2002, may affect the market.

In autumn 2002, levels of precipitation were low and resulted in a period of electricity prices that were much higher than usual. Just before and just after the New Year in 2003, spot prices were for short periods 80 per cent higher than the previous record set in 1996, when precipitation levels were also low. This gave impetus to the debate about the electricity market's capability to cope with dry years, and concern was expressed about the reliability of the electricity supply and the impact on low-income households. Subsequent analyses show that the market coped with the situation in the sense that prices rose, effectively rationing consumption (Bye 2003, Bye et al. 2003).

However, low levels of precipitation can take various forms. The winter of 2002-03 was very unusual compared with other, more typical dry years. Inflow was higher than normal up to summer 2002, but it was unusually dry in the few important autumn months when precipitation is normally plentiful. From mid-September to the end of the year, inflow was extremely low, 60 per cent below normal. Historical precipitation statistics indicate that a level of precipitation as low as this in the autumn months will only occur once every 200 years or so (Bye 2003).

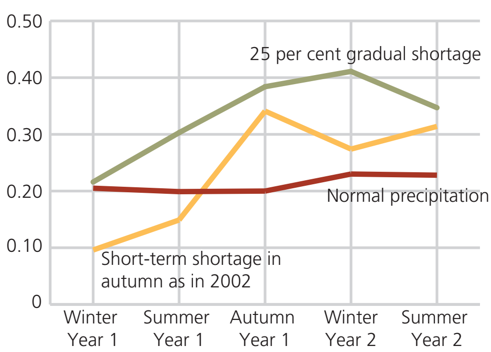
Rainfall patterns over the past 75 years show that in a typical dry year, the precipitation level is lower in all the seasons, see Figure 15.3. These dry years have typically occurred about every ten years. The average fall in precipitation levels on an annual basis in the years marked in the figure was 22 per cent, as against only 6 per cent in 2002. The last substantial long-term fall in precipitation was in 1996. However, demand in the electricity market was still under regulation then, and normal production capacity was higher than normal annual demand. In 2002 capacity was somewhat below normal annual consumption, and this was the first fall in precipitation since full deregulation of the Nordic market was implemented. Internationally, capacity in the power market showed a surplus on the demand side in both 1996 and 2002, but transmission constraints locked in the Norwegian market in parts of 2002-2003. In addition, there has only been a marginal expansion of global production capacity, and the previous capacity surplus has gradually been absorbed by increases in demand. This will pose a challenge in relation to demand when precipitation levels fall. However, we have so far no experience of how today's deregulated power market will in fact cope with a substantial fall in precipitation levels lasting for longer than a few autumn months.

Figure 15.3. Simulated seasonal and total annual inflow to Norwegian power stations, with given capacity in 2003, TWh



Source: Statnett.

Figure 15.4. Simulated electricity prices in two alternative precipitation shortage scenarios and in a scenario of normal precipitation, NOK per kWh



Source: Bye, Bruvoll and Aune (2006).

Statistics Norway's power market model (Normod-T) has been used to analyse the price and demand effects and the trade flows and constraints that can be expected if precipitation levels fall by *25 per cent throughout the year* compared with a *short-term shortage of precipitation in the autumn months*, such as in 2002. A fall of 25 per cent in Norway and Sweden corresponds to the lower limit of the 90 per cent confidence interval for annual inflow compared with the average. Thus, a fall in precipitation levels of this magnitude or more can be expected every twenty years. The model covers the hydro-dominated Norwegian power system and trade with the other Nordic countries, which are more thermal-based, even though hydro-power is widely used in Sweden too. Transmission constraints restrict the supply from the European market to the Nordic countries in situations when precipitation is very low.

If precipitation levels are very low over a lengthy period, the level of water in the reservoirs will be far lower than normal through the spring and summer. Adjustment to the lack of precipitation is smoothed, then tighter adjustments are made as the lack of inflow continues through the year. The total shortage is far greater than in the case of a short-term fall in precipitation levels in the autumn months, such as in 2002. The lower the water level in the reservoirs sinks, the more producers ration water outtake, and the more prices rise, see Figure 15.4. The largest adjustments are therefore made in the alternative with a 25 per cent shortage, so that reservoir storage levels in the year following the shortage are about the same in the two alternatives. Market mechanisms dampen the effect of the shortage as demand falls when prices rise. This curbs the rise in prices, even though demand does not react substantially in the short term. Trade with other Nordic countries also replaces hydroelectric production to a certain extent. The effects of the shortage are curbed by increased imports of thermal power from Sweden and Denmark, and imports from the rest of Europe increase until transmission capacity is fully exploited.

Varying precipitation levels and fluctuating prices are factors we will have to live with in a deregulated market heavily dependent on hydropower. The important conclusion from the model analysis is that the market would seem to clear even with a long-term, substantial shortage of rainfall of 25 per cent. The general price level will be higher than in 2002-03, but a long-term shortage does not result in the same price peaks as a short-term shortage. The model simulations seem reasonably realistic when compared with the market effects in 1996, when there was a total inflow shortage of 20 per cent.

With an inflow shortage of 25 per cent, the price households will have to pay over a year, including network service fees, VAT and taxes, is estimated to be around 30 per cent higher than in a normal year, and electricity expenses for an average household with a consumption of 20 000 kWh per year will increase by around NOK 4 000.

email: annegrete.bruvoll@ssb.no, torstein.bye@ssb.no, finn.roar.aune@ssb.no.

Documentation

Bye, T., A. Bruvoll and F.R. Aune (2006): The importance of volatility in inflow in a deregulated hydro-dominated power market, Discussion Paper no. 472, Statistics Norway. http://www.ssb.no/publikasjoner/DP/pdf/dp472.pdf

Bye, T. and A. Bruvoll (2006): Tilsigssvikt - konsekvenser for produksjon og priser. (Inflow shortages - consequences for production and prices.) Økonomiske analyser No. 4, 34-39. http://www.ssb.no/emner/08/05/10/oa/200604/bye.pdf

References

Bye, T., N.-H. Mørch Von Der Fehr, Chr. Riis and L. Sørgaard (2003): Kraft og makt. En analyse av konkurranseforholdene i kraftmarkedet. Rapport fra en ekspertgruppe utnevnt av Arbeids- og Administrasjonsdepartementet. (Power and market power. An analysis of competitive conditions in the power market. Report by a committee of experts appointed by the Ministry of Labour and Government Administration.).

Bye, T. (2003): A Nordic energy market under stress, Economic Survey 4, Statistics Norway. http://www.ssb.no/english/subjects/08/05/10/es/200304/bye.pdf

15.9. Objectives and dilemmas in electricity taxation

Geir H. Bjertnæs, Taran Fæhn and Jørgen Aasness

International competition legislation led to a reorganisation of the Norwegian electricity taxation system in 2004. Other adjustments to EU requirements are assessed here in the light of objectives concerning the effective generation of revenues, the maintenance of the industry's competitiveness and distribution issues. The analysis indicates that removing the electricity tax and raising the VAT rate instead will favourise households with a relatively low standard of living, maintain competitiveness in manufacturing and generate government revenues just as effectively as under the current system. The introduction of a flat tax rate for all electricity consumers will make the taxation system more efficient, although it will also amplify the problems facing energy-intensive manufacturing.

Background and alternatives

While about half of Norway's electricity consumption in 2006 was taxed at NOK 0.1005 per kWh, northern districts and all manufacturing were exempted for industrial policy and regional policy reasons. Under the new EU environmental support scheme of 23 May 2001, however, discrimination between industries is prohibited. A new system was therefore introduced in Norway as from 1 July 2004, where the tax rate is differentiated by use rather than by industry. In addition, various exceptions and temporary schemes are used so that the distributional profile for industrial Norway is almost the same as under the previous system. In addition to maintaining the manufacturing industry's competitive position, many other objectives and considerations have been discussed in connection with the electricity taxation system. These have been linked to energy and environmental policy objectives and to the need for government revenues. Since the share of the household budget allocated to electricity increases as income falls, low-income families feel the impact most, and the undesirable distributional effects of the tax have also been much in focus.

The new electricity taxation system is intricate and involves administrative costs. The purpose of this project has been to examine whether the electricity taxation system could be reorganised so as to meet with EU approval and at the same time fulfil national objectives as well as or better than the current system. We have assessed three alternative adaptations to EU directives. In the first two alternatives, the electricity tax rate is the same for all industrial activities: we study the effects of a standard electricity tax rate applied to all industries including manufacturing, and the effects of a zero rate. In the third alternative, the tax is removed for households and industry alike. We assess the alternatives according to how well they fulfil the objectives related to manufacturing competitiveness, the effective generation of revenues and income distribution. This analysis does not focus particularly on resource or environmental arguments for electricity taxation, as instruments that distinguish between activities that are beneficial or detrimental to the environment are more appropriate to environmental policy.

An important reason for electricity taxation is the need for government revenues. In 2005, revenues totalled more than NOK 5 billion. Using tax revenues to fund public projects and welfare schemes affects where the economy's resources are applied. This is not the purpose of most taxes, but is an unfortunate side-effect in the sense that resources are used less efficiently. In this analysis, the economic efficiency consequences of the reforms are quantified, and possible trade-offs between efficiency and distributional considerations are discussed.

One of the distributional considerations is related to industry structure. The electricity tax is currently differentiated in order to maintain the competitiveness of energy-intensive manufacturing (manufacture of pulp and paper, industrial chemicals and metals). Many manufacturing firms are regarded as key companies that are important to employment and welfare in the regions. In addition, manufacturing has an important role as a source of export revenues. The Norwegian economy is in a special, and many would say vulnerable, position with its dependency on oil and gas resources as a source of foreign currency. It is regarded as important for Norway to have a viable competitively exposed sector that continues to thrive as offshore oil and gas production declines, and this will require that the expertise and capital held in mainland manufacturing are maintained. Another distributional aspect is related to household electricity tax. In general, lowering indirect taxes on goods used in relatively large amounts by households with relatively low incomes will have a positive redistributional effect. Since electricity takes up the largest share of the budget in low-income households (see e.g. Aasness 1998 and NOU 2004:8), it may be a good candidate for tax reduction.

Reform 1: Standard tax rate for all industries

We have assessed this system according to two criteria: How economically effective is the system as a source of revenue, and how well does it support the competitive position of energy-intensive manufacturing in Norway? In our study, we have used an empirically based macroeconomic equilibrium model for Norway, MSG-6, see Heide et al. 2004. This reform will have very minor effects on the third objective, income distribution.

When the current standard rate is extended to manufacturing, we find that a small efficiency gain is achieved, equivalent to an annual average of NOK 34 per capita. Since this can be achieved despite the increase in the number of users paying the standard rate and the increase in taxes collected, this indicates that the tax theory principle of not differentiating between industries applies to the Norwegian economy. Other empirical studies of industrial policy in Norway have reached the same result, see Bye and Nyborg (2003) and Bye et al. (1999). The main explanation for the efficiency gain is that electricity and other resources are channelled away from energy-intensive manufacturing, which has a relatively low social return. This is because of small margins in export production, favourable industrial policy measures, such as government low-price power contracts, low employers' social security contributions and exemption from CO2 tax. Thus, more resources have already been allocated to this industry than would be optimal from an economic efficiency point of view.

Since the introduction of the electricity tax in manufacturing generates extra revenues that can be used to promote welfare, the potential for efficiency effects is greater than the annual NOK 34 per capita. In a scenario where revenues are returned in the form of reduced employers' contributions, economic efficiency increases to an annual NOK 233 per capita compared with a scenario where electricity tax is differentiated and employers' contributions remain at the current rate. The additional gain achieved by neutralising the budget in this way is primarily due to a reduction in the high effective tax rate on labour in Norway. High labour tax implies a labour supply that is already too low in terms of the economy, even when taking into account that recreational time is a value in itself. Holmøy and Strøm (2004) find that employers' contributions are therefore a relatively costly way of generating higher revenues and thus a good candidate for cuts. An important limitation in efficiency calculations is that restructuring costs when resources are made available in energy-intensive manufacturing have not been taken into account. In practice, we know that it takes time to move resources and that when structural changes are made, unemployment and unutilised capital represent costs. Fehr and Hjørungdal (1999), however, find that most regions are well equipped to cope with the impact of an equalisation of electricity prices, while some municipalities are in a weaker position.

The direct distributional effects among industries of an electricity tax reform are fairly obvious: the introduction of a standard tax rate for manufacturing will result in a direct increase in costs for manufacturing, particularly the energy-intensive sector. Model studies indicate that indirect effects modify the increase in cost level in manufacturing due to the electricity tax. Primarily, wage levels will fall by 1.2 per cent in the long term, provided that the reduction in employment in energy-intensive manufacturing will benefit other industries in the form of reduced pressure on the labour market. In addition, the long-term results are based on the assumption that the scaling back of export-intensive manufacturing will not result in a persistent deficit in the balance of trade, leading to a spiral of foreign debt. Sooner or later, the resulting pressure will operate through reduced factor prices, strengthening competitiveness in other sectors of business and industry in Norway. In addition, electricity prices before tax fall by 1.0 per cent in the long term, as a result of a decline in demand in the Nordic power market. This also contributes to reduced costs. However, for the energy-intensive sector, competitiveness nonetheless deteriorates considerably, both internationally in the competition for market shares and domestically in the competition for the country's resources. The production of export goods falls by as much as 22 per cent.

Reform 2: Zero rate for all industries

This reform was temporarily introduced in the first half of 2004. We have assessed the consequences for the economy of generating revenues other than via the electricity tax and have used higher VAT rates as an example. In addition, we have studied the distributional effects among industries, but excluded households, where the impact again will be small.

When exemption from the electricity tax for business and industry is combined with a rise in VAT[4], which is mainly a tax on household consumption, our calculations indicate an efficiency gain, although small, equivalent to NOK 14 per capita as an annual aver-

[4] The analysis uses a proportional increase in all VAT rates in the 1999 system, i.e. before the reforms and rate changes introduced in recent years.

age. The fact that it is positive, however, supports to a certain extent an efficiency principle first deduced by Diamond and Mirrlees (1971), which indicates that commodity tax should be a consumer tax rather than a producer tax.
There is little change in manufacturing competitiveness as a result of the reform, whether in relation to foreign firms or other industries in Norway. The direct impact of tax exemption experienced by the primary and tertiary industries has a stimulating effect on these industries. The ensuing pressure on the labour market is small and wage rates only rise marginally (0.04 per cent). The tax changes are passed through to power producers to a negligible extent in the long term. Producer prices for electricity only increase by 0.1 per cent. The deterioration in manufacturing's competitive position internationally as a result of indirect changes in factor prices is therefore modest, and there is only a slight shift in domestic resource distribution towards commodity production, service provision and power production. Total exemption from the electricity tax for all industries thus satisfactorily safeguards the objective of maintaining competitiveness in manufacturing.

Reform 3: Full removal of the electricity tax
In this case too, it is relevant to examine the economic efficiency of generating revenues other than through the electricity tax, such as through a rise in VAT. While the distributional effects among industries will be approximately as for reform 2, i.e. very small, other distributional effects will be more interesting, such as how removal of the tax will affect distribution among households with differing standards of living.

When electricity tax exemption is applied to households as well as to business and industry, and tax revenues are maintained by raising VAT rates, efficiency gains will be halved compared to the effect if the exemption only applies to business and industry, i.e. from NOK 14 to NOK 7 per capita as an annual average. This loss is consistent with another efficiency principle from the theory that suggests that consumption that does not change to any great extent under taxation, such as electricity consumption, should be taxed more than other goods (Ramsey 1927). In addition, the halving of efficiency gains is explained by higher taxation of the supply of labour as a result of higher VAT. When VAT rises, the supply of labour declines since households have less to gain from increasing their work effort. The slight efficiency gain achieved, in relation to the differentiated system, of removing the electricity tax and replacing it with higher VAT nonetheless indicates that the revenue argument is not a particularly good basis for retaining the electricity tax as a source of revenue.

To illustrate the distributional effects, we calculated how the 20 per cent poorest households, the 20 per cent wealthiest households and the remaining 60 per cent middle-income households are affected in the long term by a removal of the electricity tax in favour of an equivalent VAT increase on all goods. The short-term effects will be about the same, since almost all the exemption, even in the short term, will be passed on to household electricity prices. The calculations are based on some assumptions that simplify the picture. Nonetheless, they give a good indication of the distributional effects of the restructuring outlined here. Our main result shows that poor households, where electricity takes up the greatest share of the household budget, profit by NOK

234 per capita per year from the reform. The wealthy households, where electricity takes up the smallest share of the household budget, profit less from the removal of the electricity tax than they lose from higher VAT, losing NOK 313 per capita per year. Middle-income households profit slightly from the reform as a whole, NOK 29 per capita. The main tendency in the results is consistent with a number of empirical studies based on Statistics Norway's consumer surveys from 1967 up to today, see for example Biørn (1978), Aasness (1998) and Halvorsen et al. (2005).

Overall conclusion

Our research indicates that alternatives other than the new system of differentiation by use that was introduced in the second half of 2004 should be assessed. The reform alternative in which the electricity tax is removed and replaced by higher VAT rates is successful across the board: it meets the EFTA Surveillance Authority's requirements, it maintains competitiveness in energy-intensive manufacturing, it leads to desirable distributional effects among income groups and generates government revenues more cheaply than the current system. It would appear that we can have our cake and eat it, and the authorities are relieved of the obligation to decide on priorities between the various objectives we have assessed.

By removing the electricity tax for business and industry alone, the competitive position of energy-intensive manufacturing is maintained. And our research finds no support for the revenue argument in favour of retaining the electricity tax. Removing the electricity tax would therefore seem a good alternative to the current system of differentiation by use, which involves administrative costs.

The alternative where manufacturing is subject to the same tax as other consumers leads to more difficult political decisions. It is the most efficient way to generate revenues, but the problems for energy-intensive manufacturing will be aggravated. At the same time, previous analyses (Bjertnæs and Fæhn 2004 and Bjertnæs 2005) indicate that the disadvantages for energy-intensive manufacturing if electricity tax on their consumption is introduced are not so great that they cannot, in principle, be compensated by the extra revenue provided by a broader basis. However, in practice, it is difficult to provide compensation within EU legislation. We have not studied the possibilities that exist, nor have we assessed how international operating parameters may change in the future.

e-mail: ghb@ssb.no, tfn@ssb.no, ass@ssb.no

Documentation:

Bjertnæs, G.H., T. Fæhn and J. Aasness (2006): Bør elektrisitetsavgiften legges om? Mål og dilemmaer i utformingen av elektrisitetsavgiften. (Should the electricity tax be reorganised? Objectives and dilemmas in alternatives for electricity taxation.) *Økonomiske analyser* 2/2006, Statistics Norway. http://www.ssb.no/emner/08/05/10/oa/200602/fahn.pdf

References

Biørn, E. (1978): *Comparing consumer expenditure functions*, Articles 108, Statistics Norway.

Bjertnæs, G.H. (2005): Avoiding Adverse Employment Effects from Energy Taxation: What Does it Cost?, Discussion Papers 432, Statistisk sentralbyrå. http://www.ssb.no/publikasjoner/DP/pdf/dp-432.pdf

Bjertnæs, G.H. and T. Fæhn (2004): Energy Taxation in a Small, Open Economy: Efficiency Gains under Political Restraints, Discussion Papers 387, Statistics Norway. http://www.ssb.no/publikasjoner/DP/pdf/dp387.pdf

Bye, B. and K. Nyborg (2003): Are Differentiated Carbon Taxes Inefficient: A General Equilibrium Analysis. *The Energy Journal* **24** (2), 2003, 1-18.

Bye, T., M. Hoel and S. Strøm (1999): Et effektivt kraftmarked - konsekvenser for kraftkrevende næringer og regioner. (An efficient power market – consequences for energy-intensive industries and regions.) *Sosiale og økonomiske studier* 102, Statistics Norway. http://www.ssb.no/emner/01/03/10/sos102/

Diamond, P.A. and J.A. Mirrlees (1971): Optimal Taxation and Public Production I: Production Efficiency, *American Economic Review* **61**, 8-27.

Fehr, N.-H.M. von der and T. Hjørungdal (1999): Regionale virkninger av økte elektrisitetspriser til kraftkrevende industri. (Regional effects of higher electricity prices in energy-intensive manufacturing.) Report, Ragnar Frisch Centre for Economic Research.

Halvorsen, B., B.M. Larsen and R. Nesbakken (2005): *Norske husholdningers energiforbruk til stasjonære formål 1960-2003. En diskusjon basert på noen analyser i Statistisk sentralbyrå.* (Energy use for stationary purposes in Norwegian households. A discussion based on some analyses carried out by Statistics Norway.) Reports 2005/37, Statistics Norway. http://www.ssb.no/emner/01/03/10/rapp_200537/

Heide, K., E. Holmøy, L. Lerskau, and I.F. Solli (2004): *Macroeconomic Properties of the Norwegian Applied General Equilibrium Model MSG6*, Reports 2004/18, Statistics Norway. http://www.ssb.no/emner/09/90/rapp_200418/

Holmøy, E. and B. Strøm (2004): The Social Cost of Government Spending in an Economy with Large Tax Distortions: A CGE Decomposition for Norway, Discussion Papers 396, Statistics Norway. http://www.ssb.no/publikasjoner/DP/pdf/dp396.pdf

NOU 2004:8: *Differensiert el-avgift for husholdninger.* (Differentiated household electricity tax.) Official Norwegian Report, Ministry of Finance, Oslo: Akademika.

Ramsey, F.P. (1927): A contribution to the theory of taxation, *Economic Journal* **37**, 47-61.

Aasness, J. (1998): Fordelingsvirkninger av elektrisitetsavgifter (Distributional effects of electricity taxes), in NOU (1998:11): *Energi- og kraftbalansen mot 2020* (The energy and power balance in the years to 2020), Ministry of Petroleum and Energy, Oslo: Akademika, Annex 2, 399-404.

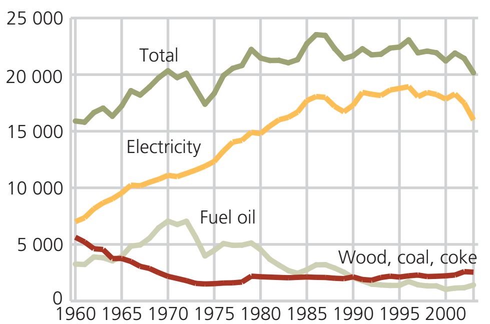
15.10. Lighting and heating through 43 years: energy use in Norwegian dwellings from 1960 to 2003

Bente Halvorsen, Bodil M. Larsen and Runa Nesbakken

It is a fairly common perception that Norwegian households' energy use in dwellings has risen substantially, and that the rise will continue. Historical data show that electricity consumption, and also to a certain extent energy use, rose sharply for more than 20 years from 1960 onwards. This applied to both the household sector and to individual households. However, energy use per household has been relatively stable at around 22 000 kWh since 1980, while electricity consumption per household has been stable at around 18 000 kWh since 1985, see Figure 15.5. Electricity consumption accounted for approximately 35 per cent of energy use in 1960, compared with close to 80 per cent at the beginning of the 2000s. Developments in electricity consumption are affected by a number of factors which have been discussed in more detail in this article.

There are *three main trends* in historical developments in average energy use per household. The first is that *the composition of energy use changed considerably*, both from year to year and through the period. The second is *strong growth in energy use and electricity consumption* in the period. The third main trend is that the *growth* in electricity consumption levelled off from 1985.

Figure 15.5. Energy use in dwellings per household, 1960-2003. kWh, utilised[1]



[1] The figures have been corrected for heating efficiency, but not for differences in temperature. For fuel oil we have applied a heating efficiency of 0.73 and for wood, coal and coke 0.65.
Source: Statistics Norway (Energy statistics, Population and Housing Censuses) and Bøeng (2005).

The reasons why electricity as a share of total energy use increased in much of the period are, for example, that households acquired an increasing number of electrical appliances. In the 1960s, the share of households with electrical appliances such as refrigerators, cooking stoves, washing machines, vacuum cleaners, televisions and deep freezes showed very sharp growth. This indicates that growth in electricity consumption in the 1960s was to a greater extent than later fuelled by growth in the use of electricity in household appliances. Growth in the 1970s and the first half of the 1980s appears to have been driven more by the transition from oil to electricity in heating, while the choice of the type of energy used for heating remained relatively stable in the 19990s. Most households had the usual household appliances, while the share of households with tumble dryers and dishwashers increased relatively sharply in the 1990s (cf. Halvorsen et al. 2005). In isolation, this pointed towards increasing growth in electricity consumption. However, growth in electricity consumption by appliances levelled off due to slower growth in the share of households with the most common appliances, and an increase in more energy-efficient appliances. Other factors that contributed to higher growth in the 1990s were income, electricity prices, residence in blocks of flats and number of household members. A somewhat higher temperature than normal in Norway in the 1990s and slower growth in both dwelling area and the share of households with their own bathroom contributed to the levelling-off in electricity consumption. The transition from energy use at home to energy use outside the home, in the form of more visits to cafés and restaurants as a result of income growth, and more energy-effective solutions in the home in the form of ready-made food and cleaning mops also point toward lower consumption. New appliances that push up electricity consumption per household do not appear on the market as frequently as previously.

Furthermore, it would appear that changes in energy prices, for example the high oil prices in 1973 and 1979, have had a relatively substantial impact on the composition of energy use in that the use of oil for home-heating purposes has fallen sharply. At the same time, the use of electricity for heating purposes has risen. Low oil prices in the last half of the 1980s led to some increase in oil consumption, although not up to previous levels. The probable explanation is that households phased out oil-based heating equipment following the oil price shocks. Heating equipment available in the home and the capacity of this equipment has considerable impact on how far households can adapt their energy use in the short term when relative energy prices, temperature or other factors change. Relatively rapid changes in consumption indicate that households had the opportunity to use more than one form of energy for home heating and that the equipment's total capacity was considerable. The reduction in electricity consumption in 1997 and 2002-03 is related to high electricity prices, considerable media coverage and appeals from the Government to save electricity. Low electricity consumption in 1990 may be due to the fact that 1990 was the mildest year in the period.

e-mail: Bente.Halvorsen@ssb.no, Bodil.Merethe.Larsen@ssb.no

References

Bøeng, A.C. (2005): Energibruk i husholdninger 1930-2004 og forbruk etter husholdningstype. (Energy use in households 1930-2004 and use according to type of household.) Reports 2005/41, Statistics Norway.
http://www.ssb.no/emner/01/03/10/rapp_200541/.

Halvorsen, B., B.M. Larsen and R. Nesbakken (2005): Norske husholdningers energiforbruk til stasjonære formål. En diskusjon basert på noen analyser i Statistisk sentralbyrå. (Energy use for stationary purposes in Norwegian households. A discussion based on some analyses carried out by Statistics Norway.) Reports 2005/37, Statistics Norway.
http://www.ssb.no/emner/01/03/10/rapp_200537/

Energy

Appendix A

Table A.1. Reserve accounts for crude oil. Fields already developed or where development has been approved. Million Sm^3 o.e.

	1990	1998	1999	2000	2001[1]	2002	2003	2004	2005
Reserves as of 01.01 . .	1 189	1 858	1 810	1 692	1 770	1 776	1 589	1 540	1 470
New fields	126	-	36	190	106	2	26	46	73
Re-evaluations	125	133	26	82	99	5	113	70	83
Extraction	-99	-181	-181	-194	-198	-193	-189	-186	-165
Reserves as of 31.12 . .	1 340	1 810	1 692	1 770	1 776	1 589	1 540	1 470	1 462
R/P-ratio.	13	10	9	9	9	8	8	8	9

[1] Break in homogeneity of time series between 2000 and 2001 due to changes in classification system.
Source: Norwegian Petroleum Directorate and Statistics Norway.

Table A.2. Reserve accounts for natural gas. Fields already developed or where development has been approved. Million Sm^3 o.e.

	1990	1998	1999	2000	2001[1]	2002	2003	2004	2005
Reserves as of 01.01	1 261	1 173	1 172	1 247	1 259	2 189	2 117	2 461	2 388
New fields	17	-	45	61	229	7	376	7	32
Re-evaluations	-20	46	82	6	759	-9	46	3	31
Extraction	-28	-48	-52	-54	-58	-70	-78	-83	-90
Reserves as of 31.12	1 230	1 172	1 247	1 259	2 189	2 117	2 461	2 388	2 361
R/P-ratio.	45	25	24	23	38	30	32	29	26

[1] Break in homogeneity of time series between 2000 and 2001 due to changes in classification system.
Source: Norwegian Petroleum Directorate and Statistics Norway.

Table A.3. Norway´s hydropower potential and developed and undeveloped hydropower[1]. GWh

	Hydro-power potential[2]	Developed as of 31 Dec.	Undeveloped					
			Under construction[3]	Licence granted	Applied for licence	Notification submitted	Protected	Remainder
1973	149 594	76 250	..	..	..	..	6 900	..
1974	149 594	80 280	..	..	..	..	6 900	..
1975	152 390	81 161	..	..	..	..	6 900	..
1976	151 046	81 813	..	..	..	..	6 900	..
1977	151 214	83 145	..	..	..	..	6 900	..
1978	151 010	85 080	..	..	..	..	6 900	..
1979	151 639	87 072	..	..	..	..	6 900	..
1980	155 763	89 676	..	..	..	..	11 438	..
1981	170 135	94 661	9 545	..	..	..	11 464	..
1982	170 638	96 963	7 774	..	..	..	11 668	..
1983	174 599	99 208	5 847	..	16 755	7 297	11 685	33 807
1984	171 940	99 696	7 100	..	14 164	6 902	11 685	32 392
1985	170 207	101 894	5 412	..	12 855	6 503	11 679	31 864
1986	169 970	102 716	4 447	..	12 217	6 559	20 947	23 084
1987	170 084	105 108	3 800	..	10 783	6 047	20 947	23 399
1988	171 209	105 578	3 778	..	8 674	4 415	20 947	27 817
1989	171 475	107 816	3 055	..	7 298	4 557	20 947	27 802
1990	171 366	108 083	3 494	..	6 609	4 890	20 947	27 343
1991	171 382	108 083	3 605	..	6 631	5 900	20 947	26 215
1992	176 395	109 457	2 913	..	4 767	3 318	22 246	33 695
1993	175 387	109 635	1 232	1 430	3 223	4 202	34 854	20 811
1994	177 745	111 850	799	1 585	3 124	4 529	35 259	20 599
1995	178 116	112 348	502	1 488	3 233	4 559	35 259	20 728
1996	178 302	112 701	161	1 532	2 774	2 180	35 258	23 694
1997	178 335	112 938	292	1 471	2 912	2 641	35 258	22 824
1998	179 647	113 015	332	1 446	3 132	2 920	35 321	23 481
1999	180 199	113 442	53	1 446	2 654	2 893	35 321	24 389
2000	186 970	118 041	73	347	2 536	3 456	36 543	25 974
2001	186 947	118 154	349	1 036	3 765	1 576	36 543	25 523
2002	186 486	118 277	993	498	3 583	1 294	36 543	25 298
2003	186 544	118 415	1 174	1 416	2 002	893	36 543	26 102
2004[4]	205 067	118 993	1 157	1 594	1 809	818	36 543	44 153
2005[5]	205 307	119 724	1 345	1 042	1 961	575	44 193	36 467

[1] Mean annual production capability. [2] Watercourses which are protected through the Storting are not included in these figures prior to 1981. Plans for undeveloped hydropower are evaluated regularly, and this is why hydropower potential changes from year to year. [3] Includes the category 'Licence granted' for all years before 1993. [4] The large rise in 2004 is explained by the inclusion of small power plants (capacity 50 - 10 000 kW). [5] In 2005, new river systems have been included in the category "Protected".
Source: Norwegian Water Resources and Energy Directorate.

Table A.4. Extraction, conversion and use[1] of energy commodities. 2004*

	Coal and coke	Wood, wood waste, black liquor, waste	Crude oil	Natural gas	Petroleum products[2]	Electricity	District heating	Total	Average annual change 1976-2004	Average annual change 2003-2004
	PJ								Per cent	
Extraction of energy commodities.	82	-	5 868	3 343	[3] 585	393	-	10 272		
Energy use in extraction sectors. . .	-	-	-	[4]-194	-14	-8	0	-216		
Imports and Norwegian purchases abroad	47	1	18	-	284	55	-	405		
Exports and foreign purchases in Norway	-78	0	-5 261	-3 061	-810	-14	-	-9 224		
Stocks (+decrease, -increase).	0	..	6	-	9	.	.	15		
Primary supplies	51	1	631	88	54	427	0	1 252		
Oil refineries	6	-	-533	-	512	-2	-	-17		
Other energy sectors or supplies . .	-1	43	-	0	17	2	11	73		
Registered losses, statistical errors .	-8	..	-99	-50	-109	-32	-2	-300		
Registered use outside energy sectors	48	45	-	37	473	395	9	1 007	0.7	2.1
Domestic use	48	45	-	37	331	395	9	866	1.3	2.3
Agriculture and fisheries	-	0	-	0	27	7	0	34	0.4	-1.4
Energy-intensive manufacturing	36	0	-	35	62	128	0	261	1.7	2.6
Other manufacturing and mining	12	16	-	2	28	53	1	111	-0.4	-1.7
Other industries	-	0	-	1	140	87	6	234	2.0	4.8
Private households	0	28	-	0	75	120	2	225	1.4	1.8
International maritime transport . .	-	-	-	-	141	-	-	141	-1.5	0.9

[1] Includes energy commodities used as raw materials. [2] Includes liquefied petroleum gas, refinery gas, fuel gas and methane. Petrol coke is included in coke. [3] Natural gas liquids and condensate from Kårstø. [4] Includes gas terminals.
Source: Energy statistics, Statistics Norway.

Table A.5. Use of energy commodities outside the energy sectors and international maritime transport[1]

Energy commodity	1976	1980	1985	1990	1995	2000	2001	2002	2003	2004*	2005*	Average annual change 1976-2003	Average annual change 2003-2004
	PJ											Per cent	
Total	**604**	**674**	**723**	**733**	**777**	**823**	**866**	**848**	**846**	**865**	**861**	**1.3**	**-0.5**
Electricity	241	269	329	349	374	395	403	392	371	395	404	1.8	2.0
Priority power	232	265	312	324	348	359	377	369	361	379	...	1.8	...
Non-priority power	9	4	17	24	26	36	26	23	11	17	...	2.2	...
Oil, total	298	291	252	245	251	246	261	262	269	267	259	-0.4	-2.9
Oil other than transport	159	137	77	57	51	43	47	48	54	45	34	-4.4	-24.4
Petrol	9	3	0	0	0	0	0	0	0	0	0	-100.0	.
Kerosene	17	16	9	7	7	5	6	6	6	5	5	-3.9	-17.7
Middle distillates	66	62	43	35	30	27	28	30	36	28	20	-3.1	-28.0
Heavy fuel oil	66	56	25	15	14	11	13	12	12	12	9	-6.0	-27.3
Oil for transport	139	154	175	188	200	203	215	214	215	222	225	1.7	1.4
Petrol, aviation fuel, jet fuel	74	82	92	99	102	97	100	99	94	96	94	1.0	-2.2
Middle distillates	62	68	75	85	98	106	115	116	118	122	128	2.5	4.9
Heavy fuel oil	3	5	7	3	1	1	0	0	3	4	3	0.3	-20.1
Gas[2]	1	41	52	52	54	81	103	96	108	102	104	16.3	1.8
District heating	0	0	2	3	4	5	7	7	8	9	9	.	0.0
Solid fuel	64	73	89	84	95	95	92	91	89	92	86	1.3	-6.9
Coal and coke	47	48	57	49	56	56	50	46	44	48	42	0.1	-13.2
Wood, wood waste, black liquor, waste	17	24	31	36	38	40	42	45	45	45	45	3.5	0.0

[1] Includes energy commodities used as raw materials. [2] Includes liquefied petroleum gas. From 1990 also fuel gas and landfill gas, and from 1995 natural gas.
Source: Energy statistics, Statistics Norway.

Table A.6. Net use[1] of energy in the energy sectors. PJ

	1976	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003*	2004*	2005*
Total	**57**	**76**	**96**	**152**	**181**	**193**	**201**	**192**	**192**	**212**	**218**	**216**	**230**	**238**	**248**
Of this:															
Electricity	4	6	8	7	10	7	11	8	9	8	9	8	9	10	13
Natural gas	30	52	61	116	141	151	153	147	145	167	175	176	186	194	194

[1] Does not include energy use for conversion purposes.
Source: Energy statistics, Statistics Norway.

Table A.7. Use of energy commodities ouside the energy sectors and international maritime transport, by sector[1]. 2003. PJ

	Coal and coke	Wood, wood waste, black liquor, waste	Crude oil	Natu-ral gas	Petro-leum pro-ducts[2]	Elec-tricity	District heating	Total
Total	**44.3**	**45.1**	**-**	**32.4**	**345.3**	**371.3**	**8.0**	**846.4**
Manufacturing and mining	**44.2**	**16.6**	**-**	**31.8**	**104.3**	**169.6**	**1.2**	**367.7**
Oil drilling	-	-	-	-	0.6	-	-	0.6
Manufacture of pulp and paper	-	12.3	-	0.3	6.9	21.7	0.2	41.4
Manufacture of basic chemicals	8.2	0.0	-	30.0	70.3	22.4	0.3	131.3
Manufacture of minerals[3]	7.8	0.9	-	0.0	9.0	4.7	0.0	22.4
Manufacture of iron, steel and ferro-alloys	18.1	0.2	-	-	1.0	20.7	0.0	40.0
Manufacture of other metals	4.9	-	-	1.2	2.9	74.2	-	83.1
Manufacture of metal goods, boats, ships and oil platforms	5.3	0.2	-	0.2	3.3	9.3	0.3	18.4
Manufacture of wood, plastic, rubber and chemical goods, printing	-	2.9	-	0.1	2.5	6.1	0.1	11.7
Manufacture of consumer goods	0.0	0.0	-	0.1	7.8	10.6	0.3	18.8
Other industries, total	**0.1**	**28.6**	**-**	**0.6**	**241.0**	**201.8**	**6.8**	**478.8**
Construction	-	0.1	-	-	8.8	2.4	-	11.3
Agriculture and forestry	-	0.1	-	0.0	6.4	6.4	0.1	12.9
Fishing, whaling and sealing	-	-	-	-	21.2	0.5	-	21.7
Land transport[4]	-	-	-	0.1	51.4	2.2	-	53.7
Sea transport, domestic	-	-	-	0.2	22.6	0.0	-	22.8
Air transport[4]	-	-	-	-	21.5	0.5	-	22.1
Other private services	-	-	-	0.0	25.2	52.1	2.9	80.2
Public sector, municipal	-	0.1	-	0.2	5.1	13.0	1.8	20.2
Public sector, state	-	0.1	-	0.0	3.0	9.3	0.7	13.1
Private households	0.1	28.2	-	0.1	75.8	115.3	1.3	220.8

[1] Includes energy commodities used as raw materials. See also tables G3 and G4, which give emission figures for the same sectors in 2004.
[2] Includes liquefied petroleum gas, fuel gas and methane. Petrol coke is included under coke. [3] Includes mining. [4] Norwegian purchases in Norway + Norwegian purchases abroad.
Source: Energy statistics, Statistics Norway.

Table A.8. Electricity balance

	1975	1980	1985	1990	1995	2000	2001	2002	2003	2004*	2005*	Average annual change 1990-2005*	Average annual change 2004-2005*
	TWh											Per cent	
Production	77.5	84.1	103.3	121.8	123.0	142.8	121.6	130.5	107.2	110.5	137.6	1.9	24.6
+ Imports	0.1	2.0	4.1	0.3	2.3	1.5	10.8	5.3	13.5	15.3	3.7	13.5	-76.1
- Exports	5.7	2.5	4.6	16.2	9.0	20.5	7.2	15.0	5.6	3.8	15.7	3.4	308.6
= Gross domestic consumption	71.9	83.6	102.7	105.9	116.3	123.8	125.2	120.8	115.1	122.1	125.6	1.9	2.8
- Electric boilers	3.2	1.2	4.8	6.7	7.5	10.5	7.8	6.8	3.2	4.9	4.1	0.7	-16.8
- Consumption in pumped storage power plants	0.1	0.5	0.8	0.3	1.4	0.7	0.8	0.7	0.9	0.7	1.1	7.5	48.6
- Consumption in power plants, losses and statistical differences	7.1	8.0	10.0	7.9	10.0	12.2	11.1	10.0	10.0	11.7	10.1	1.2	-13.8
= Net domestic consumption	61.4	73.9	87.1	91.0	97.5	100.4	105.5	103.2	101.1	104.8	110.3	2.0	5.3
- Energy-intensive manufacturing	26.2	27.9	30.0	29.6	28.4	30.5	32.1	29.6	31.7	34.6	33.7	0.8	-2.7
= Net general consumption	35.2	46.0	57.1	61.5	69.1	69.9	73.4	73.6	69.4	70.1	76.6	2.6	9.2
Gross general consumption	..	..	..	..	..	76.9	80.7	81.0	76.3	77.1	84.2	.	9.2
Net general consumption corrected for temperature[1]	36.3	45.1	54.6	65.4	69.6	..	..	..	..	..	..	.	.
Gross general consumption corrected for temperature[1]	..	..	..	..	..	81.4	81.4	83.7	79.1	80.5	87.8	.	9.0

[1] Break in the series. For the years prior to 2000, the temperature correction is made for the net general consumption. From 2000 onwards, it is the gross general consumption that is corrected for temperature.
Source: Electricity statistics, Statistics Norway and Norwegian Water Resources and Energy Directorate.

Table A.9. Average prices[1] for electricity[2] and some selected oil products. Energy supplied

	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	Price in øre/kWh[4]														
Electricity	**45.7**	**46.6**	**47.8**	**46.8**	**49.7**	**52.4**	**55.0**	**51.0**	**50.3**	**52.3**	**61.0**	**68.0**	**88.7**	**78.9**	**74,8**
Heating products	Price in øre/kWh[4]														
Heating kerosene	33.9	37.4	37.8	37.1	37.7	41.6	43.8	42.6	47.6	59.5	61.1	57.2	60.4	66.1	80,3
Fuel oil no.1/ light fuel oils[3]	26.6	28.3	28.0	28.2	29.6	34.0	37.0	34.3	39.9	51.5	53.4	48.8	54.1	58.1	71,6
Fuel oil no.2	25.7	27.2	26.9	27.1	[3]..	..	..	..	..	..	..	..	..	..	..
Transport products	Price in øre/litre[4]														
Petrol, leaded, high oct.	643	795	836	851	889	.	.	.	.	.	.	.	.	.	.
Petrol, unl. 98 octane	622	747	787	791	838	880	909	904	948	1 087	976	931	963	1 031	1 120
Petrol, unl. 95 octane	594	717	757	761	807	849	888	873	919	1 052	944	901	929	996	1 085
Auto diesel	286	326	403	649	701	757	779	781	827	991	862	808	834	871	1 003

[1] Including all taxes. [2] Price for households and agriculture. The price includes energy price, grid rent and taxes. Until 1992, prices are for priority power only. From 1993, both priority and non-priority power. [3] Fuel oil 1 and fuel oil 2 are so similar that they have been combined in the category light fuel oils after 1994. [4] 100 øre = 1 NOK.

Source: Statistics Norway, Norwegian Water Resources and Energy Directorate and Norwegian Petroleum Institute.

Table A.10. Total primary energy supply. World, total and selected countries

	1973	1980	1990	2000	2002	2003	Per unit GDP (2003)	Per unit GDP (2003)	Per capita (2003)
	Mtoe						toe/1 000 2000 USD	toe/1 000 2000 USD PPP[1]	toe/capita
World, total . .	**6 033.4**	**7 150.4**	**8 627.1**	**9 961.5**	**10 235.5**	**10 578.7**	**0.32**	**0.21**	**1.69**
OECD.	3 762.6	4 076.5	4 523.4	5 325.9	5 350.2	5 394.7	0.20	0.19	4.67
Norway	14.6	18.7	21.5	25.8	28.8	23.4	0.13	0.14	5.11
Denmark	19.8	19.8	17.9	19.4	19.7	20.8	0.13	0.13	3.85
Finland	21.4	25.4	29.2	33.0	35.6	37.6	0.30	0.27	7.20
Iceland	1.2	1.5	2.2	3.2	3.4	3.4	0.38	0.40	11.72
Sweden	39.3	40.8	47.6	48.5	52.8	51.5	0.21	0.21	5.75
Belgium	46.3	47.0	49.1	58.9	56.5	59.2	0.25	0.21	5.70
France	184.7	193.6	227.3	257.5	266.0	271.3	0.20	0.17	4.41
Greece	12.4	15.7	22.2	27.8	29.0	29.9	0.23	0.15	2.72
Italy	128.9	132.2	148.0	172.8	173.6	181.0	0.16	0.12	3.12
Netherlands	62.4	65.0	66.6	75.8	78.6	80.8	0.22	0.18	4.98
Poland	93.1	123.0	99.9	89.4	89.1	93.7	0.53	0.22	2.45
Portugal	7.2	10.3	17.8	25.3	26.5	25.8	0.24	0.14	2.47
Spain	52.4	68.6	91.1	124.7	131.6	136.1	0.22	0.15	3.34
United Kingdom	220.7	201.3	212.2	233.0	228.5	232.0	0.15	0.15	3.91
Switzerland	19.7	20.9	25.1	26.5	27.1	27.1	0.11	0.12	3.66
Czech Republic .	45.4	47.3	47.4	40.4	41.7	44.1	0.73	0.27	4.32
Turkey	24.4	31.5	53.0	77.5	75.6	79.0	0.38	0.16	1.12
Germany	337.9	360.4	356.2	343.6	346.0	347.1	0.18	0.17	4.21
Hungary.	21.3	28.5	28.6	25.0	25.8	26.3	0.51	0.19	2.60
Austria	21.7	23.3	25.0	29.0	31.1	33.2	0.17	0.14	4.10
Canada	159.8	193.0	209.1	251.9	249.2	260.6	0.34	0.28	8.24
Mexico.	53.2	97.1	124.3	150.4	155.6	159.9	0.27	0.17	1.56
United States . . .	1 736.5	1 811.7	1 927.6	2 304.2	2 289.0	2 280.8	0.22	0.22	7.84
Japan	323.5	346.5	445.3	528.6	520.7	517.1	0.11	0.15	4.05
Republic of Korea	21.6	41.4	92.7	190.9	201.0	205.3	0.35	0.23	4.28
Australia.	57.6	70.4	87.5	109.8	111.9	112.7	0.26	0.20	5.63
Non-OECD.	2 270.8	3 073.8	4 103.7	4 635.6	4 885.3	5 184.0	0.79	0.25	1.01
Romania	47.8	65.1	62.4	36.3	37.6	39.0	0.91	0.26	1.79
Russia.	..	..	..	614.0	617.8	639.7	2.09	0.51	4.46
Egypt	8.1	15.3	31.9	46.4	50.9	52.4	0.48	0.21	0.78
Ethiopia	9.4	11.1	15.2	18.7	19.9	20.5	2.92	0.45	0.30
Nigeria	39.0	52.9	70.9	90.5	96.5	97.8	2.01	0.72	0.72
South Africa. . . .	49.1	65.4	91.2	109.1	110.6	118.6	0.86	0.26	2.59
Argentina.	35.6	41.8	46.1	61.9	56.1	59.9	0.23	0.14	1.63
Brazil	82.0	111.9	133.5	185.1	191.0	193.2	0.31	0.15	1.09
Guatemala.	2.9	3.9	4.5	7.2	7.4	7.3	0.35	0.15	0.59
Venezuela	21.3	35.6	43.9	56.7	55.9	54.2	0.53	0.45	2.11
Bangladesh	6.4	8.5	12.8	18.7	21.0	21.7	0.40	0.09	0.16
India.	191.2	243.0	365.4	516.9	538.3	553.4	1.02	0.19	0.52
Indonesia	37.7	56.0	96.1	143.4	157.7	161.6	0.96	0.24	0.75
China[2]	427.3	598.5	879.9	1 140.5	1 231.3	1 409.4	1.02	0.23	1.09
Thailand.	16.4	22.8	43.9	74.6	83.3	88.8	0.63	0.20	1.43

[1] PPP (Purchasing power parity): GDP adjusted to local purchasing power. [2] Excluding Hong Kong.
Source: OECD/IEA: Energy Balances of OECD Countries 2002-2003 and OECD/IEA: Energy Balances of non-OECD Countries 2002-2003

Table A.11. Norway´s net exports of energy commodities. Selected countries and regions. 2005*. NOK Million

	Coal, coke and briquettes	Mineral oil and products	Gas, natural and manufactured	Electricity
Nordic countries.	-1	21 873	2 882	2 882
EFTA.	0	801	87	-
EU	-45	264 845	111 597	2 882
Developing countries.	-176	3 756	1 419	-
Denmark	31	7 852	363	1 005
Finland	-6	1 689	390	9
Sweden	-26	10 868	2 125	1 868
Belgium	-32	1 382	9 979	-
France	30	30 454	20 920	-
Ireland	-15	8 849	-	-
Italy	0	5 444	7 375	-
Netherlands	-59	42 299	10 224	-
Portugal	118	784	29	-
Spain	-19	6 542	3 118	-
UK	-156	121 578	20 651	-
Czech Republic	-3	-26	3 376	-
Turkey	-	1	1 085	-
Germany	485	26 662	32 364	-
China	-87	750	0	-
Canada	-	23 940	4	-
USA	-33	26 841	2 546	-

Source: External trade statistics, Statistics Norway.

Agriculture

Appendix B

Table B.1. Agricultural area in use. km²

	Agricultural area in use, total	Cereals and oil seeds	Other field crops and horticultural crops	Meadows on arable land	Other meadows and pastures
1949	10 264	1 516	1 065	5 350	2 332
1959	9 845	2 178	1 089	4 814	1 765
1969	9 553	2 522	862	4 584	1 585
1979	9 535	3 252	895	4 157	1 232
1989	9 911	3 530	903	4 385	1 093
1999	10 382	3 345	649	4 877	1 511
2000	10 422	3 363	621	4 856	1 581
2001	10 467	3 390	607	4 865	1 605
2002	10 466	3 378	536	4 917	1 635
2003	10 404	3 342	512	4 905	1 644
2004	10 397	3 351	494	4 891	1 660
2005*	10 359	3 316	482	4 873	1 688

Source: Agricultural statistics from Statistics Norway.

Table B.2. Number of holdings by size of agricultural area in use[1]

	Total	-49 decares	50-99 decares	100-199 decares	200-499 decares	500- decares
1949	213 441	150 130	42 526	15 597	4 809	379
1959	198 315	135 830	42 126	15 074	4 870	415
1969	154 977	88 481	42 240	17 938	5 822	496
1979	125 302	62 017	32 716	21 632	8 228	709
1989	99 382	37 031	24 969	25 330	11 194	858
1999	70 740	14 517	16 720	22 286	15 640	1 577
2000	68 539	13 574	15 677	21 411	16 169	1 708
2001	65 607	11 804	14 762	20 541	16 604	1 896
2002	61 890	9 975	13 476	19 555	16 772	2 112
2003	58 231	8 211	12 230	18 669	16 828	2 293
2004	55 507	7 047	11 243	17 754	16 985	2 478
2005*	53 227	6 464	10 321	16 829	16 936	2 677

[1] Up to and including 1989 the figures refer to holdings with at least 5 decares agricultural area in use. As from 1999, joint operations, etc. with less than 5 decares agricultural area in use are included.
Source: Agricultural statistics from Statistics Norway.

Table B.3. Sales of commercial fertilizer expressed as content of nitrogen and phosphorus

	Total, tonnes		Mean quantity (kg) applied per decare agricultural area in use	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus
1980/81	102 513	26 980	10.9	2.9
1981/82	107 546	28 291	11.4	3.0
1982/83	109 120	27 638	11.5	2.9
1983/84	110 648	27 382	11.6	2.9
1984/85	110 803	24 828	11.6	2.6
1985/86	106 011	22 752	11.1	2.4
1986/87	109 807	21 953	11.5	2.3
1987/88	111 208	19 699	11.6	2.0
1988/89	110 138	17 376	11.1	1.8
1989/90	110 418	16 002	11.1	1.6
1990/91	110 790	15 190	11.0	1.5
1991/92	110 875	14 818	11.1	1.5
1992/93	109 299	13 722	10.8	1.4
1993/94	108 287	13 688	10.6	1.3
1994/95	110 851	13 291	10.8	1.3
1995/96	111 976	13 836	10.9	1.3
1996/97	112 879	13 522	10.9	1.3
1997/98	112 327	13 408	10.7	1.3
1998/99	106 017	13 092	10.2	1.3
1999/00	107 410	13 325	10.3	1.3
2000/01	100 592	12 399	9.6	1.2
2001/02	101 258	12 593	9.7	1.2
2002/03	104 162	12 643	10.0	1.2
2003/04	105 096	12 786	10.1	1.2
2004/05	106 882	12 660	10.3	1.2

Source: Agricultural statistics from Statistics Norway and Norwegian Food Safety Authority.

Table B.4. Sales of pesticides. Environmental taxes on pesticides

	Sales of pesticides. Quantity of active substances					Taxes as per cent of purchase price[1]		Taxes		
	Total	Fungi-cides	Insecti-cides	Herbi-cides	Other sub-stances includ-ing addi-tives	Environ-mental tax	Control fee	Total	Environ-mental tax	Control fee and registra-tion fee
	Tonnes					Per cent		NOK million		
1985	1 529.3	138.4	38.7	1 236.2	116.1	-	-	-	-	-
1986	1 513.9	144.3	47.3	1 188.2	134.1	-	-	-	-	-
1987	1 323.2	110.9	32.1	1 057.8	122.5	-	-	-	-	-
1988	1 193.6	107.8	37.9	919.2	128.7	2.0	5.5	..	1.5	..
1989	1 033.8	119.3	27.5	856.9	30.1	8.0	6.0	30.3	17.3	..
1990	1 183.5	153.0	19.0	965.1	46.4	11.0	6.0	28.5	20.2	8.3
1991	771.0	144.2	18.4	563.6	44.8	13.0	6.0	26.7	18.8	7.9
1992	781.0	148.6	26.9	561.2	44.3	13.0	6.0	31.6	22.5	9.1
1993	764.5	179.7	16.9	510.0	57.9	13.0	6.0	32.0	21.9	10.1
1994	861.6	156.7	22.0	625.9	57.0	13.0	6.0	30.7	21.0	9.7
1995	931.3	167.3	20.4	688.9	54.7	13.0	6.0	27.6	18.9	8.7
1996	706.2	139.7	15.8	503.2	47.4	15.5	7.0	32.3	21.8	10.5
1997	754.2	175.4	19.5	503.8	55.5	15.5	7.0	30.4	21.0	9.5
1998	954.6	263.3	22.8	544.3	124.3	15.5	9.0	37.9	24.1	13.8
1999	796.3	219.9	23.8	448.7	103.9	.	.	52.6	35.4	17.2
2000	380.2	53.8	10.0	283.4	33.0	.	.	68.7	52.9	15.8
2001	518.7	119.9	8.5	377.2	13.1	.	.	44.6	34.9	9.7
2002	818.5	149.6	10.1	632.2	26.6	.	.	72.3	56.1	16.2
2003	688.5	167.1	13.6	462.6	45.2	.	.	83.6	65.4	18.2
2004	869.0	227.7	10.1	504.3	127.0	.	.	110.2	85.4	24.8
2005	529.6	69.3	7.6	425.7	27.0	.	.	62.5	49.1	13.3

[1] As from 1999 the taxes are no longer based on a fixed percentage rate of purchase price but are differentiated according to health and environmental risk of the substances.

Source: Norwegian Food Safety Authority.

Table B.5. Organic farming

	No. of holdings inspected for organic farming	Area approved as organically operated	Area under conversion	No. of dairy cows approved for organic farming	No. of sheep approved for organic farming[1]	Total grants to organic farming	Of which conversion and acreage support
		Decares				NOK million	
1986	19	..	..	..	..	-	-
1987	43	..	..	..	..	-	-
1988	55	..	..	..	..	-	-
1989	92	..	..	..	..	5	-
1990	273	..	..	..	..	13	4
1991	423	18 145	6 288	237	3 007	20	7
1992	479	26 430	5 826	193	6 524	23	8
1993	517	32 343	5 444	294	7 102	22	6
1994	561	38 278	6 916	437	10 064	22	6
1995	738	44 596	13 082	572	10 628	23	6
1996	952	46 573	32 401	766	13 291	35	14
1997	1 316	73 921	43 143	1 816	18 895	35	21
1998	1 627	105 200	50 615	2 705	29 812	33	13
1999	1 762	149 510	38 225	2 998	18 393	54	37
2000	1 840	180 841	24 387	3 531	20 776	59	35
2001	2 099	197 900	68 831	3 729	22 911	76	54
2002	2 303	252 556	72 904	4 070	47 907	85	58
2003	2 466	308 835	72 954	5 226	30 930	92	65
2004	2 484	349 567	60 793	5 643	33 589	111	81
2005	2 496	365 002	65 325	5 461	31 962	100	67

[1] Up to and including 1998 the registration date was 31 July, in 1999-2001 the registration date was 31 December, in 2002 the registration date again was 31 July while in 2003 and onwards the registration date is 31 December.
Source: Debio and Norwegian Agricultural Authority.

Forest and uncultivated land

Appendix C

Table C.1. Forest balance 2004. 1 000 m^3 without bark

	Total	Spruce	Pine	Broad-leaved trees
Growing stock as of 01.01	737 708	323 866	246 630	167 212
Total losses	11 328	7 271	2 359	1 698
Of which total roundwood cut	8 994	6 143	1 845	1 006
Sales, excl. fuelwood	7 353	5 602	1 703	48
Fuelwood, sales and private	1 439	379	105	955
Own use	202	163	37	3
Other losses	2 334	1 128	514	692
Logging waste	580	369	111	101
Natural losses	1 754	759	404	591
Total increments	25 289	12 650	6 730	5 909
Volume as of 31.12	751 669	329 246	251 000	171 423

Source: Statistics Norway and Norwegian Institute for Land Inventory.

Table C.2. Growing stock under bark and annual increment. 1 000 m^3

	Growing stock				Annual increment			
	Total	Spruce	Pine	Broad-leaved	Total	Spruce	Pine	Broad-leaved
Whole country								
1933	322 635	170 960	90 002	61 673	10 447	5 835	2 535	2 077
1967	435 121	226 168	133 972	74 981	13 200	7 131	3 364	2 706
1990	578 317	270 543	188 279	119 495	20 058	10 528	5 200	4 330
2001/2005[1]	739 025	331 238	244 397	163 390	25 763	13 867	6 165	5 731
Region, 2001/2005								
Østfold, Akershus/Oslo, Hedmark	205 354	104 941	76 393	24 020	7 810	4 521	2 245	1 044
Oppland, Buskerud, Vestfold	160 016	90 558	43 365	26 093	5 608	3 548	1 004	1 055
Telemark, Aust-Agder, Vest-Agder	132 762	43 048	59 066	30 648	4 384	1 850	1 410	1 125
Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal	95 941	26 978	36 523	32 440	3 617	1 714	858	1 045
Sør-Trøndelag, Nord-Trøndelag	88 832	52 203	20 076	16 553	2 608	1 646	407	555
Nordland, Troms	52 705	13 509	6 307	32 889	1 646	588	167	891
Finnmark	3 415	1	2 667	747	90	0	74	16

[1] Volume and average annual increment for all types of land use classes for 2001-2005 in counties inventoried and Finnmark.
Source: Norwegian Institute for Land Inventory. (Figures from inventories supplemented by calculations by Statistics Norway for Finnmark, where no inventory has been carried out.).

Table C.3. Registered non-harvest mortality of cervids

Hunting year	Total				Killed by motor car or train				Felled as pests, felled illegally or killed by other causes			
	Moose	Red deer	Wild rein-deer	Roe deer	Moose	Red deer	Wild rein-deer	Roe deer	Moose	Red deer	Wild rein-deer	Roe deer
1987/1988......	2 167	365	279	2 044	1 200	157	6	1 396	967	208	273	648
1988/1989......	2 036	444	122	2 140	1 016	200	4	1 632	1 020	244	118	508
1989/1990......	2 152	411	137	1 955	962	171	4	1 537	1 190	240	133	418
1990/1991......	2 466	485	124	2 684	1 210	201	4	2 065	1 256	284	120	619
1991/1992......	2 554	544	132	3 034	1 324	284	5	2 427	1 230	260	127	607
1992/1993......	3 748	715	233	4 195	2 048	376	5	3 327	1 700	339	228	868
1993/1994......	4 155	1 061	125	6 621	2 481	461	5	4 007	1 674	600	120	2 614
1994/1995......	3 405	915	72	4 601	1 757	374	-	3 057	1 648	541	72	1 544
1995/1996......	2 915	874	88	4 233	1 650	383	1	3 045	1 265	491	87	1 188
1996/1997......	3 378	985	89	4 587	2 010	515	4	3 513	1 368	470	85	1 074
1997/1998......	2 962	995	133	3 895	1 582	443	6	3 091	1 380	552	127	804
1998/1999......	3 215	958	123	4 097	1 886	488	7	3 259	1 329	470	116	838
1999/2000......	3 186	1 183	104	3 893	1 921	543	5	3 118	1 265	640	99	775
2000/2001......	3 338	1 082	65	4 132	1 968	461	5	3 313	1 370	621	60	819
2001/2002......	3 114	1 189	51	4 094	1 945	611	7	3 350	1 169	578	44	744
2002/2003......	4 071	997	58	4 444	2 602	540	5	3 579	1 469	457	53	865
2003/2004......	3 408	1 067	31	4 006	2 244	629	3	3 371	1 164	438	27	635
2004/2005......	2 935	1 254	46	4 354	1 762	701	11	3 752	1 173	553	35	602
2005/2006*.....	3 157	1 179	335	5 273	1 913	635	9	3 916	1 244	544	326	1 357

Source: Hunting statistics, Statistics Norway.

Table C.4. Registered mortality of large carnivores and eagles

Hunting year	Bear	Wolf	Wolverine	Lynx	White-tailed eagle	Goshawk	Golden eagle
1993/1994......................	3	-	13	48	45	60	11
1994/1995......................	1	-	17	64	36	63	8
1995/1996......................	1	-	16	103	44	44	11
1996/1997......................	3	-	17	113	42	44	14
1997/1998......................	3	-	19	127	50	37	9
1998/1999......................	5	1	22	105	40	31	9
1999/2000......................	5	2	31	101	24	31	14
2000/2001......................	6	17	41	98	32	17	8
2001/2002......................	3	2	48	102	40	26	10
2002/2003......................	1	7	38	71	26	45	19
2003/2004......................	4	6	39	46	31	44	8
2004/2005......................	1	7	50	58	43	27	12
2005/2006*.....................	6	5	63	51	43	15	10
Cause of death 2005/2006:							
Killed by vechicle or train...........	-	3	1	4	3	2	3
Felled by permit[1]	3	1	18	3	-	1	-
Licenced hunting of wolverine	.	.	36	.	.	.	.
Licenced hunting of wolf...........	.	-	.	.	.	.	.
Quota hunting of lynx.............	.	.	.	40	.	.	.
Other causes[1]	3	1	8	4	40	12	7

[1] Including animals felled in self-defence or illegally, unknown reasons, etc.
Source: Hunting statistics, Statistics Norway.

Fisheries, sealing, whaling and fish farming

Appendix D

Table D.1. Stock trends for some important fish stocks. 1 000 tonnes

	North-East Arctic cod[1]	North-East Arctic haddock[1]	North-East Arctic saithe[1]	Arctic Greenland halibut[6]	Barents Sea capelin[2, 4]	Norwegian springspawning herring[3]	North Sea herring[3]	North Sea cod[3]
1984	820	70	330	90	3 300	600	680	130
1985	960	170	270	90	1 090	500	700	120
1986	1 290	330	280	90	160	400	680	110
1987	1 130	330	330	80	110	880	900	100
1988	920	260	340	80	360	2 740	1 200	90
1989	890	210	300	90	770	3 340	1 250	90
1990	960	170	250	80	4 900	3 490	1 190	80
1991	1 560	200	360	70	6 650	3 630	980	70
1992	1 910	270	560	50	5 370	3 500	710	70
1993	2 360	450	700	50	990	3 350	470	80
1994	2 150	570	670	50	260	3 780	510	80
1995	1 830	560	830	60	190	4 590	460	100
1996	1 690	500	880	70	470	6 110	460	100
1997	1 530	380	910	70	870	7 310	550	90
1998	1 230	280	1 000	80	1 860	6 560	730	80
1999	1 100	290	1 070	80	2 580	5 930	860	70
2000	1 100	300	1 090	80	3 840	4 640	870	50
2001	1 380	430	1 140	90	3 480	3 880	1 320	40
2002	1 540	520	1 260	90	2 145	3 920	1 620	40
2003	1 580	570	1 120	100	680	5 110	1 740	40
2004	1 510	560	1 140	100	720	6 510	1 810	50
2005	1 440	570	1 000	100	390	6 100	1 700	..
2006	1 320	510	980	..	..	6 400	1 330	..

	North Sea haddock[3]	North Sea saithe[3,5]	North Sea whiting[3]	North Sea plaice[3]	North Sea sole[3]	Blue whiting (northern and southern stock[3]	Mackerel (North Sea, western and southern)[3]
1984	200	170	270	330	40	1 550	2 570
1985	240	160	270	350	40	1 650	2 540
1986	220	150	290	370	40	1 860	2 520
1987	150	150	300	450	30	1 660	2 490
1988	150	140	300	390	40	1 470	2 490
1989	120	110	280	420	30	1 410	2 540
1990	80	100	320	370	90	1 340	2 390
1991	60	90	280	340	80	1 800	2 650
1992	100	90	270	270	80	2 440	2 650
1993	140	100	240	230	60	2 390	2 470
1994	150	110	220	200	70	2 360	2 260
1995	150	130	230	180	60	2 180	2 370
1996	180	160	200	180	40	2 020	2 320
1997	190	200	170	190	30	2 060	2 370
1998	160	190	140	200	20	2 830	2 270
1999	120	200	140	150	40	3 430	2 320
2000	90	190	170	210	40	3 560	2 150
2001	230	210	190	250	30	4 010	2 170
2002	350	200	180	180	40	4 880	1 780
2003	340	220	150	200	30	5 730	1 820
2004	290	240	120	170	40	5 110	1 980
2005	270	240	..	210	40	4 940	2 340
2006	..	..	..	190	40	..	..

[1] Fish aged 3 years and older. [2] Fish aged 1 year and older. [3] Spawning stock. [4] As of 1 August. [5] Including saithe west of Scotland.
[6] Fish aged 5 years and older.
Source: ICES and the Institute of Marine Research.

Table D.2. Norwegian catches by species and groups of species. 1 000 tonnes

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003*	2004*	2005*
Total	2 584	2 526	2 702	2 820	3 055	3 040	2 809	2 891	2 862	2 923	2 702	2 672	2 546
Cod	275	374	365	358	401	321	257	219	209	228	217	231	226
Haddock	44	74	80	97	106	79	53	46	52	55	59	65	63
Saithe	188	189	219	222	184	194	198	170	170	203	212	211	231
Tusk	27	20	19	19	14	21	23	22	19	18	13	12	12
Ling/Blue ling	20	19	19	19	16	23	20	18	15	16	15	15	15
Greenland halibut	15	13	14	17	12	12	20	13	15	12	13	17	16
Redfish	33	29	22	30	23	29	31	26	29	16	17	17	13
Others and unspecified[2]	57	31	27	32	40	43	29	29	40	29	28	29	24
Capelin	530	113	28	208	158	88	92	371	483	522	249	49	67
Mackerel	224	260	202	137	137	158	161	174	181	184	164	157	120
Herring	352	539	687	763	923	832	829	800	581	574	563	616	748
Sprat	47	44	41	59	7	35	22	6	12	3	3	2	2
Other industrial fisheries[1]	541	587	745	642	798	964	828	734	811	804	922	1 037	798
Crustaceans and molluscs	61	48	49	44	45	61	68	71	70	75	72	67	56
Seaweed	170	185	185	173	192	180	179	192	175	183	153	148	154

[1] Includes lesser and greater silver smelt, Norway pout, sandeel, blue whiting and horse mackerel. [2] Includes the groups Other pelagic fish, Hake/pollack/whiting, Other demersal fish, Various deep water species and Other and unspecified fish.
Source: Directorate of Fisheries.

Table D.3. Use of antibacterial agents in fish farming. kg of active ingredients

	Total	Oxytetra-cyclin-chloride	Nifura-zolidone	Oxolinic acid	Trimeto-prim + sulphadi-azine (Tribrissen)	Sulpha-merazine	Flume-quin	Flor-fenicol
1981	3 640	3 000	-	-	540	100	-	-
1982	6 650	4 390	1 600	-	590	70	-	-
1983	10 130	6 060	3 060	-	910	100	-	-
1984	17 770	8 260	5 500	-	4 000	10	-	-
1985	18 700	12 020	4 000	-	2 600	80	-	-
1986	18 030	15 410	1 610	-	1 000	10	-	-
1987	48 570	27 130	15 840	3 700	1 900	-	-	-
1988	32 470	18 220	4 190	9 390	670	-	-	-
1989	19 350	5 014	1 345	12 630	32	-	329	-
1990	37 432	6 257	118	27 659	1 439	-	1 959	-
1991	26 798	5 751	131	11 400	5 679	-	3 837	-
1992	27 485	4 113	-	7 687	5 852	-	9 833	-
1993	6 144	583	78	2 554	696	-	2 177	56
1994	1 396	341	-	811	3	-	227	14
1995	3 116	70	-	2 800	-	-	182	64
1996	1 037	27	-	841	-	-	105	64
1997	746	42	-	507	-	-	74	123
1998	679	55	-	436	-	-	53	135
1999	591	25	-	494	-	-	7	65
2000	685	15	-	470	-	-	52	148
2001	645	12	-	517	-	-	7	109
2002	1 219	11	-	998	-	-	5	205
2003	805	45	-	546	-	-	60	154
2004	1 159	9	-	1 035	-	-	4	111
2005	1 215	8	-	977	-	-	28	202

Source: Norwegian Institute of Public Health.

Table D.4. Exports of some main groups of fish products. 1 000 tonnes

	Fresh	Frozen whole	Fillets	Salted or smoked	Dried	Canned, etc.	Meal	Oil
1983	91.5	62.6	91.6	24.9	59.4	22.4	283.9	128.0
1984	72.9	78.7	98.5	24.6	69.5	22.7	248.9	76.9
1985	74.5	79.5	95.9	20.3	64.6	23.4	173.9	114.3
1986	139.4	98.8	95.2	22.7	62.9	24.4	92.6	38.8
1987	189.6	114.2	105.0	38.0	40.6	24.3	88.3	71.3
1988	212.5	126.7	105.1	36.9	47.0	22.9	68.9	45.6
1989	215.1	159.8	95.2	46.2	48.0	23.2	45.4	39.1
1990	238.8	263.4	71.0	34.6	50.6	23.9	45.3	42.7
1991	249.6	366.9	68.7	48.6	50.3	23.0	110.8	58.5
1992	258.8	351.6	103.2	48.0	57.4	23.9	140.1	53.7
1993	309.1	412.4	141.3	66.4	62.6	23.9	139.6	62.0
1994	307.4	518.2	195.2	100.1	66.5	26.4	72.0	63.5
1995	341.1	579.7	210.8	94.4	70.5	20.6	66.1	85.6
1996	369.5	682.7	234.3	91.5	76.1	19.3	87.1	68.1
1997	427.2	801.5	241.4	82.3	75.7	18.0	64.0	55.1
1998	486.0	637.5	238.7	79.0	84.9	19.1	154.4	38.2
1999	490.5	791.0	247.6	65.6	65.7	17.7	153.6	48.5
2000	461.1	904.0	248.1	54.4	75.0	15.8	88.0	50.9
2001	417.0	908.8	208.1	53.6	76.4	12.9	85.8	39.0
2002	433.9	931.0	176.4	48.0	75.3	12.3	123.5	34.8
2003	512.6	822.4	203.7	43.2	71.2	9.9	74.0	34.6
2004	492.3	760.8	189.8	44.1	82.2	13.2	68.6	22.8
2005*	520.3	786.5	204.0	40.3	80.3	17.3	53.9	21.0

Source: External Trade Statistics from Statistics Norway.

Table D.5. Exports of fish and fish products by important recipient countries. NOK Million

	Total	EU-countries, total	Of this				Other countries, total	Of this	
			France	Denmark	United Kingdom	Germany		Japan	Russia
1983	7 367.7	3 186.2	568.8	337.2	1 022.1	515.0	4 181.3	334.5	..
1984	7 675.2	3 233.3	530.3	350.3	1 026.7	545.8	4 442.1	408.2	..
1985	8 172.3	3 605.0	605.1	377.1	1 202.0	632.8	4 567.8	463.8	..
1986	8 749.4	4 293.9	781.0	626.9	1 014.2	705.5	4 455.5	408.8	..
1987	9 992.3	5 597.0	1 114.1	926.7	1 059.1	754.2	4 395.3	501.0	..
1988	10 693.1	6 107.2	1 318.6	1 115.1	987.2	932.3	4 585.9	808.0	..
1989	10 999.2	6 416.1	1 305.5	1 196.0	1 019.5	892.9	4 583.1	755.7	..
1990	13 002.4	8 119.2	1 617.1	2 046.3	868.8	1 046.5	4 883.3	1 067.5	..
1991	14 940.4	9 114.8	1 534.8	2 021.9	991.0	1 196.1	5 825.6	1 797.7	..
1992	15 385.2	10 180.2	1 850.7	1 794.1	1 388.9	1 309.3	5 205.0	1 366.3	..
1993	16 619.1	10 365.3	1 835.9	1 690.1	1 542.3	1 369.2	6 253.8	1 810.3	61.0
1994	19 536.9	11 709.4	2 250.3	1 767.8	1 484.5	1 698.3	7 827.5	1 999.2	262.7
1995	20 095.0	13 176.4	2 138.0	2 192.2	1 591.4	1 605.4	6 918.6	1 987.5	513.8
1996	22 444.5	13 839.2	2 167.5	2 431.0	1 765.1	1 529.5	8 605.2	2 503.8	932.1
1997	24 632.3	14 531.5	2 274.3	2 640.9	2 022.2	1 532.0	10 100.8	2 752.2	1 572.8
1998	28 164.5	17 845.6	2 540.3	3 112.5	2 819.2	1 948.1	10 319.0	2 797.8	1 373.4
1999	29 740.4	18 105.4	2 669.1	3 020.8	2 710.0	1 722.2	11 634.9	4 408.2	766.3
2000	31 456.7	18 295.5	2 702.4	3 654.9	2 683.1	1 655.7	13 161.4	4 218.9	1 174.1
2001	30 645.5	16 930.5	2 340.2	3 032.6	2 204.0	1 460.7	13 715.0	4 105.5	1 548.1
2002	28 718.5	15 475.2	2 190.8	2 941.9	2 002.9	1 389.1	13 243.3	3 699.3	1 834.0
2003	26 326.0	14 799.4	2 309.1	3 060.9	1 473.1	1 413.0	11 526.6	2 513.8	1 975.9
2004	28 351.5	17 151.1	2 464.4	2 974.2	1 583.5	1 444.9	11 200.3	2 612.3	2 538.3
2005*	32 287.6	19 101.4	3 065.1	3 086.7	2 066.8	1 326.8	13 186.2	2 640.5	3 764.4

Source: External Trade Statistics from Statistics Norway.

Table D.6. Exports of salmon

	Total		Farmed salmon. Fresh, chilled and frozen		Fresh and frozen fillets, smoked, gravlax, other salmon, etc.[1]	
	Amount 1000 tonnes	Value NOK Million	Amount 1000 tonnes	Value NOK Million	Amount 1000 tonnes	Value NOK Million
1983	15.9	743.8	15.4	709.1	0.5	34.6
1984	20.4	998.5	19.6	944.8	0.7	53.7
1985	24.9	1 385.4	24.0	1 308.8	0.9	77.1
1986	40.1	1 773.4	38.9	1 663.7	1.2	109.7
1987	44.6	2 308.8	43.2	2 174.4	1.4	134.3
1988	66.9	3 175.7	66.0	3 079.7	1.0	96.0
1989	98.2	3 681.4	95.5	3 486.1	2.7	195.3
1990	132.9	5 043.3	130.7	4 834.9	2.2	208.4
1991	134.7	4 998.9	126.6	4 449.6	8.1	549.3
1992	133.3	5 117.8	122.1	4 399.9	11.1	717.9
1993	143.1	5 365.0	131.0	4 553.2	12.1	811.8
1994	170.3	6 476.4	153.8	5 425.3	16.4	1 051.1
1995	207.3	6 790.3	189.1	5 660.8	18.2	1 129.5
1996	238.1	6 991.6	214.1	5 692.9	24.0	1 298.7
1997	261.4	7 657.0	233.1	6 191.0	28.3	1 466.0
1998	282.0	8 761.9	252.3	7 135.9	29.7	1 626.0
1999	336.8	10 726.3	295.6	8 385.2	41.2	2 341.1
2000	343.1	12 271.9	304.0	9 797.7	39.1	2 474.2
2001	338.4	9 999.9	299.6	7 770.0	38.8	2 229.9
2002	360.6	9 534.2	315.6	7 358.8	45.0	2 175.5
2003	414.5	10 045.9	363.7	7 747.8	50.7	2 298.1
2004	441.2	11 204.6	388.8	8 788.0	52.4	2 416.6
2005*	472.9	13 521.7	424.8	11 161.5	48.2	2 360.2

[1] Mainly farmed salmon, but other categories are also included.
Source: External Trade Statistics from Statistics Norway.

Table D.7. Catch quantities[1] and export value[2] of fish and fish products. Selected countries

Country[3]	2000		2001		2002		2003		2004	
	Catch quantity	Export value	Catch quantity	Export value	Catch quantity	Export value	Catch quantity	Export value	Catch quantity	Export value
	1000 tonnes	Million USD	1000 tonnes	Million USD	1000 tonnes	Million USD	1000 tonnes	Million USD	1000 tonnes	Million USD
World, total	95 613	55 295	93 086	56 291	93 268	58 356	90 530	63 686	95 007	71 508
China[4]	16 987	3 603	16 529	3 999	16 553	4 485	16 756	5 243	16 893	6 637
Peru	10 658	1 129	7 983	1 213	8 765	1 067	6 086	1 031	9 613	1 387
USA	4 718	3 055	4 944	3 316	4 937	3 260	4 939	3 399	4 960	3 851
Chile	4 300	1 794	3 797	1 939	4 272	1 869	3 613	2 134	4 935	2 484
Indonesia	4 083	1 584	4 242	1 533	4 323	1 491	4 627	1 551	4 811	1 654
Japan	4 986	802	4 703	768	4 361	789	4 670	923	4 401	1 077
India	3 666	1 405	3 777	1 248	3 737	1 421	3 712	1 307	3 616	1 365
Russia	3 973	1 386	3 628	1 551	3 232	1 421	3 281	1 483	2 942	1 525
Thailand	2 997	4 367	2 834	4 039	2 843	3 676	2 850	3 906	2 845	4 034
Norway	2 699	3 533	2 687	3 364	2 740	3 569	2 549	3 624	2 522	4 132
Philippines	1 897	400	1 949	374	2 031	415	2 166	428	2 212	413
Viet Nam	1 623	1 481	1 725	1 782	1 802	2 030	1 856	2 202	1 879	2 403
Iceland	1 983	1 229	1 981	1 270	2 130	1 429	1 978	1 508	1 728	1 770
Myanmar	1 093	..	1 188	..	1 284	252	1 344	317	1 587	319
Korea Rep	1 825	1 386	1 991	1 156	1 671	1 046	1 643	1 003	1 575	1 139

[1] Catch quantities include marine and inland waters fisheries, but not aquaculture production. Whales, seals and other marine mammals and marine plants are not included. [2] Aquaculture production is included in the export figures. [3] The countries are ranked according to catch quantities in 2004. [4] Catch data, considered to be overstated since the early 1990s, under review and subject to possible downward revisions.
Source:FAO.

Table D.8. Total catches[1] in world fisheries. 2004

	1000 tonnes	Per cent
Total catches	**95 007**	**100**
By area:		
Inland waters	9 219	9.7
Marine areas	85 788	90.3
By animal group:		
Fishes	80 985	85.2
Crustaceans	6 196	6.5
Molluscs	7 319	7.7
Others	507	0.5
Catches in marine areas by various distributions		
Marine catches, total	**85 788**	**100**
By marine fishing areas:		
North Atlantic	12 325	14.4
Central Atlantic	5 046	5.9
Mediterranean and Black Sea	1 530	1.8
South Atlantic	3 597	4.2
Indian Ocean	9 779	11.4
North Pacific	24 608	28.7
Central Pacific	12 712	14.8
South Pacific	16 190	18.9
By continents:		
Africa	4 989	5.8
North America	8 071	9.4
South America	17 074	19.9
Asia	40 630	47.4
Europe	13 555	15.8
Oceania	1 304	1.5
Other, not elsewhere specified	165	0.2
By species:		
Anchoveta - *Engraulis ringens*	10 679	12.4
Alaska pollock - *Theragra chalcogramma*	2 692	3.1
Blue whiting - *Micromesistius poutassou*	2 428	2.8
Skipjack tuna - *Katsuwonus pelamis*	2 092	2.4
Atlantic herring - *Clupea harengus*	2 020	2.4
Chub mackerel - *Scomber japonicus*	2 017	2.4
Japanese anchovy - *Engraulis japonicus*	1 796	2.1
Chilean jack mackerel - *Trachurus murphyi*	1 779	2.1
Largehead hairtail - *Trichiurus lepturus*	1 587	1.8
Yellowfin tuna - *Thunnus albacares*	1 384	1.6
European pilchard - Sardina pilchardus	1 062	1.2
Atlantic cod - *Gadus morhua*	900	1.0
Jumbo flying squid - *Dosidicus gigas*	799	0.9
Atlantic mackerel - *Scomber scombrus*	709	0.8
European sprat - *Sprattus sprattus*	684	0.8
Californian pilchard - *Sardinops caeruleus*	684	0.8
Akiami paste shrimp - *Acetes japonicus*	681	0.8
Capelin - *Mallotus villosus*	661	0.8
European anchovy - *Engraulis encrasicolus*	612	0.7
Argentine hake - *Merluccius hubbsi*	481	0.6
Round sardinella - *Sardinella aurita*	474	0.6
Gulf menhaden - *Brevoortia patronus*	464	0.5
Japanese flying squid - *Todarodes pacificus*	447	0.5
Northern prawn - *Pandalus borealis*	446	0.5
Japanese Spanish mackerel - *Scomberomorus niphonius*	428	0.5
Bigeye tuna - *Thunnus obesus*	405	0.5
Saithe - *Pollachius virens*	403	0.5

[1] Not including farmed fish. Not including whales, seals and other sea mammals and aquatic plants.
Source:FAO.

Water resources and water supply

Appendix E

Table E.1. Water sources, number of water works and number of people supplied. By county. 2004

	Total		Lake[1]		River/stream		Ground water	
	Number of water works[3]	Number of people	Number of water works	Number of people	Number of water works	Number of people	Number of water works	Number of people
Whole country[3]	**1 502**	**4 128 350**	**596**	**3 374 500**	**365**	**351 300**	**571**	**400 900**
Østfold	25	232 400	15	156 850	4	57 200	8	18 350
Akershus	28	466 550	19	344 650	1	120 350	8	1 500
Oslo	1	527 000	1	527 000	-	-	-	-
Hedmark	96	147 650	11	71 000	6	1 050	81	75 350
Oppland	76	129 300	19	72 150	7	3 050	50	54 100
Buskerud	64	230 950	16	158 900	-	-	48	72 100
Vestfold	34	205 750	10	199 250	-	-	24	5 950
Telemark	55	142 950	21	113 850	3	12 000	33	16 800
Aust-Agder	32	87 800	18	79 300	5	2 400	9	6 100
Vest-Agder	38	140 600	14	122 000	4	1 100	20	17 500
Rogaland	48	364 500	34	356 200	6	2 750	12	5 550
Hordaland	155	383 000	83	337 150	32	24 750	41	21 150
Sogn og Fjordane	104	78 650	43	47 400	36	15 850	27	15 400
Møre og Romsdal	155	221 650	57	178 250	53	25 150	49	17 750
Sør-Trøndelag	112	253 350	49	220 300	12	2 300	53	30 750
Nord-Trøndelag	71	104 600	36	95 200	8	1 550	30	7 850
Nordland	205	210 650	87	166 800	85	37 050	39	6 600
Troms	125	131 650	30	99 750	76	27 550	20	4 350
Finnmark	77	67 700	32	27 400	26	16 450	19	23 850
Svalbard[2]	1	1 750	1	1 100	1	650	-	-

[1] Including 4 waterworks supplying 475 persons from sea water in Sør-Trøndelag and Nordland county. [2] One waterworks in Svalbard has two main water sources of different types. [3] The table contains information from 1544 water works. As some water works use several sources of water of different types, the total figure given in the table is higher than 1544.
Source: Norwegian Institute of Public Health.

Table E.2. Water fees, for a private dwelling of 120 m^2. Counties. 2006. NOK

		Two-level fee system		Payment by water used		Connection fee	
	Fixed annual fee	Variable portion (NOK per m^3 water used)	Fixed portion	Variable portion (NOK per m^3 water used)	Minimum use charged, m^3	Lowest level	Highest level
Country average							
2 004	2 076	7.06	1 145	9.16	146	7 331	10 556
2 005	2 132	7.22	1 079	8.05	149	7 596	10 828
2 006	2 084	7.37	1 029	8.07	147	7 712	10 659
County average							
Østfold	2 156	8.07	598	9.20	82	7 053	10 092
Akershus	1 911	9.00	843	8.98	95	10 348	17 178
Oslo	984	5.73	91	.	.	.	12 695
Hedmark	2 625	12.04	785	11.69	79	7 833	12 135
Oppland	2 099	9.86	890	10.53	132	7 363	13 558
Buskerud	2 321	9.29	585	10.90	109	8 276	12 677
Vestfold	1 794	5.52	778	6.17	147	12 233	12 229
Telemark	2 121	7.91	1 664	8.04	137	3 610	3 621
Aust-Agder	1 800	5.66	980	5.42	143	7 868	9 748
Vest-Agder	1 529	5.81	738	5.64	68	6 192	10 803
Rogaland	1 630	5.63	872	5.84	194	7 694	10 191
Hordaland	2 389	7.73	1 324	8.48	129	10 018	12 574
Sogn og Fjordane	2 400	7.07	1 232	8.25	174	6 735	10 474
Møre og Romsdal	2 267	6.59	1 462	7.66	212	6 150	9 294
Sør-Trøndelag	2 523	7.84	1 580	8.39	256	9 003	13 378
Nord-Trøndelag	2 364	7.62	1 318	8.33	164	7 157	10 624
Nordland	2 362	6.97	1 341	8.28	174	5 220	10 348
Troms	2 128	5.77	1 147	7.49	213	4 600	4 981
Finnmark	2 190	5.92	1 323	5.98	.	11 466	5 923

Source: Environmental protection expenditure statistics, Statistics Norway.

Land use

Appendix F

Table F.1. Urban settlements with more than 20 000 inhabitants. 1 January 2006

	Population	Inhabitants per km²	Total urb. settlemt. area km²	Percentage urb. settlemt. area built on[2]	Percentage urb. settlemt. area covered by roads[2]	Percentage change urb. settlemt. pop. 2000-2006	Percentage change urb. settlemt. area 2000-2006
All urban settlements in Norway	3 607 813	1 594	2 263.1	9.7	15.4	6.2	5.5
Oslo	825 105	2 944	280.3	12.0	14.7	6.7	4.0
Bergen	218 032	2 405	90.6	11.3	17.8	6.0	5.0
Stavanger/Sandnes	177 337	2 361	75.1	13.5	16.3	9.4	7.1
Trondheim	150 049	2 485	60.4	12.7	13.8	6.7	3.7
Fredrikstad/Sarpsborg	98 152	1 523	64.4	10.2	15.0	5.2	3.0
Drammen	91 584	1 894	48.4	11.0	16.3	5.6	3.8
Porsgrunn/Skien	85 408	1 514	56.4	9.2	15.8	2.4	5.4
Kristiansand	64 930	2 107	30.8	11.4	16.4	5.7	5.0
Tromsø	53 042	2 403	22.1	10.9	17.1	7.4	3.8
Tønsberg	45 447	1 502	30.3	9.6	15.0	4.8	2.9
Ålesund[1]	44 706	1 526	29.3	8.4	15.5	24.8	27.6
Haugesund	40 685	1 778	22.9	11.5	18.4	4.0	4.9
Sandefjord	39 849	1 500	26.6	9.3	14.8	7.0	7.4
Bodø	35 106	2 452	14.3	11.9	17.5	8.5	7.3
Moss	34 684	1 960	17.7	11.0	13.9	4.8	7.6
Arendal	31 182	1 228	25.4	7.6	15.4	3.4	5.5
Hamar	29 077	1 642	17.7	12.7	17.2	5.7	6.5
Larvik	23 164	1 645	14.1	12.0	16.4	4.4	7.1
Halden	22 184	1 611	13.8	10.3	15.5	4.2	9.2

[1] As of 1 January 2002, urban settlement 6025 Ålesund/Spjelkavik was combined with Langevåg urban settlement to form 6025 Ålesund urban settlement. [2] Figures as of January 1st 2005.
Source: Land use statistics and population statistics from Statistics Norway.

Table F.2. Area and land use in urban settlements. Whole country. 2005*.

	Area in km²				Land use			
	Total	Of which transport	Of which buildings	Within edge[1]	Number of buildings	Number of residents	Number of businesses	Number of employees
Total	2 219.2	352.7	216.1	244.6	1 690 192	3 560 133	273 575	1 571 192
Detached houses area	811.8	137.5	107.8	47.7	1 161 904	2 160 145	82 281	71 816
Row houses area	60.0	10.3	12.8	1.8	129 214	389 806	10 856	7 160
Multi-dwelling house area	29.4	4.4	8.0	0.5	27 727	448 158	17 546	14 088
Other dwelling area	78.6	12.6	6.8	14.5	92 190	86 476	7 814	25 531
Business area	181.8	18.8	48.2	22.3	106 678	182 993	104 724	992 084
Recreational and green areas	520.7	41.4	10.6	147.6	68 082	71 713	8 119	50 259
Other built up areas	72.7	49.0	8.0	10.2	14 580	59 241	18 143	216 097
Unclassified	464.3	78.6	13.9	93.7	89 817	161 601	24 092	194 157

[1] The edge is a 15 meter wide belt from the outer limit of the urban settlement and inwards.
Source: Land use statistics from Statistics Norway.

Table F.3. Percentage day care centres, schools, residential housing and residents with safe access to recreational areas. 2004*.

	Day care centres	Schools	Blocks of flats	Row, detached, etc. houses	Residents
Whole country	**85**	**88**	**65**	**83**	**80**
Østfold	82	86	68	78	76
Akershus	82	88	77	76	77
Oslo	75	80	61	63	67
Hedmark	87	89	66	86	82
Oppland	90	94	72	90	87
Buskerud	87	91	71	84	82
Vestfold	81	81	55	73	71
Telemark	91	92	75	85	84
Aust-Agder	93	88	64	88	87
Vest-Agder	93	85	67	88	86
Rogaland	77	83	59	73	71
Hordaland	88	89	52	88	83
Sogn og Fjordane	92	96	74	94	91
Møre og Romsdal	88	86	68	89	86
Sør-Trøndelag	83	86	61	83	79
Nord-Trøndelag	89	90	72	89	86
Nordland	91	94	75	92	90
Troms	94	94	73	92	90
Finnmark	94	93	82	90	89

Source: Land use statistics from Statistics Norway.

Table F.4. Percentage of coastline within 100 m from buildings

	1985	1990	2000	2004	2005	2006
Whole country	**22.2**	**22.6**	**23.0**	**23.3**	**23.7**	**23.8**
County nos. 01-03 and 06-12	37.1	37.6	38.3	38.8	39.3	39.4
01 Østfold	41.4	41.7	42.2	42.3	42.3	42.3
02 Akershus	70.4	70.7	71.4	71.5	71.6	71.6
03 Oslo	:	:	78.7	78.9	79.1	79.4
06 Buskerud	66.5	67.3	68.2	68.3	68.4	68.5
07 Vestfold	43.1	43.5	44.2	44.5	44.6	44.7
08 Telemark	57.6	58.1	59.7	60.1	60.4	60.7
09 Aust-Agder	49.1	49.6	50.4	50.8	50.8	50.9
10 Vest-Agder	34.3	35.1	36.6	37.2	37.3	37.3
11 Rogaland	30.7	31.2	32.4	32.7	32.8	32.9
12 Hordaland	32.8	33.3	34.3	34.8	34.9	35.0
14 Sogn og Fjordane	22.0	22.5	23.3	23.6	23.6	23.7
15 Møre og Romsdal	27.7	28.1	28.9	29.3	29.3	29.4
16 Sør-Trøndelag	14.8	15.0	15.6	15.8	15.9	16.0
17 Nord-Trøndelag	13.6	13.8	14.4	14.6	14.7	14.8
18 Nordland	13.2	13.5	14.1	14.4	14.4	14.5
19 Troms	27.2	27.5	28.2	28.5	28.6	28.6
20 Finnmark	12.4	12.5	12.8	12.9	13.0	13.0

Source: Land use statistics from Statistics Norway.

Table F.5. Protected areas[1]. Number[2] and area[3], by county. 31 December

	National parks		Nature reserves		Landscape protected areas		Other area protections[4]	
	Number	Area	Number	Area	Number	Area	Number	Area
		Hectares		Hectares		Hectares		Hectares
1975	13	508 660	53	14 775	8	21 586	2	115
1980	14	622 840	295	21 930	25	63 849	4	200
1985	15	965 040	630	89 515	52	179 524	28	5 193
1990	17	1 255 840	909	142 677	70	422 882	66	10 239
1995	18	1 378 840	1 220	220 966	80	465 867	73	10 776
1996	18	1 378 840	1 293	228 895	82	467 117	75	10 869
1997	18	1 378 840	1 318	242 906	86	506 303	76	11 052
1998	18	1 386 840	1 319	243 019	86	506 303	76	11 052
1999	18	1 386 840	1 352	257 315	88	506 843	76	11 052
2000	18	1 386 840	1 441	279 590	97	779 825	75	9 325
2001	19	1 493 000	1 485	299 500	106	827 800	75	9 300
2002	19	1 702 200	1 615	322 000	126	1 139 300	79	9 700
2003	21	1 839 455	1 659	328 590	135	1 228 405	98	12 406
2004	24	2 165 000	1 701	341 800	153	1 407 100	98	12 500
2005	25	2 219 318	1 753	380 547	159	1 416 260	98	12 500
2005								
Østfold	-	-	74	7 182	4	1 017	2	6
Akershus	-	-	96	12 063	7	2 946	19	133
Oslo	-	-	9	535	3	3 073	12	63
Hedmark	5	103 939	97	66 960	10	88 520	5	7
Oppland	6	251 525	93	31 405	16	87 913	13	461
Buskerud	1	84 669	96	19 411	10	44 192	14	15
Vestfold	-	-	69	1 923	6	487	9	61
Telemark	1	77 251	116	13 654	11	71 502	22	3 329
Aust-Agder	-	-	83	10 736	9	163 237	-	-
Vest-Agder	-	-	87	5 012	9	88 119	14	453
Rogaland	-	-	118	6 177	14	105 314	13	1 405
Hordaland	2	237 359	134	8 407	15	57 780	1	3
Sogn og Fjordane	2	155 412	108	15 581	8	117 840	5	370
Møre og Romsdal	1	58 303	129	14 201	8	214 133	17	570
Sør-Trøndelag	4	169 496	87	21 805	20	110 607	9	254
Nord-Trøndelag	4	292 698	100	39 954	2	9 901	23	4 843
Nordland	5	393 542	175	54 542	18	83 953	4	454
Troms	4	166 842	70	14 855	20	128 193	4	190
Finnmark	4	228 283	51	36 144	9	37 535	2	37
Svalbard[5]	7	1 448 700	21	2 531 400	-	-	1	1 400

[1] The table does not include nature relics (99 geological+about 190 trees) and flora and fauna protections. [2] Some areas are located in more than one county. Thus the sum of the number in the counties is higher than the total number. [3] From 31 Dec. 2003 onwards the area figures are calculated based on digital overlay analysis, a higher accuracy is thus obtained. [4] Flora and fauna protection areas (biotop protections). [5] Protected according to the Svalbard law. These areas are not included in the sum figures for protected areas.
Source: Directorate for Nature Management. More information: http://www.environment.no/

Air pollution and climate

Appendix G

Table G.1. Emissions of greenhouse gases to air

	CO_2	CH_4	N_2O	HFC 23	HFC 32	HFC 125	HFC 134	HFC 143	HFC 152	HFC 227	C_3F_8	CF_4	C_2F_6	SF_6	CO_2 equiva-lents
	Mill. tonnes	1000 tonnes		Tonnes											Mill. tonnes
GWP[1] . .	1	21	310	11 700	650	2 800	1 300	3 800	140	2 900	7 000	6 500	9 200	23 900	
1950 . .	..	131	7	-	-	-	-	-	-	-	..	..	..	..	..
1960 . .	..	175	10	-	-	-	-	-	-	-	..	..	..	..	..
1970 . .	..	216	12	-	-	-	-	-	-	-	..	..	..	..	..
1973 . .	30.6	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1974 . .	27.8	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1975 . .	30.7	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1976 . .	33.4	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1977 . .	33.3	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1978 . .	32.6	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1979 . .	34.6	..	..	-	-	-	-	-	-	-	..	..	..	0	..
1980 . .	31.7	192	13	-	-	-	-	-	-	-	..	..	..	0	..
1981 . .	31.8	..	..	-	-	-	-	-	-	-	..	..	..	1	..
1982 . .	30.9	..	..	-	-	-	-	-	-	-	..	..	..	91	..
1983 . .	31.9	..	..	-	-	-	-	-	-	-	..	..	..	100	..
1984 . .	33.7	..	..	-	-	-	-	-	-	-	..	..	..	185	..
1985 . .	32.2	..	..	-	-	-	-	-	-	-	..	489	20	199	..
1986 . .	34.7	..	..	-	-	-	-	-	-	-	..	479	20	240	..
1987 . .	33.1	224	13	-	-	-	-	-	-	-	..	464	19	240	50.8
1988 . .	35.4	220	14	-	-	-	-	-	-	-	..	443	18	224	52.7
1989 . .	34.0	233	15	-	-	-	-	-	-	-	..	430	18	108	49.0
1990 . .	34.8	227	15	-	-	-	-	-	0	-	..	467	36	92	49.8
1991 . .	33.2	230	15	-	-	-	0	-	0	-	..	417	31	87	47.8
1992 . .	34.2	234	13	-	-	-	0	-	1	-	..	322	21	29	46.0
1993 . .	35.9	238	14	-	-	-	2	-	1	-	..	324	21	31	48.1
1994 . .	37.8	242	14	0	0	0	5	0	1	-	..	287	18	37	50.2
1995 . .	37.8	242	14	0	0	2	10	2	1	-	0	283	18	25	49.9
1996 . .	40.8	243	14	0	0	5	17	4	1	0	0	259	16	24	52.8
1997 . .	41.0	244	14	0	0	10	26	7	2	0	0	230	15	24	52.7
1998 . .	41.1	238	15	0	0	15	38	10	6	0	0	210	13	30	52.9
1999 . .	41.9	231	15	0	1	20	52	15	9	0	0	196	12	37	53.9
2000 . .	41.5	236	15	0	1	26	66	20	12	0	0	186	12	39	53.5
2001 . .	42.9	236	14	0	2	33	80	27	16	0	0	188	12	33	54.7
2002 . .	42.0	228	15	0	2	38	95	32	19	0	0	201	14	10	53.5
2003 . .	43.5	230	14	0	2	38	110	32	23	0	0	126	10	10	54.3
2004* .	44.0	229	15	0	2	39	124	32	29	0	0	122	9	12	54.9
2005* .	43.3	221	15	0	2	39	144	33	36	0	0	117	8	13	54.2

[1] Impact on greenhouse effect of emission of 1 tonne of the gas compared with that of 1 tonne CO_2.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.2. Emissions to air

	SO_2	NO_X	NH_3	Acid equivalents[1]	NMVOC	CO	Particulates[2]
	1 000 tonnes						
1973	156	184	..	..	187	719	..
1974	150	180	..	..	179	679	..
1975	138	185	..	..	200	733	..
1976	147	181	..	..	202	776	..
1977	146	195	..	..	207	822	..
1978	142	188	..	..	166	848	..
1979	144	198	..	..	182	886	..
1980	136	192	20	9.6	173	878	47
1981	128	181	..	..	181	871	..
1982	111	186	..	..	189	879	..
1983	104	191	..	..	201	871	..
1984	96	205	..	..	212	898	..
1985	98	217	..	..	231	901	..
1986	91	231	..	..	249	926	..
1987	73	230	21	8.5	253	887	51
1988	68	226	19	8.2	252	918	..
1989	58	225	21	7.9	273	870	48
1990	52	224	20	7.7	295	868	70
1991	44	214	21	7.2	294	801	65
1992	37	212	22	7.1	323	780	61
1993	35	222	22	7.2	340	782	68
1994	35	220	22	7.2	353	767	69
1995	34	221	23	7.2	367	735	68
1996	33	231	24	7.4	369	707	70
1997	31	233	23	7.4	367	671	74
1998	30	235	23	7.4	360	631	67
1999	29	238	23	7.4	368	595	64
2000	27	224	23	7.1	379	564	64
2001	25	220	23	6.9	389	552	64
2002	23	212	23	6.7	343	546	66
2003	23	215	23	6.7	297	510	62
2004*	25	215	23	6.8	265	483	61
2005*	24	216	23	6.8	222	460	60

[1] Total acidifying effect of SO_2, NOx and NH_3. [2] PM_{10}.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.3. Emissions of greenhouse gases to air by sector. 2004

	CO_2	CH_4	N_2O	HFC[1]	PFC[2]	SF_6	CO_2 equiva-lents
	Mill. tonnes	1000 tonnes		Tonnes			Mill. tonnes
Total	**44.0**	**228.6**	**14.8**	**227.0**	**131.5**	**11.5**	**54.9**
Energy sectors	**15.7**	**41.0**	**0.2**	**2.5**	**0.0**	**2.3**	**16.7**
Extraction of oil and gas[3]	13.4	35.4	0.1	2.3	0.0	-	14.2
Extraction of coal	0.0	2.8	-	0.1	-	-	0.1
Oil refining	1.8	2.6	0.0	0.1	-	-	1.9
Electricity supplies[4]	0.4	0.2	0.0	0.1	-	2.3	0.5
Manufacturing and mining	**11.2**	**10.2**	**6.4**	**45.5**	**131.5**	**8.7**	**14.6**
Oil drilling	0.0	0.1	0.0	0.1	-	-	0.1
Manufacture of pulp and paper	0.6	3.8	0.0	0.1	-	-	0.7
Manufacture of basic chemicals	2.9	0.7	6.1	0.1	-	-	4.8
Manufacture of minerals[5]	1.9	0.0	0.1	0.1	-	-	1.9
Manufacture of iron, steel and ferro-alloys	2.4	0.5	0.2	1.1	-	-	2.5
Manufacture of other metals	2.3	0.0	0.0	1.1	131.5	8.6	3.4
Manufacture of metal goods, boats, ships and oil platforms	0.2	0.0	0.0	26.1	-	0.1	0.2
Manufacture of wood, plastic, rubber, and chemical goods, printing	0.2	5.1	0.0	1.7	-	-	0.3
Manufacture of consumer goods	0.7	0.0	0.0	15.3	0.0	-	0.8
Other	**11.6**	**168.3**	**7.9**	**153.7**	**0.0**	**0.2**	**17.9**
Construction	0.6	0.0	0.1	3.1	-	-	0.7
Agriculture and forestry	0.5	105.4	6.9	2.3	-	-	4.8
Fishing, whaling and sealing	1.4	0.1	0.0	9.0	0.0	-	1.5
Land transport, domestic	4.1	0.2	0.1	13.3	0.0	-	4.2
Sea transport, domestic	1.7	0.4	0.0	4.9	0.0	-	1.7
Air transport[6]	0.9	0.0	0.0	0.8	-	-	1.0
Other private services	1.8	0.4	0.1	111.7	0.0	0.2	2.1
Public sector, municipal[7]	0.2	61.8	0.5	5.6	0.0	-	1.7
Public sector, state	0.4	0.0	0.0	3.2	0.0	-	0.4
Private households	**5.4**	**9.1**	**0.4**	**25.3**	**-**	**0.4**	**5.8**

[1] The distribution by sectors is uncertain. [2] Includes C_3F_8, CF_4 and C_2F_6. [3] Includes gas terminal, transport and supply ships. [4] Includes emissions from waste incineration plants. [5] Including mining. [6] Domestic air transport only, including emissions above 1000 m.
[7] Includes water supply.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.4. Emissions to air by sector. 2004

	SO_2	NO_X	NH_3	Acid equiva-lents[1]	NMVOC	CO	Parti-culates[2]
				1000 tonnes			
Total	**25.2**	**214.7**	**22.9**	**6.8**	**265.3**	**483.2**	**61.5**
Energy sectors	**3.9**	**65.5**	**0.0**	**1.5**	**154.4**	**11.5**	**1.1**
Extraction of oil and gas[3]	0.7	61.8	-	1.4	144.5	8.8	0.7
Extraction of coal	-	0.0	-	0.0	0.0	0.0	-
Oil refining	1.8	2.4	-	0.1	9.1	0.0	0.2
Electricity supplies[4]	1.3	1.4	0.0	0.1	0.8	2.7	0.2
Manufacturing and mining	**16.3**	**21.2**	**0.6**	**1.0**	**22.4**	**25.9**	**10.2**
Oil drilling	0.0	0.8	-	0.0	0.1	0.1	0.1
Manufacture of pulp and paper	2.0	1.8	-	0.1	0.4	3.4	0.3
Manufacture of basic chemicals	5.8	4.5	0.4	0.3	1.7	16.3	2.8
Manufacture of minerals[5]	1.5	5.6	0.1	0.2	2.1	1.0	2.6
Manufacture of iron, steel and ferro-alloys	4.4	5.4	0.0	0.3	1.8	0.3	1.8
Manufacture of other metals	1.9	1.3	0.0	0.1	0.0	0.1	2.4
Manufacture of metal goods, boats, ships and oil platforms	0.0	0.4	0.0	0.0	2.5	0.7	0.0
Manufacture of wood, plastic, rubber, and chemical goods, printing	0.2	0.5	0.0	0.0	12.3	3.3	0.1
Manufacture of consumer goods	0.5	0.9	0.0	0.0	1.5	0.8	0.1
Other	**4.2**	**112.7**	**20.7**	**3.8**	**36.9**	**78.2**	**6.5**
Construction	0.1	5.1	0.0	0.1	10.3	3.8	1.5
Agriculture and forestry	0.1	6.0	20.2	1.3	2.6	9.4	2.0
Fishing, whaling and sealing	1.0	32.0	0.0	0.7	0.8	6.7	0.2
Land transport, domestic	0.2	22.7	0.1	0.5	4.3	16.1	1.9
Sea transport, domestic	2.2	35.4	-	0.8	1.7	1.5	0.4
Air transport[6]	0.1	3.2	-	0.1	2.3	6.6	0.0
Other private services	0.3	5.4	0.4	0.1	11.6	32.1	0.4
Public sector, municipal[7]	0.1	0.2	0.0	0.0	1.6	0.3	0.0
Public sector, state	0.1	2.6	0.0	0.1	1.8	1.6	0.0
Private households	**0.7**	**15.3**	**1.7**	**0.5**	**51.6**	**367.6**	**43.6**

[1] Total acidifying effect of SO_2, NO_X and NH_3. [2] PM_{10}. [3] Includes gas terminal, transport and supply ships. [4] Includes emissions from waste incineration. [5] Including mining. [6] Includes only domestic air transport. [7] Includes water supplies.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.5. Emissions to air by source[1]. 2003

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particulates[2]
	Mill. tonnes	1000 tonnes							
Total	**43.5**	**229.6**	**14.3**	**23.4**	**214.7**	**22.8**	**297.3**	**510.3**	**62.1**
Stationary combustion	19.9	12.5	0.3	6.4	59.3	0.1	13.5	201.0	46.0
Process emissions	8.1	214.2	13.0	12.4	9.1	20.7	232.7	22.5	11.4
Mobile combustion	15.6	2.9	1.0	4.6	146.4	2.0	51.1	286.9	4.8
Stationary combustion									
Total	**19.9**	**12.5**	**0.3**	**6.4**	**59.3**	**0.1**	**13.5**	**201.0**	**46.0**
Oil and gas extraction	11.9	3.9	0.1	0.3	44.1	-	1.3	8.1	0.5
Natural gas	9.4	3.5	0.1	0.0	33.2	-	0.9	6.4	0.5
Flaring	1.0	0.1	0.0	0.0	5.2	-	0.0	0.6	0.0
Diesel combustion	0.4	0.0	0.0	0.3	4.7	-	0.3	0.3	0.0
Gas terminals	1.2	0.3	0.0	0.0	1.0	-	0.1	0.7	0.1
Manufacturing and mining	5.4	0.7	0.1	4.7	10.5	-	1.7	9.8	0.7
Refining	1.0	0.3	0.0	0.2	1.5	-	0.6	0.0	0.1
Manufacture of pulp and paper	0.5	0.1	0.0	1.4	1.8	-	0.4	3.7	0.1
Manufacture of mineral products	0.8	0.0	0.0	0.3	4.0	-	0.1	0.3	0.0
Manufacture of chemicals	1.6	0.1	0.0	0.6	1.3	-	0.0	0.1	0.1
Manufacture of metals	0.3	0.0	0.0	0.1	0.5	-	0.0	0.3	0.0
Other manufacturing	1.1	0.1	0.0	2.2	1.5	-	0.6	5.4	0.4
Other industries	1.3	0.4	0.0	0.4	1.3	-	0.2	6.0	1.2
Dwellings	1.0	7.4	0.1	0.6	2.2	0.1	9.9	176.9	43.5
Incineration of waste and landfill gas	0.2	0.2	0.0	0.3	1.2	-	0.5	0.2	0.0
Process emissions									
Total	**8.1**	**214.2**	**13.0**	**12.4**	**9.1**	**20.7**	**232.7**	**22.5**	**11.4**
Oil and gas extraction	0.7	28.6	0.0	-	0.1	-	172.7	0.1	0.2
Venting, leaks, etc.	0.1	13.0	0.0	-	0.1	-	6.8	0.1	0.2
Oil loading at sea	0.5	13.0	-	-	-	-	152.9	-	-
Oil loading, on shore	0.0	0.9	-	-	-	-	9.9	-	-
Gas terminals	0.0	1.6	-	-	-	-	3.1	-	-
Manufacturing and mining	7.3	7.6	5.7	12.4	9.0	0.5	11.6	22.4	9.3
Refining	1.0	2.3	-	1.6	1.1	-	8.7	-	0.1
Manufacture of pulp and paper	0.0	-	-	0.5	-	-	-	-	0.2
Manufacture of chemicals	0.6	0.3	5.5	1.3	1.4	0.4	0.6	22.4	0.8
Manufacture of mineral products	1.0	-	-	0.7	-	0.1	-	-	3.4
Manufacture of metals	4.6	0.6	0.2	8.3	6.5	0.0	1.3	0.0	4.8
Iron, steel and ferro-alloys	2.6	0.6	0.2	6.1	5.7	-	1.3	-	2.7
Aluminium	1.9	-	-	1.5	0.8	-	-	-	2.2
Other metals	0.1	-	-	0.7	0.0	0.0	-	0.0	0.0
Other manufacturing	0.2	4.3	-	-	-	-	1.0	-	0.0
Petrol distribution	0.0	-	-	-	-	-	6.1	-	-
Agriculture	-	107.3	6.8	-	-	20.2	-	-	0.0
Landfill gas	-	69.7	-	-	-	-	-	-	-
Solvents	0.1	-	-	-	-	-	42.3	-	0.0
Road dust	-	-	-	-	-	-	-	-	1.9
Other process emissions	0.0	1.0	0.5	-	-	0.0	-	-	0.0

Table G.5. (cont.). Emissions to air by source[1]. 2003

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Parti-culates[2]
	Mill. tonnes	1000 tonnes							
Mobile combustion									
Total	**15.6**	**2.9**	**1.0**	**4.6**	**146.4**	**2.0**	**51.1**	**286.9**	**4.8**
Road traffic	9.6	2.0	0.5	0.4	41.6	2.0	33.1	223.8	2.2
Petrol engines	4.9	1.7	0.4	0.2	15.6	2.0	23.6	189.0	0.3
Passenger cars	4.3	1.6	0.4	0.1	13.7	1.9	21.5	170.9	0.2
Other light vehicles	0.5	0.1	0.0	0.0	1.5	0.1	1.9	16.5	0.0
Heavy vehicles	0.1	0.0	0.0	0.0	0.5	0.0	0.3	1.6	0.0
Diesel engines	4.6	0.1	0.1	0.3	25.8	0.0	3.5	12.7	1.9
Passenger cars	0.7	0.0	0.0	0.0	1.5	0.0	0.4	2.1	0.4
Other light vehicles	1.3	0.0	0.0	0.1	2.6	0.0	0.8	4.8	0.6
Heavy vehicles	2.6	0.1	0.1	0.1	21.7	0.0	2.3	5.8	0.9
Motorcycles, mopeds	0.1	0.2	0.0	0.0	0.2	0.0	5.9	22.1	0.0
Motorcycles	0.1	0.1	0.0	0.0	0.2	0.0	3.0	16.4	0.0
Mopeds	0.0	0.0	0.0	0.0	0.0	0.0	3.0	5.7	0.0
Snow scooters	0.0	0.0	0.0	0.0	0.0	0.0	1.8	3.5	0.0
Small boats	0.2	0.2	0.0	0.0	1.1	-	8.9	22.7	0.3
Motorized equipment	0.8	0.1	0.3	0.2	12.2	0.0	3.3	24.8	1.4
Railways	0.0	0.0	0.0	0.0	0.6	-	0.1	0.1	0.0
Air traffic	1.0	0.0	0.0	0.1	3.3	-	1.4	6.2	0.0
Domestic < 1000 m	0.3	0.0	0.0	0.0	1.0	-	0.3	2.0	0.0
Domestic > 1000 m	0.7	-	0.0	0.1	2.3	-	1.1	4.3	0.0
Shipping	3.9	0.5	0.1	3.9	87.6	-	2.5	5.7	0.8
Coastal traffic, etc.	2.4	0.4	0.1	2.7	54.0	-	1.8	2.0	0.6
Fishing vessels	1.4	0.1	0.0	1.1	32.6	-	0.6	3.6	0.2
Mobile oil rigs, etc.	0.0	0.0	0.0	0.0	1.0	-	0.1	0.1	0.0

[1] Does not include international sea traffic. [2] PM_{10}.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.6. Emissions to air by source[1]. 2004*

	CO_2	CH_4	N_2O	SO_2	NO_x	NH_3	NMVOC	CO	Parti-culates[2]
	Mill. tonnes	1000 tonnes							
Total	**44.0**	**228.6**	**14.8**	**25.2**	**214.7**	**22.9**	**265.3**	**483.2**	**61.5**
Stationary combustion	19.4	12.9	0.3	6.1	58.4	0.1	13.5	196.0	44.2
Process emissions	8.5	212.9	13.5	14.7	10.7	20.7	202.8	16.3	12.5
Mobile combustion	16.1	2.9	1.0	4.4	145.7	2.1	49.0	270.9	4.7
Stationary combustion									
Total	**19.4**	**12.9**	**0.3**	**6.1**	**58.4**	**0.1**	**13.5**	**196.0**	**44.2**
Oil and gas extraction	12.3	4.2	0.1	0.3	45.9	-	1.4	8.4	0.5
Natural gas	9.7	3.7	0.1	0.0	35.1	-	0.9	6.6	0.5
Flaring	1.0	0.1	0.0	0.0	5.1	-	0.0	0.6	0.0
Diesel combustion	0.3	0.0	0.0	0.3	4.7	-	0.3	0.3	0.0
Gas terminals	1.2	0.4	0.0	0.0	1.0	-	0.1	0.9	0.1
Manufacturing and mining	5.0	0.7	0.1	4.6	8.6	-	1.6	9.8	0.7
Refining	0.9	0.3	0.0	0.3	1.1	-	0.5	0.0	0.1
Manufacture of pulp and paper	0.6	0.1	0.0	1.4	1.7	-	0.3	3.4	0.1
Manufacture of mineral products	0.8	0.0	0.0	0.3	2.8	-	0.1	0.3	0.0
Manufacture of chemicals	1.6	0.1	0.0	0.6	1.2	-	0.0	0.1	0.1
Manufacture of metals	0.3	0.0	0.0	0.1	0.5	-	0.0	0.2	0.0
Other manufacturing	0.9	0.1	0.0	1.9	1.3	-	0.6	5.8	0.3
Other industries	1.1	0.4	0.0	0.4	1.1	-	0.2	6.5	1.3
Dwellings	0.9	7.4	0.1	0.6	2.1	0.1	9.9	171.1	41.7
Incineration of waste and landfill gas	0.2	0.2	0.0	0.2	0.8	-	0.5	0.2	0.0
Process emissions									
Total	**8.5**	**212.9**	**13.5**	**14.7**	**10.7**	**20.7**	**202.8**	**16.3**	**12.5**
Oil and gas extraction	0.6	31.2	0.0	-	0.1	-	142.7	0.1	0.1
Venting, leaks, etc.	0.1	15.2	0.0	-	0.1	-	8.0	0.1	0.1
Oil loading at sea	0.4	13.5	-	-	-	-	122.7	-	-
Oil loading, on shore	0.0	0.9	-	-	-	-	9.0	-	-
Gas terminals	0.0	1.7	-	-	-	-	3.0	-	-
Manufacturing and mining	7.8	6.1	6.2	14.7	10.6	0.5	12.0	16.2	10.6
Refining	0.9	2.3	-	1.6	1.1	-	8.5	-	0.1
Manufacture of pulp and paper	0.0	-	-	0.6	-	-	-	-	0.2
Manufacture of chemicals	0.6	0.3	6.0	2.0	1.3	0.4	0.8	16.2	0.7
Manufacture of mineral products	0.8	-	-	0.5	-	0.1	-	-	3.4
Manufacture of metals	5.2	0.7	0.3	10.0	8.1	0.0	1.7	0.0	6.1
Iron, steel and ferro-alloys	3.1	0.7	0.3	7.6	7.1	-	1.7	-	3.8
Aluminium	2.1	-	-	1.6	1.0	-	-	-	2.3
Other metals	0.1	-	-	0.8	0.0	0.0	-	0.0	0.0
Other manufacturing	0.2	2.8	-	-	-	-	1.0	-	0.0
Petrol distribution	0.0	-	-	-	-	-	5.8	-	-
Agriculture	-	105.1	6.8	-	-	20.2	-	-	0.0
Landfill gas	-	69.4	-	-	-	-	-	-	-
Solvents	0.1	-	-	-	-	-	42.3	-	0.0
Road dust	-	-	-	-	-	-	-	-	1.9
Other process emissions	0.0	1.0	0.5	-	-	0.0	-	-	0.0

Table G.6. (cont.). Emissions to air by source[1]. 2004*

	CO_2	CH_4	N_2O	SO_2	NO_x	NH_3	NMVOC	CO	Particulates[2]
	Mill. tonnes	1000 tonnes							
Mobile combustion									
Total	**16.1**	**2.9**	**1.0**	**4.4**	**145.7**	**2.1**	**49.0**	**270.9**	**4.7**
Road traffic	10.0	1.9	0.6	0.4	40.8	2.1	30.7	206.2	2.1
Petrol engines	4.8	1.6	0.4	0.1	14.2	2.1	20.9	170.1	0.2
Passenger cars	4.3	1.5	0.4	0.1	12.4	1.9	19.0	154.3	0.2
Other light vehicles	0.5	0.1	0.0	0.0	1.3	0.1	1.6	14.2	0.0
Heavy vehicles	0.1	0.0	0.0	0.0	0.5	0.0	0.3	1.5	0.0
Diesel engines	5.1	0.1	0.1	0.3	26.3	0.0	3.6	13.0	1.8
Passenger cars	0.9	0.0	0.0	0.0	1.8	0.0	0.4	2.4	0.4
Other light vehicles	1.4	0.0	0.0	0.1	2.7	0.0	0.8	5.1	0.6
Heavy vehicles	2.8	0.1	0.1	0.2	21.9	0.0	2.3	5.5	0.8
Motorcycles, mopeds	0.1	0.2	0.0	0.0	0.2	0.0	6.3	23.1	0.0
Motorcycles	0.1	0.1	0.0	0.0	0.2	0.0	3.1	17.1	0.0
Mopeds	0.0	0.1	0.0	0.0	0.0	0.0	3.1	6.0	0.0
Snow scooters	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.6	0.0
Small boats	0.2	0.2	0.0	0.0	1.1	-	8.9	22.7	0.3
Motorized equipment	0.8	0.1	0.3	0.2	12.4	0.0	3.3	24.9	1.4
Railways	0.0	0.0	0.0	0.0	0.7	-	0.1	0.2	0.1
Air traffic	1.1	0.0	0.0	0.1	3.9	-	1.6	7.9	0.0
Domestic < 1000 m	0.3	0.0	0.0	0.0	1.0	-	0.3	2.2	0.0
Domestic > 1000 m	0.8	-	0.0	0.1	2.9	-	1.3	5.7	0.0
Shipping	3.9	0.6	0.1	3.7	86.9	-	2.5	5.5	0.8
Coastal traffic, etc.	2.5	0.5	0.1	2.7	54.3	-	1.8	2.0	0.6
Fishing vessels	1.4	0.1	0.0	1.0	31.9	-	0.6	3.5	0.2
Mobile oil rigs, etc.	0.0	0.0	0.0	0.0	0.7	-	0.1	0.1	0.0

[1] Does not include international sea traffic. [2] PM_{10}.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.7. Emissions to air by county. 2004

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particulates[4]
	Mill. tonnes	1000 tonnes							
Total	**44.1**	**228.1**	**15.9**	**25.7**	**216.9**	**22.8**	**265.4**	**483.9**	**61.5**
Of this, national emission figures	43.9	228.0	15.9	25.2	214.8	22.8	265.2	483.2	61.5
Of this, international sea and air traffic[1]	0.2	0.0	0.0	0.4	2.2	-	0.2	0.6	0.0
Østfold	1.3	8.0	0.7	1.9	4.6	1.3	7.2	27.7	3.1
Akershus	1.8	7.5	0.7	0.3	7.1	1.1	11.7	47.6	4.4
Oslo	1.3	2.5	0.1	0.3	4.4	0.2	9.4	22.0	0.9
Hedmark	0.8	11.4	0.9	0.1	4.1	1.9	5.0	29.7	4.3
Oppland	0.7	16.1	0.9	0.1	3.6	2.1	5.0	29.6	4.7
Buskerud	1.1	8.4	0.5	0.9	5.0	0.8	5.9	31.0	4.0
Vestfold	1.2	5.6	0.4	1.0	4.2	0.8	7.2	23.3	2.5
Telemark	2.8	5.9	4.3	0.6	5.2	0.8	5.2	21.6	3.2
Aust-Agder	0.5	3.8	0.1	1.6	1.7	0.3	2.9	25.9	2.1
Vest-Agder	1.2	6.3	0.2	1.7	3.1	0.5	4.0	16.5	2.2
Rogaland	3.2	27.3	1.2	0.7	7.5	3.8	11.6	30.9	4.1
Hordaland	3.7	17.9	0.5	2.1	9.1	1.0	26.7	32.5	3.5
Sogn og Fjordane	1.3	9.1	0.4	1.7	3.6	1.1	2.4	11.3	2.8
Møre og Romsdal	1.6	12.7	0.6	0.4	5.1	1.3	6.0	24.0	4.0
Sør-Trøndelag	1.2	13.1	0.7	2.3	4.6	1.6	5.6	26.2	4.0
Nord-Trøndelag	0.7	12.3	0.8	0.9	3.1	2.1	3.4	19.7	3.8
Nordland	2.3	13.2	2.4	2.9	8.3	1.4	5.2	21.8	3.7
Troms	0.8	5.5	0.2	1.1	3.7	0.6	3.0	13.0	2.2
Finnmark	0.3	5.7	0.1	0.1	1.7	0.2	1.8	7.0	0.7
Svalbard and Jan Mayen	0.2	2.7	0.0	1.1	0.3	0.0	0.4	0.3	0.2
Continental shelf	14.7	32.9	0.2	3.3	115.7	-	134.2	14.8	1.2
Airspace[2]	1.0	0.0	0.0	0.1	3.5	-	1.5	6.6	0.0
Open sea[3]	0.5	0.0	0.0	0.3	8.1	-	0.2	0.9	0.1

[1] Emissions from international sea traffic in Norwegian ports and international air traffic below 100 metres. [2] Domestic air transport.
[3] Emissions from Norwegian fishing vessels outside the Norwegian Economic Zone. [4] PM_{10}.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.8. Emissions factors

	Tonnes CO_2 / tonne of energy	Tonnes CO_2 / TJ of energy
LPG	3.00	65.08
Motor gasoline	3.13	71.30
Other gasoline	3.13	71.30
Heating kerosene	3.15	73.09
Kerosene type jet fuel	3.15	73.09
Auto diesel	3.17	73.55
Marine gas oil	3.17	73.55
Light fuel oil	3.17	73.55
Heavy fuel oil	3.20	78.82
Natural gas (2005)	2.75	58.50
Coal	2.52	89.68
Coal coke	3.19	111.93
Petrol coke	3.59	102.57
Fuelwood and black liquor	-	-
Garbage	0.25	23.90
Refinery gas	2.80	57.61
Fuel gas	2.50	50.00
Methane	0.28	5.48

Source: Statistics Norway.

Table G.9. Selected factors for mobile emissions to air, by source[1]. 2004

	CO_2	CH_4	N_2O	SO_2	NO_X	NH_3	NMVOC	CO	Particulates[2]
	kg/kg	g/kg							
Petrol engines									
Passenger cars	3.13	1.10	0.28	0.06	9.07	1.422	13.87	112.63	0.160
Other light vehicles	3.13	0.61	0.15	0.06	8.38	0.757	10.30	92.85	0.121
Heavy vehicles	3.13	0.89	0.04	0.06	26.26	0.087	14.66	76.82	0.100
Diesel engines									
Passenger cars	3.17	0.05	0.07	0.18	6.40	0.023	1.53	8.54	1.516
Other light vehicles	3.17	0.06	0.04	0.18	5.89	0.014	1.85	11.26	1.383
Heavy vehicles	3.17	0.10	0.13	0.18	25.05	0.003	2.66	6.33	0.915
Motorcycles	3.13	4.94	0.05	0.06	6.98	0.051	129.22	710.86	0.145
Mopeds	3.13	5.85	0.06	0.06	2.74	0.053	367.53	699.88	0.140
Snow scooters	3.13	5.85	0.06	0.06	2.74	0.053	367.53	699.88	0.140
Small boats, petrol[3]	3.13	5.10	0.02	0.06	6.00	-	240.00	415.00	8.000
Small boats, diesel	3.17	0.18	0.03	0.80	54.00	-	27.00	25.00	4.000
Motorized equipment, petrol[4]	3.13	5.50	0.07	0.06	10.00	0.005	110.00	1 200.00	1.000
Motorized equipment, diesel	3.17	0.17	1.30	0.80	50.00	0.005	6.00	15.00	4.000
Railways	3.17	0.18	1.20	0.80	47.00	-	4.00	11.00	3.800
Air traffic									
Domestic < 100 m	3.15	0.19	0.10	0.30	6.85	-	1.67	18.76	0.025
Domestic 100-1000 m	3.15	0.03	0.10	0.30	13.21	-	0.27	2.04	0.025
Domestic > 1000 m	3.15	-	0.10	0.30	12.11	-	0.57	3.08	0.007
Shipping[5]									
Coastal traffic, etc.	3.17	0.23	0.08	1.80	67.90	-	2.40	2.90	0.700
Fishing vessels	3.17	0.23	0.08	1.80	71.81	-	1.40	7.90	0.500
Mobile oil rigs, etc.	3.17	0.80	0.02	1.80	70.00	-	5.00	7.00	0.500

[1] Does not include international sea traffic. [2] PM_{10}. [3] 2 stroke. [4] 4 stroke. [5] Marine fuel.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.10. Emissions to air of carbon dioxide (CO_2) from energy use[1]. Million tonnes

	1980	1990	2000	2001	2002	Per unit GDP (kg/1 000 USD) 2002[2]	Per capita (tonnes/ capita) 2002
World, total	**18 123**	**20 664**	**23 006**	**23 156**	**23 710**	**..**	**3.8**
OECD	10 928	11 141	12 486	12 511	12 600	497	11.0
Norway	29	29	36	35	36	282	7.8
Denmark	61	49	50	52	51	362	9.5
Finland	59	53	55	60	65	522	12.6
Iceland	2	2	2	2	2	292	7.7
Sweden	69	48	46	49	51	234	5.8
Belgium	126	107	121	121	113	440	11.1
France	472	364	355	375	369	260	6.2
Greece	45	69	85	88	88	511	8.2
Ireland	26	32	40	43	42	363	10.9
Italy	370	397	427	428	430	332	7.4
Luxembourg	12	10	8	8	9	481	20.9
Netherlands	154	156	172	176	177	442	11.0
Poland	439	352	295	296	292	820	7.6
Portugal	25	40	60	59	63	375	6.1
Slovak Republic	63	55	35	39	39	625	7.2
Spain	192	212	286	288	303	401	7.5
United Kingdom	584	569	542	555	532	403	8.8
Switzerland	40	43	41	45	43	215	5.9
Czech Republic	165	150	122	123	121	846	11.8
Turkey	73	138	205	186	193	459	2.8
Germany	1 077	971	840	868	848	440	10.3
Hungary	81	68	55	57	56	462	5.5
Austria	58	59	64	69	67	335	8.3
Canada	429	421	516	513	507	581	16.2
Mexico	244	297	360	365	380	467	3.8
United States	4 765	4 852	5 699	5 643	5 705	616	19.8
Japan	913	1 075	1 168	1 164	1 178	372	9.2
Republic of Korea	125	237	440	448	472	657	9.9
Australia	212	261	328	322	334	679	17.0
New Zealand	17	23	32	34	33	432	8.4

[1] The Norwegian figures in this OECD survey diverge somewhat from the most recent emission calculations. [2] GDP 2002 expressed in 1995 prices adjusted to local purchasing power. Source: OECD Environmental Data. Compendium 2004 (OECD 2005).
More information: http://www.oecd.org/

Table G.11. International emissions of SO_X[1]. Emissions per unit GDP and per capita

	1990	1995	1999	2000	2001	2002	Per unit GDP[2]	Per capita
	1000 tonnes						kg/1000 USD	kg per capita
Norway	52	33	28	27	25	22	0.2	4.9
Denmark	176	136	53	27	24	24	0.2	4.5
Finland	237	97	85	76	87	85	0.7	16.4
Sweden	106	77	59	55	57	58	0.3	6.5
Belgium	355	256	176	169	159	151	0.6	14.7
France	1 326	978	705	627	570	537	0.4	9.0
Italy	1 773	1 287	922	771	736	655	0.5	11.5
Netherlands	204	142	105	91	90	85	0.2	5.3
Poland	3 210	2 376	1 719	1 511	1 564	1 455	4.1	38.1
Portugal	322	333	343	312	295	295	1.7	28.4
Russian Fed.[3]	..	6 612	..	..	..	..	..	..
Spain	2 178	1 808	1 640	1 522	1 464	1 541	2.0	37.4
United Kingdom	3 722	2 364	1 230	1 190	1 116	1 003	0.8	16.6
Switzerland	45	29	20	18	21	19	0.1	2.6
Czech Republic	1 876	1 091	268	264	251	237	1.7	23.2
Germany	5 326	1 937	735	636	643	611	0.3	7.4
Hungary	1 010	705	590	486	400	359	3.0	35.3
Austria	80	52	38	35	38	36	0.2	4.5
Canada	3 260	2 626	2 500	2 379	2 405	2 394	2.7	76.3
United States	20 925	16 881	15 856	14 767	14 413	13 847	1.5	48.0
Japan	1 001	938	848	857	857	857	0.3	6.7
Republic of Korea	1 611	1 532	951	..	..	..	..	..

[1] The Norwegian figures in this OECD survey diverge somewhat from the most recent emission calculations. [2] GDP at 1995 prices and purchasing power parities. [3] Data for Russian Fed. are from OECD 2002.
Source: OECD (2002) and OECD (2005).

Table G.12. International emissions of NO_X[1]. Emissions per unit GDP and per capita

	1990	1995	1999	2000	2001	2002	Per unit GDP[2]	Per capita
	1000 tonnes						kg/1000 USD	kg per capita
Norway	224	221	237	224	220	213	1.7	46.9
Denmark	276	265	216	198	193	191	1.4	35.5
Finland	311	259	248	236	210	211	1.7	40.5
Sweden	324	298	262	250	247	242	1.1	27.1
Belgium	365	354	304	307	298	290	1.1	28.1
France	1 895	1 702	1 510	1 429	1 393	1 350	1.0	22.7
Italy	1 927	1 789	1 451	1 373	1 358	1 267	1.0	21.8
Netherlands	599	518	464	447	436	430	1.1	26.6
Poland	1 280	1 120	951	838	805	796	2.2	20.8
Portugal	255	287	291	290	285	288	1.7	27.8
Russian Fed.[3]	4 023	3 119	..	..	..	..	..	..
Spain	1 256	1 338	1 399	1 417	1 393	1 432	1.9	34.8
United Kingdom	2 775	2 192	1 815	1 723	1 652	1 587	1.2	26.3
Switzerland	167	124	104	100	95	90	0.5	12.4
Czech Republic	544	370	313	321	332	318	2.2	31.2
Germany	2 745	1 916	1 632	1 553	1 482	1 417	0.7	17.2
Hungary	238	190	201	185	185	180	1.5	17.7
Austria	207	184	184	185	191	200	1.0	24.8
Canada	2 615	2 528	2 475	2 548	2 487	2 459	2.8	78.4
United States	22 830	22 405	20 510	20 263	19 394	18 833	2.0	65.3
Japan	2 052	2 143	2 047	2 064	2 029	2 018	0.6	15.8
Republic of Korea	925	1 153	1 136	..	..	..	..	..

[1] The Norwegian figures in this OECD survey diverge somewhat from the most recent emission calculations. [2] GDP at 1995 prices and purchasing power parities. [3] Data for Russian Fed. are from OECD 2002.
Source: OECD (2002) and OECD (2005).

Table G.13. Emissions to air of hazardous substances

	Lead	Cadmium	Mercury	Arsenic	Chromium	Copper	PAHs	Dioxins
	Tonnes	kg					Tonnes	Grammes
1990	187	1 098	1 506	3 143	12 478	22 018	156	130
1991	144	1 035	1 407	3 056	12 417	22 515	143	98
1992	127	1 018	1 240	3 009	12 282	19 457	144	96
1993	87	1 093	929	3 200	12 027	19 478	147	95
1994	24	1 137	963	3 605	11 330	19 234	145	94
1995	22	969	878	2 947	11 051	18 887	145	71
1996	10	1 055	905	3 044	11 114	19 149	151	50
1997	10	1 026	905	2 864	12 047	19 694	158	41
1998	10	1 069	868	3 290	11 523	20 565	150	35
1999	9	1 006	913	3 286	10 909	20 721	141	39
2000	7	670	760	2 436	8 367	19 415	144	34
2001	6	656	708	2 154	6 611	19 795	150	33
2002	8	654	660	1 774	5 451	19 455	172	32
2003	7	664	676	1 606	3 051	20 029	142	29
2004*	8	619	704	1 415	2 898	20 472	153	33

Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Table G.14. Emissions to air of hazardous substances[1] by source. 2004*

	Lead	Cadmi-um	Mercury	Arsenic	Chromi-um	Copper	PAH	Dioxins
	kg	kg	kg	kg	kg	kg	Tonnes	Grammes
Total	**8 255.5**	**618.6**	**703.5**	**1 415.3**	**2 898.0**	**20 472.3**	**152.7**	**33.0**
Stationary combustion	857.7	363.9	225.5	723.3	1 990.9	2 185.5	58.6	15.5
Process emissions	4 180.2	195.4	298.7	389.1	543.1	12 188.2	83.1	12.2
Mobile combustion	3 217.6	59.3	179.3	302.9	364.0	6 098.6	11.0	5.3
Stationary combustion								
Total	**857.7**	**363.9**	**225.5**	**723.3**	**1 990.9**	**2 185.5**	**58.6**	**15.5**
Oil and gas extraction	12.7	9.4	10.6	24.1	106.3	83.2	0.3	0.7
Natural gas	1.0	6.6	3.9	14.9	82.1	62.6	0.1	0.2
Flaring	0.1	0.7	0.4	1.6	8.7	6.6	0.0	0.0
Diesel combustion	11.5	1.1	5.7	5.7	4.6	5.7	0.2	0.5
Gas terminals	0.1	0.9	0.5	2.0	10.9	8.3	0.0	0.0
Manufacturing and mining	648.6	191.2	80.2	410.7	1 537.5	1 451.5	0.4	2.2
Refining	1.7	0.2	0.3	3.5	16.4	11.7	0.0	0.0
Manufacture of pulp and paper	451.4	125.0	41.3	250.4	884.5	882.0	0.2	1.1
Manufacture of mineral products	45.7	10.9	6.8	13.9	202.8	138.9	0.1	0.1
Manufacture of chemicals	48.5	5.2	10.5	34.5	289.3	210.7	0.0	0.0
Manufacture of metals	1.8	1.5	0.7	3.2	4.8	7.0	0.0	0.0
Other manufacturing	99.5	48.5	20.6	105.1	139.8	201.2	0.1	0.9
Other industries	71.0	18.3	28.6	40.2	107.0	128.0	3.3	1.9
Dwellings	104.3	143.2	29.3	241.1	228.7	512.9	53.6	10.1
Incineration of waste and landfill gas	21.1	1.9	76.8	7.2	11.5	9.8	1.0	0.6
Process emissions								
Total	**4 180.2**	**195.4**	**298.7**	**389.1**	**543.1**	**12 188.2**	**83.1**	**12.2**
Oil and gas extraction	-	-	-	-	-	-	0.0	0.0
Venting, leaks, etc.	-	-	-	-	-	-	0.0	0.0
Oil loading at sea	-	-	-	-	-	-	-	-
Oil loading, on shore	-	-	-	-	-	-	-	-
Gas terminals	-	-	-	-	-	-	-	-
Manufacturing and mining	2 747.7	162.7	251.4	389.0	486.4	2 134.2	70.6	12.1
Refining	-	-	-	-	-	-	-	-
Manufacture of pulp and paper	-	-	-	-	-	-	-	-
Manufacture of chemicals	192.0	26.5	1.9	18.9	137.6	216.7	1.3	0.0
Manufacture of mineral products	121.7	6.9	37.3	5.7	145.5	86.5	-	0.1
Manufacture of metals	2 434.0	129.4	212.2	364.4	203.4	1 831.0	69.3	12.0
Iron, steel and ferro-alloys	2 108.4	83.0	199.6	199.3	192.8	355.3	1.1	10.6
Aluminium	2.0	2.3	0.0	0.4	7.9	5.2	63.4	1.1
Other metals	323.6	44.1	12.6	164.7	2.7	1 470.6	4.8	0.3
Other manufacturing	-	-	-	-	-	-	0.0	0.1
Petrol distribution	-	-	-	-	-	-	-	-
Agriculture	-	-	-	-	-	-	-	-
Landfill gas	-	-	-	-	-	-	-	-
Solvents	-	-	-	-	-	-	12.0	-
Road dust	1 427	32	2	0	57	9 063	0	-
Use of products	-	-	42	-	-	-	-	-
Other process emissions	5	0	3	-	0	991	0	0

Table G.14. (cont.).

	Lead	Cadmium	Mercury	Arsenic	Chromium	Copper	PAH	Dioxins
	kg	kg	kg	kg	kg	kg	Tonnes	Grammes
Mobile combustion								
Total	**3 218**	**59**	**179**	**303**	**364**	**6 099**	**11**	**5**
Road traffic	207	32	80	159	159	5 396	8	0
Petrol engines	46	15	-	77	77	2 623	2	0
Passenger cars	41	14	-	69	69	2 329	1	0
Other light vehicles	5	2	-	8	8	261	0	0
Heavy vehicles	1	0	-	1	1	33	0	0
Diesel engines	160	16	80	80	80	2 717	6	0
Passenger cars	27	3	14	14	14	462	1	0
Other light vehicles	45	5	23	23	23	769	2	0
Heavy vehicles	87	9	44	44	44	1 486	3	0
Motorcycles, mopeds	1	0	-	2	2	55	0	0
Motorcycles	1	0	-	1	1	41	0	0
Mopeds	0	0	-	0	0	15	0	0
Snow scooters	0	0	-	0	0	9	0	0
Small boats	3	1	1	3	3	96	0	0
Motorized equipment	25	3	12	13	13	444	1	0
Railways	1	0	1	1	1	24	0	0
Air traffic	2 776	4	11	18	18	25	0	0
Domestic < 1000 m	547	1	3	5	5	7	0	0
Domestic > 1000 m	2 228	3	7	13	13	18	0	0
Shipping	205	21	75	109	170	106	2	5
Coastal traffic, etc.	156	16	52	84	146	81	1	3
Fishing vessels	49	5	23	25	24	24	1	2
Mobile oil rigs, etc.	1	0	1	1	0	1	0	0

[1] Does not include international sea and air traffic.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

Waste

Appendix H

Table H.1. Waste in Norway. By material type. 1995-2005* and projections for 2006-2010. 1 000 tonnes

	Total[1]	Paper, card-board and paste-board	Metals	Plastic	Glass	Wood waste	Textiles	Biode-grada-ble waste	Con-crete	Sludge	Other materi-als	Hazard-ous
1995	7 313	910	1 047	351	176	1 119	94	900	609	330	1 140	638
1996	7 351	907	1 074	366	168	1 099	99	929	643	329	1 103	635
1997	7 596	937	1 096	393	170	1 080	103	939	655	333	1 258	633
1998	7 935	987	1 055	411	166	1 094	108	973	750	334	1 428	630
1999	8 073	1 002	985	426	163	1 077	109	1 027	754	345	1 557	628
2000	8 109	1 080	939	449	165	1 081	113	1 006	732	345	1 536	662
2001	8 085	1 085	936	472	171	1 089	113	990	762	347	1 527	593
2002	8 165	1 140	916	498	176	1 078	113	989	757	341	1 523	634
2003	8 266	1 176	913	516	186	1 055	113	966	706	342	1 498	794
2004*	8 400	1 200	880	530	180	1 000	120	1 000	820	350	1 600	730
2005*	8 600	1 200	850	560	180	1 000	130	1 000	880	350	1 600	740
2006	8 700	..	..	..	..	..	..	..	..	..	..	..
2007	8 700	..	..	..	..	..	..	..	..	..	..	..
2008	8 800	..	..	..	..	..	..	..	..	..	..	..
2009	8 900	..	..	..	..	..	..	..	..	..	..	..
2010	9 000	..	..	..	..	..	..	..	..	..	..	..

[1] Preliminary figures for 2004 and 2005 are rounded. Consequently, the sum of the different waste types may deviate from the total given in the table.
Source: Waste statistics from Statistics Norway.

Table H.2. Waste in Norway. By source of origin. 1995-2005*. 1 000 tonnes

	Total	House-holds[1]	Agricul-ture, forestry and fishing	Mining and quarrying	Manu-facturing	Electricity, gas and water supply	Con-struction	Service indu-stries	Unspeci-fied
1995	7 313	1 268	131	104	3 129	19	949	706	1 006
1996	7 351	1 458	159	113	3 065	19	990	725	822
1997	7 596	1 333	141	128	3 164	21	1 001	753	1 055
1998	7 935	1 475	141	133	3 251	21	1 134	777	1 003
1999	8 073	1 526	179	131	3 319	19	1 110	803	987
2000	8 109	1 578	170	135	3 280	20	1 093	818	1 015
2001	8 085	1 634	164	150	3 149	30	1 152	833	975
2002	8 165	1 750	161	175	3 107	28	1 162	832	950
2003	8 266	1 803	147	135	3 157	27	1 102	842	1 054
2004*	8 400	1 900	170	150	3 200	20	1 200	870	870
2005*	8 600	2 000	170	150	3 200	30	1 300	890	830
By material type, 2003									
Total	8 266	1 803	147	135	3 157	27	1 102	842	1 054
Paper, cardboard and pasteboard	1 176	525	7	8	276	2	10	349	-
Metals	913	191	4	28	133	7	34	36	478
Plastic	516	175	17	1	29	0	3	4	287
Glass	186	56	0	0	23	0	60	1	44
Wood waste	1 055	140	0	9	682	2	154	4	64
Textiles	113	86	10	-	2	0	0	0	15
Biodegradable waste	966	421	106	1	357	0	0	80	-
Concrete	706	3	-	7	74	2	607	12	-
Sludge	342	-	-	0	238	0	-	105	-
Other materials	1 498	195	-	15	842	4	220	185	37
Hazardous	794	12	2	65	501	9	13	65	128

[1] Covers, in addition to ordinary household waste, scrapped cars and waste treated in the household, e.g. as kindling.
Source: Waste statistics from Statistics Norway.

Table H.3. Waste in Norway. By way of treatment. 1995-2005*. 1 000 tonnes

	Total	Material re-covery	Biological treatment	Energy re-covery	Incineration without energy recovery	Landfill	Other or unspecified
1995	7 313	1 940	57	970	131	2 772	1 442
1996	7 351	2 166	68	813	120	2 832	1 352
1997	7 596	2 229	89	784	123	2 764	1 606
1998	7 935	2 338	110	759	126	2 843	1 759
1999	8 073	2 484	177	758	138	2 720	1 796
2000	8 109	2 489	238	837	157	2 476	1 912
2001	8 085	2 604	299	912	178	2 187	1 905
2002	8 165	2 672	296	989	196	2 048	1 965
2003	8 266	2 690	292	1 075	213	1 970	2 026
2004*	8 400	2 700	320	1 100	230	1 800	2 200
2005*	8 600	2 800	350	1 200	250	1 600	2 400
By material type, 2003							
Total	8 266	2 690	292	1 075	213	1 970	2 026
Paper, cardboard and paste-board	1 176	526	-	142	53	218	237
Metals	913	807	-	-	-	72	33
Plastic	516	47	-	75	28	72	292
Glass	186	76	-	-	-	30	80
Wood waste	1 055	383	92	339	15	147	78
Textiles	113	11	-	33	13	30	26
Biodegradable waste	966	344	155	90	34	122	221
Concrete	706	171	-	-	-	179	355
Sludge	342	66	43	127	-	20	87
Other materials	1 498	206	2	193	69	566	462
Hazardous	794	51	-	75	-	514	153

Source: Waste statistics from Statistics Norway.

Table H.4. Hazardous waste entering approved treatment. By material. 2004. 1 000 tonnes

	Collected
Total	**908**
Waste containing petroleum products	216
Solvents	13
Other organic	10
Waste containing heavy metals	384
Corrosive waste	208
Other inorganic	17
Photo chemicals	2
Processing water	59
Unknown	0

Source: Waste statistics from Statistics Norway.

Table H.5. Hazardous waste entering approved treatment. By treatment/disposal operation. 2004. 1 000 tonnes[1]

	Collected
Total	**919**
Material recycling	12
Energy recovery	66
Final treatment/disposal [2]	580
Other treatment [3]	181
Exports	81

[1] Secondary hazardous waste is included. [2] Includes all types of landfilling, permanent storage, incineration without energy recovery and treatment operations producing only non-hazardous treatment products. [3] Including pre-treatment.
Source: Waste statistics from Statistics Norway.

Table H.6. Quantities of household waste. Total and separated for recovery[1]

	Total	For recovery	Total	For recovery	Percentage for recovery
	kg per capita		1 000 tonnes		
1974	174	..	693	..	..
1985	200	..	831	..	..
1992	235	20	1 012	86	9
1995	269	49	1 174	213	18
1996	272	60	1 195	260	22
1997	287	83	1 259	366	29
1998	308	102	1 365	453	33
1999	314	118	1 397	524	38
2000	324	130	1 452	581	40
2001	334	149	1 507	668	44
2002	354	161	1 613	732	45
2003	365	167	1 671	764	45
2004	378	185	1 746	854	49
2005	402	198	1 844	906	49

[1] The figures have been adjusted downwards to correct for the intermixture of waste from industrial sectors.
Source: Waste statistics from Statistics Norway and Heie (1998).

Table H.7. Household waste, by recovery or disposal. 1 000 tonnes

The whole country	Total	Sent for recovery	Deposited in landfills	Incinerated	Other
1998	1 365	..	592	..	..
2000	1 452	..	467	..	..
2001	1 507	..	382	..	..
2002	1 613	..	384	..	..
2003	1 671	..	357	..	..
2004	1 746	639	345	641	115
2005	1 844	727	333	732	52

Source: Waste statistics from Statistics Norway.

Table H.8. Average annual fee for waste management services. County. 2006. NOK

	Average fee
Country average	
2004	1 773
2005	1 833
2006	1 882
County average	
Østfold	1 476
Akershus	1 564
Oslo	1 469
Hedmark	1 646
Oppland	1 634
Buskerud	1 826
Vestfold	1 959
Telemark	1 773
Aust-Agder	1 855
Vest-Agder	1 896
Rogaland	2 036
Hordaland	1 709
Sogn og Fjordane	1 902
Møre og Romsdal	1 944
Sør-Trøndelag	1 870
Nord-Trøndelag	2 195
Nordland	2 056
Troms	2 114
Finnmark	2 363

Source: Environmental protection expenditure statistics, Statistics Norway.

Water pollution and waste water

Appendix I

Table I.1. Number of municipal waste water treatment plants. Whole country 2001-2004. By county, 2004

County/region	Total[1]	Direct discharges	Mechanical	Chemical	Biological	Chemical-biological	Other treatment	Individual treatment facilities (<50 PE)
Total 2001	**2 639**	**700**	**976**	**256**	**125**	**299**	**283**	**336 321**
Total 2002	**2 530**	**570**	**1 027**	**250**	**129**	**278**	**276**	**340 204**
Total 2003	**2 549**	**558**	**1 029**	**250**	**133**	**296**	**283**	**331 228**
Total 2004	**2 597**	**529**	**1 093**	**247**	**124**	**279**	**325**	**327 916**
North Sea counties (01-10)	651	6	36	210	30	207	162	162 343
Rest of the counties (11-20)	1 946	523	1 057	37	94	72	163	165 573
01 Østfold	35	-	1	10	-	21	3	12 659
02-03 Akershus and Oslo	54	2	1	26	1	16	8	20 098
04 Hedmark	84	2	-	31	3	29	19	32 711
05 Oppland	161	1	3	17	4	67	69	32 661
06 Buskerud	106	-	1	47	3	13	42	18 272
07 Vestfold	41	-	3	13	1	20	4	12 075
08 Telemark	68	-	2	34	8	16	8	15 057
09 Aust-Agder	38	-	2	15	4	13	4	10 573
10 Vest-Agder	64	1	23	17	6	12	5	8 238
11 Rogaland	207	24	141	9	5	4	24	17 125
12 Hordaland	322	18	236	1	23	13	31	34 626
14 Sogn og Fjordane	202	31	148	3	10	7	3	15 609
15 Møre og Romsdal	483	188	262	1	3	4	25	22 463
16 Sør-Trøndelag	123	9	42	7	20	14	31	18 381
17 Nord-Trøndelag	120	6	44	8	18	21	23	13 752
18 Nordland	254	123	100	2	10	2	17	25 933
19 Troms	124	49	60	4	3	3	5	11 396
20 Finnmark	111	75	24	2	2	4	4	6 288

[1] Individual treatment facilities are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table I.2. Hydraulic capacity (1 000 PE) of waste water treatment plants. Whole country 1993-2004. By county, 2004

County/region	Total	Direct discharges	Mechanical	Chemical	Biological	Chemical-biological	Other treatment
Total 1993	**[1]4 837**	**..**	**1 282**	**2 685**	**61**	**752**	**49**
Total 1995	**[1]5 219**	**..**	**1 318**	**3 326**	**70**	**411**	**68**
Total 1997	**5 801**	**576**	**1 358**	**2 568**	**95**	**1 115**	**89**
Total 1999	**6 250**	**541**	**1 744**	**2 189**	**72**	**1 575**	**129**
Total 2000	**6 257**	**541**	**1 750**	**2 194**	**71**	**1 574**	**127**
Total 2001	**6 326**	**554**	**1 420**	**2 289**	**116**	**1 566**	**382**
Total 2002	**5 912**	**529**	**1 294**	**2 295**	**123**	**1 591**	**80**
Total 2003	**6 093**	**524**	**1 425**	**2 207**	**133**	**1 701**	**102**
Total 2004	**6 109**	**411**	**1 523**	**2 257**	**129**	**1 689**	**99**
North Sea counties (01-10)	3 448	4	45	1 689	58	1 599	54
Rest of the counties (11-20)	2 661	407	1 478	568	71	91	45
01 Østfold	349	-	0	318	-	21	10
02-03 Akerhus and Oslo	1 388	2	0	188	0	1 196	2
04 Hedmark	219	0	-	94	1	104	19
05 Oppland	317	2	0	99	9	191	16
06 Buskerud	309	-	0	280	0	26	2
07 Vestfold	266	-	0	248	0	17	1
08 Telemark	232	-	5	203	6	16	2
09 Aust-Agder	151	-	3	103	24	21	0
10 Vest-Agder	217	0	35	157	17	6	2
11 Rogaland	549	69	180	269	26	2	4
12 Hordaland	548	25	421	66	8	18	11
14 Sogn og Fjordane	133	8	110	0	3	12	0
15 Møre og Romsdal	319	88	201	20	1	1	8
16 Sør-Trøndelag	409	2	228	144	11	19	5
17 Nord-Trøndelag	175	1	82	58	15	14	5
18 Nordland	232	90	131	2	6	1	2
19 Troms	188	58	97	9	1	13	10
20 Finnmark	109	67	28	1	1	11	1

[1] Direct discharges are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table I.3. Number of people connected to different types of treatment plants. Whole country 2000-2004. By county, 2004[1]

County/region	Total[2]	Direct discharges	Mechanical	Chemical	Biological	Chemical-biological	Other treatment	Individual treatment facilities (<50 PE)	Proportion connected to the sewage system[2]
Total 2000	**3 580 550**	**262 520**	**964 285**	**1 331 811**	**40 049**	**957 686**	**24 200**	**892 796**	**80**
Total 2001	**3 640 136**	**320 859**	**823 459**	**1 392 459**	**75 751**	**935 425**	**92 183**	**930 673**	**81**
Total 2002	**3 640 173**	**294 632**	**777 502**	**1 408 410**	**80 927**	**1 026 775**	**51 927**	**869 161**	**80**
Total 2003	**3 696 147**	**274 560**	**841 076**	**1 302 132**	**81 738**	**1 137 801**	**58 840**	**877 999**	**81**
Total 2004	**3 705 734**	**227 535**	**866 881**	**1 380 907**	**68 215**	**1 124 650**	**37 546**	**852 305**	**80**
North Sea counties (01-10)	2 208 949	1 197	22 052	1 054 387	33 748	1 081 214	16 351	385 356	87
Rest of the counties (11-20)	1 496 785	226 338	844 829	326 520	34 467	43 436	21 195	466 949	73
01 Østfold	231 184	-	-	213 069	-	11 555	6 560	33 207	89
02-03 Akershus and Oslo	986 026	320	-	109 883	2	875 384	437	52 459	96
04 Hedmark	138 819	2	-	57 427	360	75 830	5 200	66 239	74
05 Oppland	123 093	847	0	42 742	3 635	74 661	1 208	68 462	67
06 Buskerud	184 547	-	165	173 796	139	9 395	1 052	46 100	76
07 Vestfold	187 476	-	425	176 657	0	9 854	540	33 207	85
08 Telemark	144 318	-	3 796	128 686	3 320	8 031	485	33 586	87
09 Aust-Agder	78 368	-	618	50 529	13 547	13 525	149	27 594	76
10 Vest-Agder	135 118	28	17 048	101 598	12 745	2 979	720	24 502	84
11 Rogaland	297 733	18 185	99 766	162 447	14 482	1 280	1 573	55 009	76
12 Hordaland	328 919	14 725	240 073	54 000	3 991	10 569	5 561	99 164	73
14 Sogn og Fjordane	63 388	5 166	53 492	220	1 489	2 957	64	42 954	59
15 Møre og Romsdal	194 440	50 996	124 995	12 546	164	1 104	4 635	58 416	79
16 Sør-Trøndelag	195 539	895	122 894	51 415	4 102	13 069	3 164	50 857	72
17 Nord-Trøndelag	90 853	1 589	29 863	43 563	5 550	8 329	1 959	35 681	71
18 Nordland	145 817	47 527	92 131	790	3 834	418	1 117	69 855	62
19 Troms	116 996	42 187	67 558	1 295	565	2 484	2 907	40 080	77
20 Finnmark	63 100	45 068	14 057	244	290	3 226	215	14 933	86

[1] The reported number of persons connected to the sewage system might differ slightly from the official population statistics. [2] The number of persons connected to individual treatment facilities are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table I.4. Discharges of phosphorus by treatment methods. 1993-2004. By county, 2004. Tonnes

County/region	Total[1]	Direct discharges	Mechanical	Chemical	Biological	Chemical-biological	Other treatment	Individual treatment facilities (<50 PE)	Discharges per inhabitant connected, kilograms[1]	Average treatment efficiency, Per cent[1]
Total 1993	[2] **534**	..	..	..	..	..	..	..	..	..
Total 1995	[2] **601**	..	..	..	..	..	..	..	..	..
Total 1997	[2] **570**	..	..	..	..	..	..	..	..	..
Total 1999	**836**	..	..	..	..	..	..	..	..	..
Total 2000	**825**	**198**	**482**	**87**	**10**	**45**	**5**	..	**0.23**	**66.8**
Total 2001	**795**	**182**	**443**	**89**	**13**	**58**	**11**	**362**	**0.22**	**67.6**
Total 2002	**725**	**170**	**416**	**76**	**10**	**45**	**7**	**347**	**0.20**	**69.9**
Total 2003	**756**	**151**	**421**	**80**	**34**	**63**	**8**	**351**	**0.20**	**69.0**
Total 2004	**708**	**132**	**424**	**74**	**12**	**47**	**20**	**340**	**0.19**	**71.1**
North Sea counties (01-10)	108	0	9	50	4	41	5	122	0.05	92.6
Rest of the counties (11-20)	599	132	415	24	8	6	15	218	0.41	39.4
01 Østfold	17	-	-	15	0	1	1	12	0.07	86.2
02-03 Akershus and Oslo	38	0	0	4	0	34	0	19	0.04	94.4
04 Hedmark	5	0	-	2	0	3	1	18	0.04	94.5
05 Oppland	4	0	0	1	0	2	0	20	0.03	96.5
06 Buskerud	9	-	0	8	0	0	0	13	0.05	92.3
07 Vestfold	8	-	0	7	0	0	1	15	0.04	92.7
08 Telemark	8	-	0	7	0	0	0	12	0.05	90.3
09 Aust-Agder	7	-	0	2	3	0	2	7	0.09	90.0
10 Vest-Agder	13	0	8	3	1	0	0	6	0.10	83.8
11 Rogaland	71	11	49	9	1	0	0	23	0.24	60.1
12 Hordaland	130	9	115	3	1	0	2	40	0.41	32.0
14 Sogn og Fjordane	33	3	26	0	0	4	0	19	0.53	27.6
15 Møre og Romsdal	86	30	54	1	0	0	1	29	0.48	27.5
16 Sør-Trøndelag	86	1	70	7	3	1	5	28	0.44	53.6
17 Nord-Trøndelag	19	1	13	3	2	0	1	16	0.21	67.4
18 Nordland	74	28	46	0	1	0	0	38	0.52	12.4
19 Troms	66	25	35	0	0	0	6	17	0.58	20.6
20 Finnmark	34	26	7	0	0	0	0	8	0.54	22.1

[1] Discharges from individual treatment facilities are not included. [2] Direct discharges are not included.
Source: Waste water treatment statistics from Statistics Norway.

Table I.5. Discharges of nitrogen by treatment methods. Whole country 1998-2004. By county, 2004. Tonnes

County/region	Total[1]	Direct dis-charges	Mecha-nical	Chem-ical	Biolo-gical	Chemi-cal-bio-logical	Other treat-ment	Individu-al treat-ment facilities (<50 PE)	Discharg-es per in-habitant connect-ed, kilograms[1]	Average treat-ment effi-ciency, Per cent[1]
Total 1998	**13 554**	..	..	..	..	..	..	..	..	..
Total 1999	**13 492**	..	..	..	..	..	..	..	..	..
Total 2000	**13 191**	**1 478**	**3 824**	**4 921**	**126**	**2 686**	**156**	..	**3.68**	**27.7**
Total 2001	**12 303**	**1 384**	**3 022**	**5 146**	**247**	**2 200**	**304**	**3 560**	**3.38**	**28.3**
Total 2002	**11 785**	**1 284**	**2 979**	**5 134**	**280**	**1 925**	**183**	**3 246**	**3.24**	**29.0**
Total 2003	**11 426**	**1 133**	**3 065**	**4 560**	**341**	**2 138**	**189**	**3 338**	**3.09**	**30.8**
Total 2004	**11 494**	**995**	**3 143**	**4 809**	**219**	**2 063**	**264**	**3 207**	**3.16**	**32.2**
North Sea counties (01-10)	5 863	5	73	3 665	110	1 921	89	1 365	2.70	43.6
Rest of the counties (11-20)	5 631	990	3 070	1 144	109	142	175	1 842	3.84	14.2
01 Østfold	850	-	-	772	0	55	23	97	3.68	19.7
02-03 Akershus and Oslo	1 708	1	-	385	0	1 311	11	184	1.73	64.8
04 Hedmark	456	0	-	184	1	253	18	233	3.59	25.9
05 Oppland	368	4	0	171	13	176	4	257	3.01	45.6
06 Buskerud	513	-	1	475	0	31	6	156	3.13	22.5
07 Vestfold	718	-	2	678	0	32	6	122	3.83	21.8
08 Telemark	490	-	14	436	12	26	2	128	3.40	20.4
09 Aust-Agder	263	-	2	176	41	30	14	98	3.45	25.7
10 Vest-Agder	497	0	54	386	44	8	5	90	3.68	21.1
11 Rogaland	1 092	80	367	569	51	4	21	202	3.68	17.2
12 Hordaland	1 188	64	866	189	8	35	25	358	3.71	15.6
14 Sogn og Fjordane	237	23	199	1	5	10	0	163	3.75	14.4
15 Møre og Romsdal	696	223	408	44	1	4	17	246	3.89	11.3
16 Sør-Trøndelag	739	4	456	180	14	43	43	245	3.79	16.5
17 Nord-Trøndelag	328	7	111	153	19	27	11	136	3.62	18.4
18 Nordland	554	207	331	3	9	1	3	290	3.85	10.8
19 Troms	534	185	280	5	2	8	54	138	4.70	9.5
20 Finnmark	263	197	52	1	1	11	1	64	4.17	4.9

[1] Discharges from individual treatment facilities are not included. Source: Waste water treatment statistics from Statistics Norway.

Table I.6. Disposal of sewage sludge. Whole country 2001-2004. By county, 2004. Tonnes dry weight

	Total[1]	Agriculture	Parks and green spaces	Delivered producer of fertilizer	Cover on landfills	Deposited	Incineration	Other use	Use unknown	Delivered treatment plant
Total 2001	**107 101**	**48 039**	**14 160**	**..**	**4 217**	**11 659**	**..**	**12 812**	**16 214**	**4 995**
Total 2002	**103 135**	**43 560**	**8 995**	**5 714**	**6 160**	**9 929**	**..**	**28 776**	**..**	**40 364**
Total 2003	**104 585**	**39 850**	**9 351**	**3 317**	**8 476**	**..**	**..**	**15 171**	**28 421**	**48 908**
Total 2004	**112 177**	**41 874**	**8 932**	**1 329**	**14 005**	**10 657**	**847**	**12 333**	**22 200**	**66 154**
County/region, 2004										
Østfold	6 610	1 664	-	194	486	39	-	1 754	2 473	315
Akershus and Oslo	30 091	26 264	145	-	949	353	7	2 373	-	2 645
Hedmark	6 627	-	275	-	4 491	1 705	-	156	-	3 193
Oppland	4 536	779	95	-	2 457	-	240	235	730	4 135
Buskerud	9 752	2 195	460	307	1 542	-	-	2 091	3 157	8 013
Vestfold	9 328	6 805	1 422	-	-	-	-	1 101	-	2 021
Telemark	7 916	917	1 621	-	235	5 067	-	76	-	1 880
Aust-Agder	3 826	36	316	573	238	-	-	-	2 663	1 042
Vest-Agder	3 798	162	1 844	255	-	83	-	472	982	4 991
Rogaland	604	-	-	-	230	227	-	128	19	204
Hordaland	4 154	60	-	-	10	48	-	3	4 033	1 639
Sogn og Fjordane	5 784	-	-	-	653	196	-	-	4 935	8 316
Møre og Romsdal	4 295	-	-	-	1 077	707	-	293	2 218	2 571
Sør-Trøndelag	4 819	-	2 515	-	30	31	600	1 643	-	101
Nord-Trøndelag	3 258	2 992	130	-	-	130	-	6	-	1 092
Nordland	4 457	-	-	-	870	1 585	-	2 002	-	22 188
Troms	1 707	-	109	-	577	457	-	-	564	1 779
Finnmark	616	-	-	-	160	29	-	-	427	29

[1] "Delivered treatment plant" is not included in the "Total"-column due to risk of double-counting.
Source: Waste water treatment statistics from Statistics Norway.

Table I.7. Wastewater treatment fees, for a private dwelling of 120 m². Counties. 2006. NOK

	Fixed annual fee	Two-level fee system: Variable portion (NOK per m³ wastewater	Two-level fee system: Fixed portion	Payment by water used: Variable portion (NOK per m³ wastewater)	Payment by water used: Minimum use charged, m³	Connection fee: Lowest level	Connection fee: Highest level
Country average							
2004	2 491	7.06	1 145	9.16	143	8 369	13 039
2005	2 479	9.90	1 175	10.57	149	8 643	13 164
2006	2 649	9.80	1 225	10.65	147	8 880	12 653
North Sea counties	3 071	11.60	1 230	13.29	111	10 026	14 712
Rest of the counties	2 179	7.79	1 221	8.00	187	7 734	10 366
County average							
Østfold	3 902	14.74	948	15.93	93	10 277	11 629
Akershus	2 972	10.82	1 570	13.25	94	13 580	23 094
Oslo	1 432	8.60	91	.	.	.	19 035
Hedmark	3 501	14.43	1 036	16.58	85	10 520	15 574
Oppland	3 311	15.07	1 354	16.23	132	11 169	20 258
Buskerud	3 530	12.90	636	15.93	109	9 508	14 638
Vestfold	2 903	8.74	1 158	10.21	142	13 838	14 972
Telemark	3 305	11.26	2 428	12.76	137	3 312	3 708
Aust-Agder	3 088	9.54	1 898	9.12	143	8 629	11 325
Vest-Agder	2 768	9.93	1 178	9.62	68	9 403	12 888
Rogaland	1 798	6.39	893	6.45	205	8 024	13 372
Hordaland	2 086	7.35	1 037	7.82	124	10 608	12 484
Sogn og Fjordane	2 489	8.45	1 252	8.22	174	6 701	10 360
Møre og Romsdal	1 810	6.10	1 042	6.88	206	6 734	10 212
Sør-Trøndelag	2 310	8.58	1 151	9.72	235	9 532	13 742
Nord-Trøndelag	2 973	12.39	1 955	11.37	164	7 609	12 693
Nordland	1 875	7.00	1 186	7.60	175	5 629	9 009
Troms	2 226	7.77	1 394	7.63	213	5 727	5 187
Finnmark	2 042	6.11	1 076	6.36	:	9 042	6 237

Source: Environmental protection expenditure statistics, Statistics Norway.

Links between environment and economy

Appendix J

Table J.1. Environmental protection expenditure in large companies, by type of transactions and environmental domain. Manufacturing, mining and quarrying (NACE 10, 12-37). 2003

	Total	Air/ climate	Waste- water	Solid waste	Soil and ground- water	Biodiversity and land- scape	Other
	NOK 1 000	Per cent					
Total	**1 597 177**	**19**	**33**	**30**	**1**	**1**	**15**
Current expenditure	1 123 445	13	39	40	1	1	7
Investments	473 732	31	20	8	2	2	36
End-of-pipe investments	308 721	16	19	9	2	2	53
Process-integrated investments	165 011	61	23	6	3	1	5

Source: Environmental protection expenditure statistics, Statistics Norway.

Table J.2. Environmental protection expenditure by type of transaction and share of the establishments' total expenditure. Large establishments in manufacturing, mining and quarrying industries (NACE 10, 12-37). 2000-2003

	Number of Local kind of activity units	Current costs for environmental protection	Share of the establishments total current costs (Costs of goods and services consumed + compensation of employees)	Environmental protection investment: Pollution treatment	Pollution prevention	Total environmental protection investments[1]	Share of the establishments' total gross investments (acquisitions less disposals of fixed assets)[1]
		NOK 1 000	Per cent	NOK 1 000			Per cent
2000	11 760	..	..	793 788	..	793 788	5.2
2001	11 161	..	..	585 985	..	585 985	3.5
2002[2]	990	1 321 656	0.6	425 715	437 660	863 375	7.8
2003[2]	1 159	1 123 445	0.4	308 721	165 011	473 732	4.7

[1] Figures for 2002 and 2003 do not include pollution prevention investments. This should be regarded for total environmental protection investments and share of the establishments total gross investments. [2] The figures for 2002 and 2003 only include a sample, and not the entire population.
Source: Environmental protection expenditure statistics, Statistics Norway.

Table J.3. Environmental taxes in Norway. 1991-2004*. NOK million

	1991	1994	1997	1998	1999	2000	2001	2002	2003*	2004*
Environmental taxes, total	**23 167**	**33 211**	**39 555**	**40 675**	**42 185**	**45 268**	**46 857**	**46 829**	**48 287**	**52 219**
Energy taxes	14 665	20 133	23 741	23 303	24 888	26 935	27 212	25 321	26 178	25 387
CO_2 tax in the petroleum activity on the continental shelf	810	2 557	3 034	3 229	3 261	3 047	2 861	3 012	3 056	3 309
Tax on mineral products, total .	2 172	2 001	1 514	1 631	-	-	-	-	-	-
CO_2 tax on mineral products . .	-	-	-	-	3 644	3 815	3 575	3 587	3 853	3 809
Sulphur tax	-	-	-	-	343	138	119	84	94	84
Basic tax on fuel oil	-	-	-	-	-	372	754	482	716	655
Excise on petrol	8 345	9 581	10 883	11 367	9 623	9 756	8 821	8 548	8 651	8 729
Auto fuel tax	-	1 746	3 489	3 679	4 533	4 814	4 067	3 977	4 305	4 675
Tax on coal and coke	-	7	6	2	-	-	-	-	-	-
Tax on production of electrisity.	3 338	1 286	1 471	2	2	-	-	-	-	-
Tax on consumption of electricity	-	2 955	3 344	3 393	3 482	4 993	7 015	5 631	5 503	4 126
Pollution taxes	216	533	548	529	1 058	1 145	1 150	1 260	1 346	1 368
Basic tax on non-refillable beverage containers.	-	52	166	162	259	325	363	433	483	462
Tax on beer containers	13	91	13	11	31	3	-	-	-	-
Tax on wine/spirit containers. . .	45	41	66	59	63	8	-	-	-	-
Tax on non-alcoholic lemonade containers	59	30	11	9	22	1	-	-	-	-
Tax on non-alcoholic non-fizzy lemonade containers.	59	71	37	32	29	1	-	-	-	-
Tax on plastic beverage containers	-	-	-	-	-	15	22	39	58	57
Tax on metal beverage containers	-	-	-	-	-	100	102	86	77	63
Tax on glass beverage containers	-	-	-	-	-	48	45	45	58	39
Tax on paper beverage containers	-	-	-	-	-	13	15	17	17	18
Tax on final treatment of waste	-	-	-	-	442	483	473	498	501	554
Tax on artificial fertiliser.	-	171	171	165	108	2	-	-	-	-
Tax on pesticides.	-	21	21	24	35	53	35	56	65	85
Tax on lubricating oil.	28	56	63	67	69	88	86	80	81	84
Tax on batteries.	12	-	-	-	-	-	-	-	-	-
Tax on trichloroethane	-	-	-	-	-	4	7	4	4	4
Tax on tetrachloroethane	-	-	-	-	-	1	2	2	2	2
Tax on hydrofluorocarbons (HFCs) og perfluorocarbons (PFCs).	-	-	-	-	-	-	-	-	61	123
Transport taxes	8 286	12 545	15 266	16 843	16 239	17 188	18 495	20 248	20 763	25 464
Tax on car ownership	3 300	7 365	9 345	9 976	8 889	9 557	9 821	12 319	12 888	16 387
Tax on heavy vehicles	-	293	271	214	226	273	342	314	299	293
Car re-registration tax.	887	1 049	1 307	1 348	1 402	1 410	1 595	1 598	1 796	1 820
Annual vehicle tax.	2 240	3 134	3 688	4 247	4 442	4 626	5 348	5 583	5 780	6 964
Tax per driven km by diesel vehicles	1 745	560	4	2	8	1	-	-	-	-
Tax on aircrafts	114	144	651	1 056	1 272	1 321	1 389	434	-	-
Resource taxes.	0	0	0	0	0	0	0	0	0	0

Source: Environmental statistics and National accounts, Statistics Norway.