# Natural Resources and the Environment 2004. 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 82-537-6769-2 Printed version
ISBN 82-537-6770-6 Electronic version
ISSN 0804-3221

**Emnegruppe**
01 Naturressurser og naturmiljø

Design: Siri Boquist
Printed: PDC Tangen / 468

| 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| Not for publication | : |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 2004* starts with an updated presentation of indicators that illustrate aspects of the government's priority areas for environmental policy. This is followed by detailed descriptions of various topics, which include both statistics and analyses. 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 2004*.

The publication was produced by the Division for Environmental Statistics, Department of Economic Statistics, with contributions from the Unit for Energy and Environmental Economics and the Unit for Petroleum and Environmental Economics, Research Department, and the Division for Primary Industry Statistics, Department of Industry Statistics. The 2004 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 2004* is also available at http://www.ssb.no/english/subjects/01/sa_nrm/ . More detailed information on the topics covered may be found at http://www.ssb.no/english/subjects/ and in StatBank Norway at http://www.ssb.no/english.

Statistics Norway,
Oslo/Kongsvinger 13 April 2005

Øystein Olsen

# Contents

# List of figures

## 1. Status and important trends



## 2. Energy

### 6. Air pollution and climate change



### 7. Waste



### 8. Water resources and water pollution

# List of tables

# List of boxes

**5. Fisheries, sealing, whaling and fish farming**



**6. Air pollution and climate change**



**7. Waste**



**8. Water resources and water pollution**



**9. Land use**

# 1. Status and important trends

**The state of the environment, which depends on a complex variety of biological and physical processes that interact with human behaviour and the pressures this exerts, is of crucial importance to people's welfare. 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. Strategies for sustainable development at both national and international level are being given high priority. 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. Introduction

Sections 1.2 and 1.3 of this chapter present some indicators or key figures (see box 1.1) that can be used to describe the state of the environment, environmental pressures and resource use in Norway. In section 1.4, we describe some features of economic developments in Norway and discuss how these affect the environment. Environmental protection expenditure in manufacturing industries is also discussed.

The book continues with statistics and analyses related to Norway's natural resources and resource policy issues in Chapters 2-5. Chapters 6-9 focus on important environmental problems. Finally, the appendix provides more detailed statistics on various aspects of the environment and natural resources in the form of tables.

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 in Chapter 1 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/).

**Box 1.1. Environmental indicators**

Information on the environment includes a variety of topics, and it can be difficult to interpret 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 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 and 2004). 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 Pressures* 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 four 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 *Environmental signals* (EEA 2002a), *EEA Signals 2004* (EEA 2004), *TERM 2002 - Paving the way for EU enlargement - Indicators of transport and environment integration* (EEA 2002b), *Environmental pressure indicators for the EU* (Eurostat 2001) and *Environmental indicators for agriculture* (OECD 2001b) .

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

**Box 1.2. Priority areas of Norwegian environmental policy**

In Report No. 58 (1996-97) to the Storting on an environmental policy for sustainable development, eight priority areas of environmental policy were established. These are:

1. Conservation and sustainable use of biological diversity
2. Outdoor recreation
3. The cultural heritage
4. Eutrophication and oil pollution
5. Hazardous substances
6. Waste and waste recovery
7. Climate change, air pollution and noise
8. International cooperation on environmental issues and environmental protection in the polar areas

These priority areas provide the basic structure for the result monitoring system used by the environmental authorities. This system was developed to provide a structure for the background data for the white papers on the Government's environmental policy and the state of the environment in Norway, based on reporting from various sectors and data from environmental statistics and environmental monitoring. Strategic objectives and national targets have been set for each of the priority areas. The results are to be monitored by means of key figures for each of the priority areas.

*Natural Resources and the Environment 2004* describes environmental pressures in several of the priority areas of environmental policy and presents several of the key figures that have been selected.

Based on: Ministry of the Environment (2003).

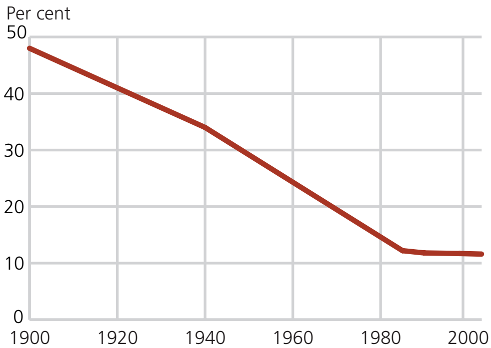
## 1.2. The state of the environment in Norway

This description of the state of the environment in Norway is structured according to the priority areas of environmental policy defined by the environmental authorities (see box 1.2). Some of the priority areas are described in more detail than others because more statistical material is available, making it possible to describe the current status using suitable indicators. In other areas, the environmental statistics do not provide an adequate basis for describing the current status or trends.

## *Priority area 1*: Conservation and sustainable use of biological diversity

Human activities are influencing and threatening biological diversity in many different ways, and calculations show alarmingly high figures for losses of both species and habitats (SSB/SFT/DN 1994). Such losses may be a direct result of various forms of development or over-exploitation, or they may be caused indirectly when our activities cause pollution or result in climate change, thus altering or worsening conditions for animals and plants. One important way of responding to these problems is to protect areas in some way. At the end of 2003, 34 089 $km^2$ or 10.5 per cent of the total area of Norway was protected. This is an increase of 7 per cent from the year before, and is mainly due to the expansion of national parks and the establishment of a number of new protected landscapes.

**Figure 1.1. Wilderness-like areas[1] as a percentage of Norway's total land area[2]. 1900-2003**




[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.
[2] Excluding Svalbard and Jan Mayen.
Source: Directorate for Nature Management.

### 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.
- The extent of such areas in Norway fell dramatically from 1900 to 1985, especially in the period 1940 to 1985. Since 1985, the loss of wilderness-like habitat has continued, but at a much slower pace.
- In 2003, wilderness-like areas made up between 11 and 12 per cent of the total area of Norway.

For more information, see Chapter 9: Land use.

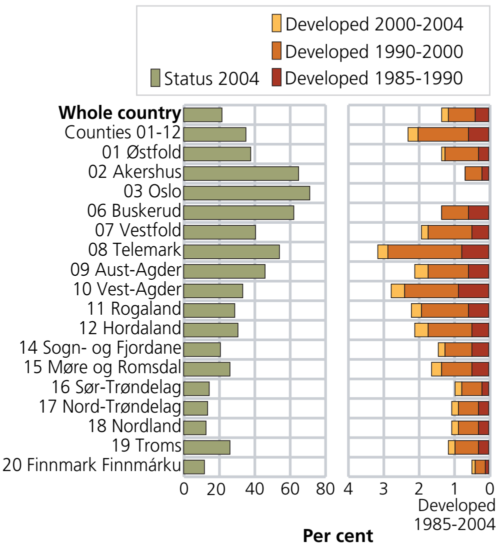
### National targets – biological diversity

1. A representative selection of Norwegian habitats shall be protected for future generations.
2. Major disturbance such as infrastructure development shall be avoided in endangered habitats, and in vulnerable habitats important ecological functions shall be maintained.
3. The cultural landscape shall be managed in such a way that biological diversity, the historical and aesthetic value of the landscape and its accessibility are maintained.
4. Harvesting and other use of living resources shall not cause species or populations to become extinct or endangered.
5. The introduction of alien species through human activity shall not damage or limit ecosystem functions.
6. Populations of endangered species shall be maintained or restored to viable levels.
7. The needs of future generations shall be taken into account when managing soil resources that are suitable for cereal production.

## *Priority area 2*: Outdoor recreation

Norway's strategic objective for this 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 1.2. Proportion of the coastline less than 100 m from the nearest building in 2004. Changes from 1985 to 2004**




Source: Land use statistics, Statistics Norway.

## Access to the coast

- 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. Despite this, buildings were constructed or altered along 1.3 per cent, or 1 100 km, of the shoreline from 1985 to 2004.
- 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 I4).

For more information, see Chapter 9: Land use.

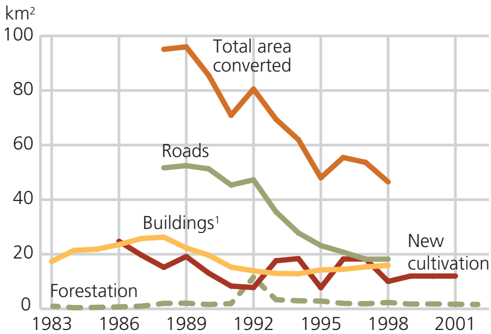
### National targets – outdoor recreation

1. The tradition of outdoor recreation based on the right of access to uncultivated land shall be kept up by all sections of the population.
2. Children and young people shall be given the opportunity to develop skills in outdoor recreation activities.
3. Areas of value for outdoor recreation shall be safeguarded so that environmentally-friendly access and passage and harvesting of natural resources is promoted and the natural resource base is maintained.
4. 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.

## *Priority area 3*: The cultural heritage

Our cultural heritage is a source of knowledge about people's lives and activities throughout history. It can improve our understanding of the links between history and the present day, the natural environment and different cultures. We can use our heritage to rediscover lost knowledge and skills and to find answers to new questions that arise in connection with sustainable development. Cultural monuments and sites and cultural environments are often damaged by changes in land use. The extent of changes in land use can tell us something about the pressure on the cultural heritage.

**Figure 1.3. Annual conversion of land for roads, new buildings[1], forestation and new cultivation. 1983-2003**




[1] The area of the buildings is multiplied by 5 to take into account the fact that areas immediately around the buildings are also changed significantly.
Source: Statistics Norway, Norwegian Agricultural Economics Research Institute and Directorate of Public Roads.

### Conversion of land for other purposes

- During the 1990s, the area per year converted for other purposes has been reduced. This is mainly because less land has been used for new roads, especially forest roads.
- The area cultivated for the first time has fluctuated a good deal from year to year, whereas the area built on for the first time varied less.

More information: the indicator is not discussed further in this publication, but there is some relevant material on cultural environments in Chapter 3: Agriculture (section 3.3) and background material in Chapter 9: Land use.

**National targets – cultural heritage**

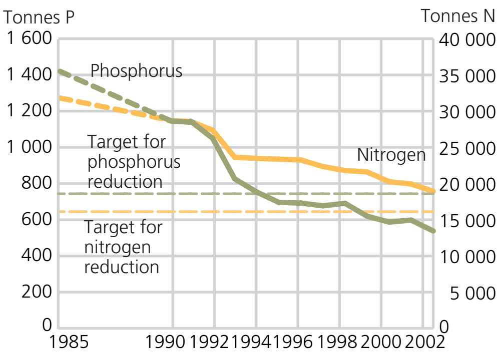
1. Annual losses of archaeological and architectural monuments and sites and cultural environments as a result of demolition, damage or decay shall be minimised, and by the year 2008 shall not exceed 0.5 per cent of the total.
2. The representative selection of monuments, sites and cultural environments shall be maintained at a standard corresponding to the 1998 level, and a standard requiring only normal maintenance shall be achieved for protected buildings and installations by 2010.
3. The selection of permanently protected monuments, sites and cultural environments shall include a wider range in terms of geography, social class, ethnicity and time periods, so that any important categories that are poorly represented or missing are better represented by 2004 than in 1998.

### ***Priority area 4***: Eutrophication and oil pollution

Eutrophication is caused by excessive discharges of nutrients to water, and results in a deterioration of water quality. The most important nutrients involved are phosphorus and nitrogen, and the main sources are industry, agriculture, fish farming and private households. Both marine areas and fresh water bodies are affected. Norway's coastal waters from the border with Sweden to Lindesnes at the southernmost tip of Norway are adversely affected by eutrophication, and this stretch of coastline is a sensitive area as defined by the EU waste water directive.

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 1.4. Trends in anthropogenic discharges of phosphorus (P) and nitrogen (N) to the North Sea (from the border with Sweden to Lindesnes at the southernmost tip of Norway). 1985-2002**



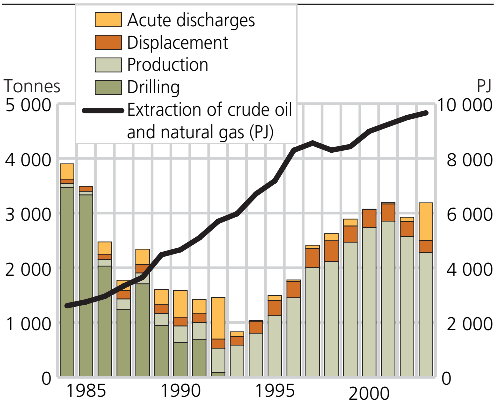

Source: Norwegian Institute for Water Research 2003.

## Eutrophication of fjords and marine waters

- In the North Sea region (from the border with Sweden to Lindesnes), where extensive measures have been put into effect to reduce discharges, calculations show that inputs of nitrogen and phosphorus to the North Sea have been reduced by 41 and 64 per cent respectively from 1985 to 2002.
- The reduction in phosphorus discharges is mainly a result of more efficient treatment of waste water from industry and private households, but measures in the agricultural sector have also had some effect. It has proved more difficult to reduce nitrogen discharges, but nitrogen removal has been given priority in the last few years in areas where Norwegian discharges of nitrogen have a significant effect on eutrophication status.

For more information, see Chapter 8: Water resources and water pollution.

**Figure 1.5. Discharges of oil from petroleum activities. Tonnes. Extraction of crude oil and natural gas. PJ. 1984-2003**




Source: Norwegian Pollution Control Authority and Energy Statistics, Statistics Norway.

## Oil pollution

- 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 somewhat reduced in the last two years.
- Acute discharges from oil production and other activities have varied widely in the period 1984-2003. They rose substantially in 2003, largely as a result of discharges from the Draugen field.

**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.

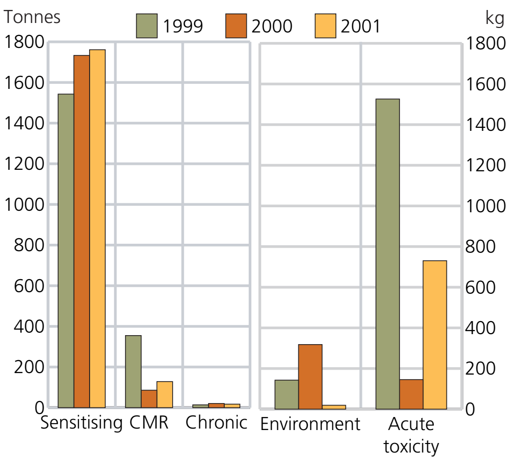
***Priority area 5*: Hazardous substances**

Our use of hazardous chemicals and emissions of these substances are responsible for one of the most serious environmental threats facing the world. A number of chemicals break down very slowly in the environment and can therefore accumulate in food chains. They are a serious threat to biological diversity, food supplies and the health of our and future generations. There have been substantial reductions in emissions of many of the most dangerous substances, but new problems are constantly being revealed. There is a general rise in the use of chemicals, and chemicals are being used in new types of products.

In 2002, Statistics Norway developed a methodology for a set of indicators that can show trends in the use of products containing hazardous substances. This uses data from the Product Register, which runs the central register of chemicals in Norway. The Product Register holds information on all products that are required to carry warning labelling (quantities manufactured, imported and exported, and their composition). Statistics Norway uses the different groups or danger categories into which products are divided on the basis of their intrinsic properties.

The method provides a basis for establishing complete statistics on chemicals including all products on which the Product Register holds information. For the moment, results have been obtained for hazardous products used for non-occupational purposes (by private households), in the construction industry (NACE 45) and in other service activities (NACE 93).

**Figure 1.6. Consumption of hazardous chemicals in households, by danger categories[1,2]. 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 toxic for reproduction.
Source: Finstad 2003.

- Consumption of substances containing carcinogenic, mutagenic and reprotoxic substances dropped by more than 60 per cent from 1999 to 2001. The main reason for this is a cut in consumption by the textile industry after the introduction of a tax on perchloroethylene in cleaning products.
- On the other hand, the consumption of products containing sensitising substances rose by 200 tonnes or 14 per cent from 1999 to 2001. This was mainly because of a rise in consumption of paints and varnishes and of ordinary 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.

For more information, see Chapter 6: Air pollution and climate change.

**National targets – hazardous substances**

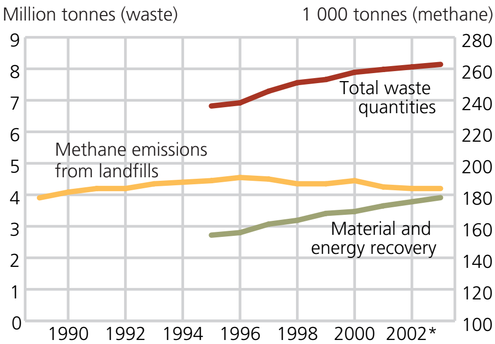
1. Emissions of certain environmentally hazardous substances shall be eliminated or substantially reduced by 2000, 2005 or 2010.
2. Emissions and use of substances that pose a serious threat to health or the environment shall be continuously reduced with a view to eliminating them within one generation (by the year 2020).
3. The risk that emissions and use of chemicals will cause injury to health or environmental damage shall be reduced substantially.
4. Pollution of soil, water and sediments caused by earlier activities, inappropriate disposal of waste, etc., shall not entail a risk of serious pollution problems.

## ***Priority area 6*: Waste and waste recovery**

Waste causes environmental problems in itself, and waste treatment releases pollutants. Landfilling of waste generates emissions of methane, which is a greenhouse gas. Landfills, particularly the older ones, also contain various kinds of POPs and heavy metals, and other substances that can pollute air and water. Waste incineration eliminates methane emissions and other problems associated with landfilling, but generates emissions of various pollutants to air and produces dust and ash that must be treated as hazardous waste. However, new incineration technology has made it possible to reduce such emissions considerably.

Waste contains both energy and materials that can be recovered and replace other energy sources or natural resources.

**Figure 1.7. Methane emissions from landfills, total quantity of waste generated[1,2] and waste delivered for recovery. 1989-2003***




[1] Waste quantities are based on the most recent calculations in the waste accounts, and the time series cannot at present be continued further back than 1995. The figures for 2001, 2002 and 2003 are projections.
[2] Hazardous waste is not included.
Source: Waste statistics, Statistics Norway and emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

### Waste generated, waste recovery and methane emissions

- The quantity of waste generated in Norway rose by about 18 per cent from 1996 to 2003.
- The quantity of waste delivered for material recovery and energy recovery has risen by 38 per cent in the same period. In 2003, 71 per cent of all waste was dealt with by material or energy recovery. Norway's goal is to reach an overall recovery rate of 75 per cent by 2010. It should be noted that these figures exclude 2.6 million tonnes of waste for which there is no information on the form of treatment or disposal. If this is included, the recovery rate drops to 48 per cent.
- Methane emissions, which are considered to be one of the most serious environmental problems associated with waste management, have changed little since 1989.

For more information see Chapter 6: Air pollution and climate change and Chapter 7: Waste.

**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 quantity of waste delivered for final treatment is to be reduced to an appropriate level in economic and environmental terms. Using this as a basis, the target is for 25 per cent of the total quantity of waste generated to be delivered for final treatment in 2010.
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.

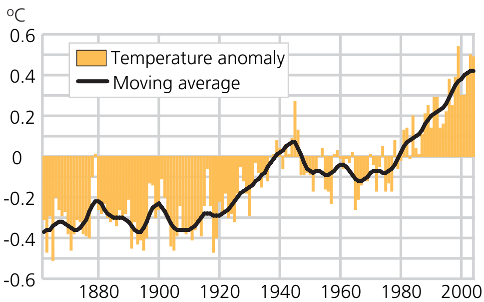
## *Priority area 7*: Climate change, air pollution and noise

### 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 400 000 years (Norwegian Pollution Control Authority 2004). As concentrations of greenhouse gases rise, the atmosphere retains more of the thermal radiation from the earth, which will cause the global mean temperature to rise and result in climate change. This phenomenon is called the anthropogenic greenhouse effect.

If greenhouse gas emissions continue to rise, there will be a growing risk of extensive and damaging climate change accompanied by the more frequent occurrence of extreme weather conditions. To solve the problem will require a complete 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 Chapter 6, box 6.5).

**Figure 1.8. Global mean temperature[1] 1861-2003**

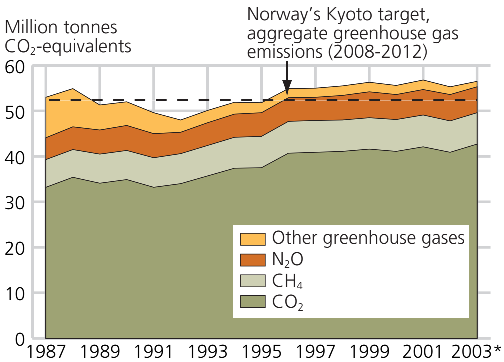



[1] Deviation from the normal value for the period 1961-1990.
Source: Climate Research Unit, University of East Anglia and Hadley Centre, UK Meteorological Office.

### 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 1861, while 2003 and 2002 were the next warmest.
- The annual mean temperature in Norway in 2003 was 1.2 °C above average, making it the sixth warmest year since the Norwegian Meteorological Institute started measurements in 1867.

**Figure 1.9. Greenhouse gas emissions in Norway. Historical figures and Kyoto target. 1987-2003**




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

## Greenhouse gas emissions in Norway

- Norwegian greenhouse gas emissions rose by more than 8 per cent from 1990 to 2003. According to the Kyoto Protocol, Norwegian emissions may only rise by 1 per cent between 1990 and the period 2008-2012 when the Kyoto mechanisms (see box 6.5) are taken into account.
- From 2002 to 2003, Norway's greenhouse gas emissions rose by 2 per cent. This was almost entirely due to a 4 per cent rise in $CO_2$ emissions.
- $CO_2$ accounts for three quarters of Norway's greenhouse gas emissions.

For more information, see Chapter 6.1.

## Depletion of the ozone layer

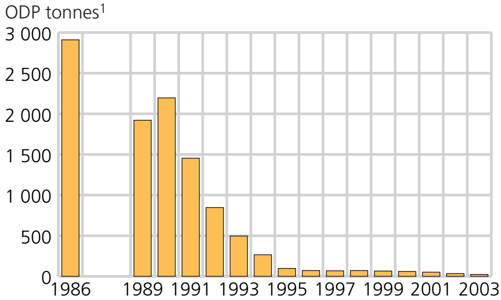
Emissions of gases containing chlorine and bromine, such as CFCs, HCFCs and halons, deplete the atmospheric ozone layer, which protects the earth against harmful UV radiation from the sun. Excessive UV radiation may harm people, plants and animals and marine ecosystems. The greatest rise in UV radiation as a result of depletion of the ozone layer is expected to occur in polar marine ecosystems.

The largest decreases in ozone concentrations are currently being observed over Antarctica, particularly in September and October each year. In this "ozone hole", up to 60 per cent of the total ozone is lost. After a couple of months new ozone is produced and the ozone layer regenerates until the next cycle starts. This phenomenon was first registered in the early 1980s (Norwegian Pollution Control Authority 2004).

Since 1969, the thickness of the earth's ozone layer has been reduced by an average of 5 per cent at mid-latitudes. Over Oslo, records have shown an average annual reduction of 0.21 per cent in the thickness of the ozone layer in the period 1979-2003 (Norwegian Institute for Air Research 2004).

In 1987, an international agreement, the Montreal Protocol, was drawn up with the aim of reducing global production and consumption of ozone-depleting substances. If all countries comply with the requirements of the agreement, the ozone layer is expected to return to normal in 2050.

**Figure 1.10. Imports of ozone-depleting substances to Norway. 1986-2003**




[1] 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.

## Imports of ozone-depleting substances

- Imports of ozone-depleting substances to Norway have been very low in recent years. Emissions are still being generated in connection with the use and replacement of old products that contain ozone-depleting substances, but these emissions are dropping as old products are phased out.
- Norway has met all its commitments under the Montreal Protocol and the EU targets for ozone-depleting substances. Measured in ODP tonnes, the country's consumption of ozone-depleting substances has been reduced by 99 per cent since 1986.

For more information, see Chapter 6.3

### National targets - climate change, air pollution and noise

**Climate change**

1. In the period 2008-2012, greenhouse gas emissions shall not be more than 1 per cent higher than in 1990.

**Depletion of the ozone layer**

1. The 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 2015.

## Long-range air pollution

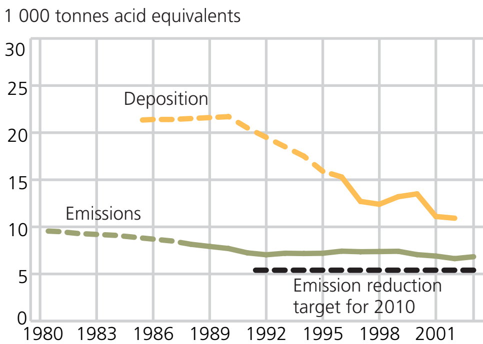
Acid rain is still one of the most serious environmental problems in Norway, even though reductions in emissions have reduced the extent of acidification. Acid rain is caused by emissions of sulphur and nitrogen compounds to air. In the atmosphere, sulphur and nitrogen react chemically with water vapour to form sulphuric acid and nitric acid. Acid rain 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 severely affected by acid rain, but its impacts can also be seen in some areas of the eastern part of Finnmark county. The most obvious effect is damage to fish stocks, but acidification can also cause forest damage. Inputs of nitrogen oxides and ammonia can also cause eutrophication.

Deposition of sulphur is still the most important cause of acidification in Norway, while nitrogen accounts for about 10 per cent of acid deposition in most parts of the country. Because sulphur emissions are being reduced more rapidly than nitrogen emissions, the relative importance of nitrogen as a source of pollution is increasing (Norwegian Pollution Control Authority 2004).

The areas of Norway where critical loads for acidification of surface water are exceeded have been gradually reduced. Inputs of acidifying substances to Norway were highest around 1980, when critical loads were exceeded across roughly 30 per cent of the total area of Norway.

As emissions in other parts of Europe have been reduced, so has acid deposition in the Norwegian environment. In 2000, the area where critical loads were exceeded had dropped to 13 per cent of Norway's total area. If all countries meet their commitments under the Gothenburg Protocol, this will drop to about 7 per cent. This means that there will still be fish mortality and damage to fish stocks unless preventive measures such as liming are also kept up (Norwegian Pollution Control Authority 2004).

**Figure 1.11. Emissions and deposition of acidifying substances ($NO_x$, $SO_2$ and $NH_3$) in Norway. 1980-2003***




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

For more information, see Chapter 6.2.

### Acid deposition and emissions

- The international agreements on reductions in emissions of long-range pollutants are now showing results. The deposition of acidifying substances in Norway has dropped considerably in the last 10 years.
- However, Norway's emissions have not been significantly reduced over the past few years, and the authorities' target for 2010 has not yet been reached. Nevertheless, acidification has been reduced, mainly as a result of lower inputs from abroad.

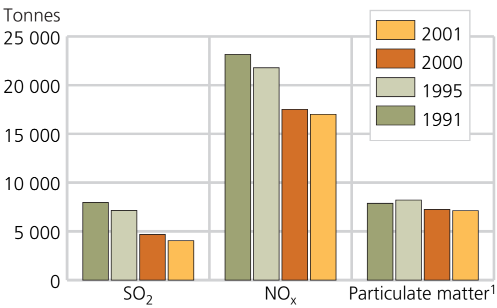
## Local air quality

Clean air is important for people's health and quality of life. At times, local air pollution causes serious health and welfare problems in the largest towns and urban settlements in Norway. In the largest towns, a substantial proportion of the population is exposed to concentrations of pollutants that increase the risk of premature death and health problems such as respiratory infections, lung disease and cancer.

Some important pollutants that contribute to local air pollution are particulate matter ($PM_{10}$ and $PM_{2.5}$), nitrogen dioxide ($NO_2$), sulphur dioxide ($SO_2$), ground-level ozone ($O_3$), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs), benzene ($C_6H_6$) and other aromatic compounds.

Several hundred thousand people in Norway are exposed to levels of air pollution that entail a health risk. The socio-economic costs of the resulting health problems are estimated to be several billion NOK a year (Rosendahl 2000).

**Figure 1.12. Emissions of particulate matter ($PM_{10}$[1]), $SO_2$ and NOx in the 10 largest towns in Norway. Tonnes. 1991, 1995, 2000 and 2001**




[1] $PM_{10}$ = Particles with diameter < 10 µm.
Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

### Emissions of harmful substances in urban settlements

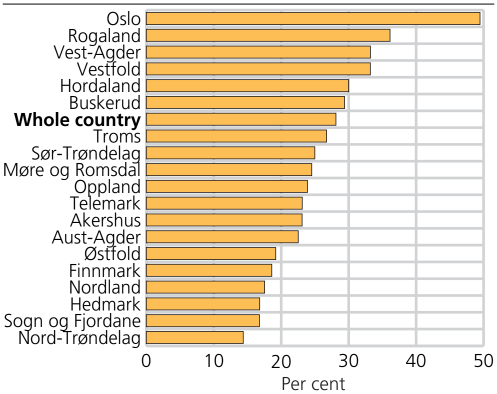
- There has been a marked reduction in emissions of $NO_X$ and $SO_2$ in the last 10 years. There has been a certain reduction of emissions of particulate matter towards the end of this period, but the level is not very different from 10 years ago.
- The most important causes of local air pollution today are road traffic and fuelwood use. Even with the projected growth in road traffic, emissions from this source will probably be gradually reduced in future because considerable reductions in emissions from individual vehicles are expected. Nevertheless, it may be difficult to achieve the national air quality target for nitrogen dioxide ($NO_2$) in 2010 in certain towns unless measures are introduced to reduce traffic.

For more information, see Chapter 6.6.

## Noise

Noise is one of the environmental problems that affects the largest number of people in Norway. According to the "noise annoyance index", which is an indicator of noise annoyance from various sources, about three-quarters of noise annoyance is caused by road traffic. Industry, construction, air traffic and railways account for 4 per cent each. Surveys of living conditions carried out by Statistics Norway show that 5 per cent of the population have sleep problems as a result of noise. For more information on the noise annoyance index, see box 1.3.

**Figure 1.13. Proportion of the population exposed to road traffic noise levels exceeding 55 dBA, by county. 2002***




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

### Distribution of road traffic noise by county

- About 1.3 million people in Norway are exposed to road traffic noise exceeding a 24-hour average of 55 dBA (decibels). In Oslo, half the population is exposed to noise exceeding this level.
- More than 36 000 people in Norway were exposed to noise levels above 70 dBA in 2002. Well over half of these, 21 000 people, lived in Oslo.

### National targets - climate change, air pollution and noise

**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. In the period up to 2010, annual emissions shall not exceed the 1987 level.
3. Total annual emissions of volatile organic compounds (VOCs) shall be reduced to the 1988 level at the earliest possible date, and from 2010 onwards shall not exceed 195 000 tonnes. Annual VOC emissions from the entire mainland and the Economic Zone of Norway south of 62° N shall be reduced by 30 per cent from the 1989 level at the earliest possible date.
4. Emissions of ammonia ($NH_3$) shall not exceed 23 000 tonnes from 2010 onwards.

**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.

**Noise**

1. By 2010, noise annoyance shall be reduced by 25 per cent from the 1999 level.

## Box 1.3. 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 table below shows a decrease in the noise annoyance index for industry, air traffic and railways in 2002 compared with 1999. It is not yet possible to say anything about changes in noise annoyance caused by road traffic after the base year 1999.

**Noise annoyance index, by source of noise[1,2]. 1999 and 2002**

| | Index 1999 | Index 2002 | Percentages, 2002 | Change 1999-2002, per cent |
|---|---|---|---|---|
| **Total, all sources** | **..** | **579 038** | **100** | **..** |
| Road traffic[3] | .. | 459 103 | 79 | .. |
| Manufacturing | 24 724 | 23 517 | 4 | -5 |
| Other industry | 10 929 | 11 292 | 2 | 3 |
| Air traffic | 26 710 | 23 375 | 4 | -12 |
| Railways | 27 745 | 23 699 | 4 | -15 |
| Construction[4] | 21 079 | 21 144 | 4 | 0 |
| Firing ranges (military) | .. | .. | .. | . |
| Shooting ranges[5] | 12 060 | 12 060 | 2 | 0 |
| Motor racing tracks[5] | 4 848 | 4 848 | 1 | 0 |
| Products used outdoors | .. | .. | .. | . |

[1] The figures do not show the number of people annoyed, but the index values.

[2] Index for road traffic noise applies to noise levels exceeding 55dBA.

[3] The method for calculating road traffic noise has been revised and quality assessment carried out. Figures calculated according to the new method will be published next year.

[4] Figures for 1999 are from the report 'Støy fra bygge- og anleggsvirksomhet i Norge (Noise from the construction industry in Norway). (Source: Akustikk, report R1132, 1999). Figures for 2002 were calculated on the basis of the 1999 figures and adjusted for changes in the level of activity.

[5] No new index values were calculated. The 1999 value is also being used for 2002 for the moment. Source for the 1999 figure: Norwegian Pollution Control Authority.

Source: Statistics Norway.

### Road traffic the most important source of noise

Road traffic is much the most important source of noise annoyance in Norway, and accounted for 79 per cent of noise annoyance in 2002.

The calculations for road traffic are based on surveys of noise levels outside dwellings carried out by the Directorate of Public Roads using the specially developed tool VSTØY. Statistics Norway has made additional calculations to include dwellings not covered by the Directorate's surveys.

### Noise annoyance from railways dropped by 15 per cent…

Railways accounted for 4 per cent estimated noise annoyance in 2002. From 1999 to 2002, noise annoyance from this source dropped by 15 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.

*Cont.*

*..cont.*

**… noise annoyance from air traffic by 12 per cent …**
Air traffic accounted for 4 per cent of registered noise annoyance in 2002, and much of this is caused by fighter planes around military airports. The noise annoyance index for air traffic has dropped by 12 per cent from 1999 to 2002. This is mainly explained by a lower level of activity at airports, with a considerable drop in the number of landings and take-offs at civilian airports in Norway during this period. For example, there was an 18 per cent reduction in the number of flights at Oslo (Gardermoen) and a reduction of 14 per cent at Bergen (Flesland). Norway's F16 fighter planes have been moved from Rygge airport (Østfold county) to Bodø (Nordland county), but this has had little effect on the noise annoyance index in the country as a whole. The noise annoyance index for Østfold was reduced by 1600 units, or about one third, but the index for Nordland rose correspondingly.

**… and industrial noise also caused less annoyance**
The method for calculating noise annoyance from industry has been changed on the basis of new studies by SINTEF (2003). Steady industrial noise is now considered to result in the same level of annoyance as road traffic noise. In addition, the method takes into account the fact that some enterprises generate impulse noise, which is more annoying than a steady noise level. This is why there are such large discrepancies between the figures published in 2002 and 2004 for this noise source.

The calculations for 2002 show that industry accounted for 4 per cent of total noise annoyance, and that overall noise annoyance dropped by 5 per cent from 1999 to 2002. However, the figures are uncertain.

**About the model**
Statistics Norway was commissioned by the Norwegian Pollution Control Authority to develop a model to calculate exposure to noise and noise annoyance in Norway, 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. The model calculates data for noise exposure from various sources (measured as the number of people exposed to different noise levels, $L_{eq}$) and noise annoyance (measured using the noise annoyance index) in Norway.

A GIS model has been developed to calculate and record noise levels outside individual dwellings throughout Norway. Additional calculations are being made for dwellings that have not been included in earlier surveys.

The calculations are uncertain, and the level of uncertainty varies between sources. As a general rule, the level of uncertainty is lowest in areas where there is a great deal of noise and the model is largely based on existing surveys (for example around Oslo airport Gardermoen and areas surveyed using the road traffic noise model VSTØY). The uncertainties are described in more detail in the article documenting the model (Engelien et al. 2004).

For more information, see: Støyplage i Norge. 1999-2002: Veistøy på plagetoppen. SSBmagasinet (Noise annoyance in Norway. 1999-2002. Revised figures. Noise from road traffic most annoying): http://www.ssb.no/english/magazine/.

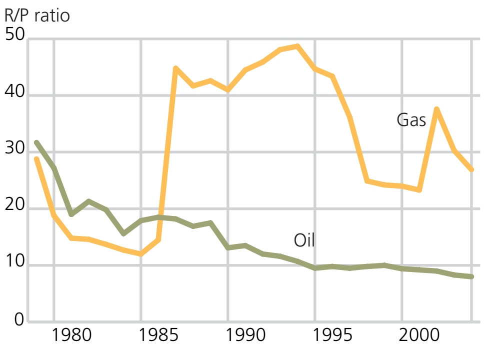
## 1.3. Natural resources

Many natural resources are important raw materials for industrial production. These resources, and the way they are used, are also of crucial importance for biological diversity. It is therefore essential that natural resources are managed sustainably and are not over-exploited. In this section, we consider some important natural resources that Norway is responsible for managing - oil and gas, hydropower, fish stocks, agricultural land and forests.

### Oil and gas resources

In 2003, Norway's oil and gas reserves corresponded to just over 1 per cent of the world's petroleum reserves. In the same year, however, Norway accounted for 4.1 per cent of the world's oil production and 2.8 per cent of gas production. The estimates of reserves are revised regularly and the figures may change markedly from one year to another. In addition, new fields are added to the list almost every year. The length of time that the remaining oil and gas reserves will last (at the current rate of production) is expressed as the R/P ratio, i.e. the ratio between the estimated petroleum reserves (defined as the remaining resources in fields that are already developed or where development has been approved) and production in a particular year.

**Figure 1.14. R/P ratio[1,2] for Norwegian oil and gas reserves. 1978-2003**




[1] The R/P ratio, or the ratio between reserves and 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.

### R/P ratio for oil and gas reserves

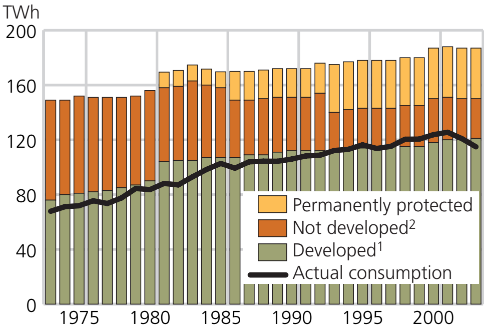
- The length of time that Norway's oil and gas reserves will last at the current rate of production, expressed as the R/P ratio, is calculated to be 8 years for oil and 27 years for gas.
- BP (2004) quotes the following R/P ratios for the whole world at the end of 2003: oil 41 years and natural gas 67 years.
- These figures do not include the total petroleum resources, which are much larger. They are defined as including all more or less certainly proven finds.

For more information, see Chapter 2: Energy.

## Hydropower resources

Unlike petroleum resources, hydropower resources are renewable. Norway has Europe's largest hydropower resources, and hydropower was an important basis for the industrialisation of the country. The rich supplies of hydropower have a great influence on the energy mix. Almost 100 per cent of electricity production in Norway is based on hydropower. Some of the electricity that Norway imports is generated from other energy sources, but this accounts for only a very modest share of the total. In 2003, electricity accounted for 44 per cent of total domestic energy use outside the energy sectors (50 per cent if energy commodities used as raw materials are excluded: see Appendix, table B5 and figure 2.13). This is the highest percentage in the world.

**Figure 1.15. Hydropower resources: developed[1], not developed[2] and protected. Actual electricity consumption. 1973-2003**




[1] Includes the categories under construction and licence granted.
[2] Includes the categories prior notification submitted and licence application submitted.
Source: Norwegian Water Resources and Energy Directorate.

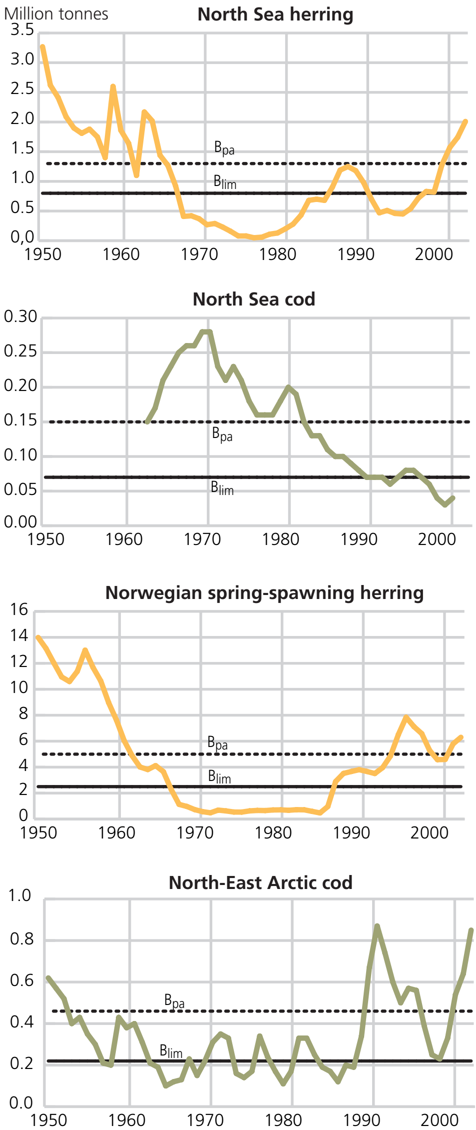
- Norway's hydropower potential is evaluated on a continuous basis and depends on technological and economic factors. The calculated hydropower potential may therefore change from year to year. In addition, the resources in fact available vary from year to year depending on rainfall.
- In the last 30 years, electricity consumption has risen faster than production capability. However, consumption has dropped in the last two years, probably as a result of lower production and higher prices (see chapter 2).
- Of Norway's total hydropower potential, about 37 per cent has not been developed, and rather more than half of this is protected.

For more information, see Chapter 2: Energy.

## Fish stocks

In its annual report on marine resources (Michalsen 2004), the Institute of Marine Research states that great caution must still be shown in harvesting several of Norway's important fish stocks. This is particularly the case for demersal fish stocks: the pelagic stocks are generally in a better state. The North Sea cod stock appears to be at a particularly low level. This stock is still being very heavily exploited. The capelin stock in the Barents Sea has collapsed again, but this is not considered to have been caused primarily by fishing.

**Figure 1.16. Actual spawning stocks and critical ($B_{lim}$) and precautionary ($B_{pa}$) reference points for four important fish stocks. 1950-2004**




Source: ICES and Institute of Marine Research.

## Spawning stocks

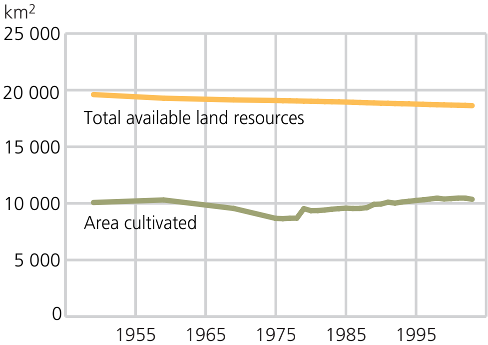
- The North Sea herring stock is well within safe biological limits.
- The North Sea cod stock appears to have been greatly depleted, and the spawning stock is well below safe biological limits.
- The spawning stock of Norwegian spring-spawning herring is within safe biological limits. Sound management seems to have given good results.
- The spawning stock of North-East Arctic cod has risen considerably in the past year, and is now definitely above the precautionary level.

For more information, see Chapter 5: Fisheries, sealing, whaling and fish farming.

## Agricultural areas

Norway has only limited land resources that are suitable for agricultural production. About 3 per cent of the country is cultivated, as compared with over 10 per cent in the world as a whole. The scarcity of land resources means that the current self-sufficiency rate is between 40 and 50 per cent.

**Figure 1.17. Cultivated land and available land resources in Norway. 1949-2003***




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

### Available land resources and cultivated land

- In the past 100 years, the cultivated area of Norway has varied between 11 200 km$^2$ at the end of the 1930s and 8 700 km$^2$ in the 1970s, and is now about 10 400 km$^2$.
- The available land resources (cultivated and cultivable area) have dropped by almost 1 000 km$^2$ or 5 per cent from 1949 to 2003 as a result of irreversible conversion of agricultural land for non-agricultural uses. The proportion of the available resources actually cultivated was 56 per cent in 2003, as compared with 51 per cent in 1949.

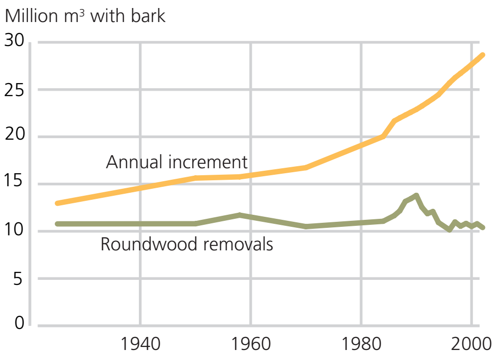
For more information, see Chapter 3: Agriculture.

## Forest resources

The volume of the growing stock of forest has risen a great deal in the past century, resulting in an increase both in timber resources and in the potential value of forest as a $CO_2$ sink (this is not included in the Kyoto Protocol). The type of forest has also changed greatly during this period. Clear-cutting, silviculture, drainage, the construction of forest roads, the introduction of alien species and pollution are some of the factors that have had an impact on the forest as a natural resource and on biological diversity in forests.

The Norwegian monitoring programme for forest damage shows that in recent years, there has been a slight improvement in the health of forests measured as crown condition.

**Figure 1.18. Roundwood removals and annual increment in Norwegian forest. 1925-2002**




Source: Statistics Norway and Norwegian Institute for Land Inventory.

### Roundwood removals and annual increment

- Since the early 1920s, roundwood removals in Norway have been less than the annual increment. About 80 per cent of the increment was harvested in 1925, but this had dropped to only about 40 per cent in 2002.
- In recent years, only 40 to 60 per cent of the annual increment has been harvested. As a result, the volume of the growing stock has more than doubled since the 1920s.

For more information, see Chapter 4: Forest and uncultivated land.

## 1.4. The relationship between environment and economy – indicators for selected sectors

There is a close relationship between economic activity and many environmental problems. Pollution and disturbance of the natural environment are often side effects of production and/or consumption, and such effects result in growing pressure on the environment as the economy expands. For example, energy use and greenhouse gas emissions show a tendency to rise with economic growth. However, this relationship is not at all clear-cut.

An analysis of factors that have influenced emissions to air in Norway (Bruvoll and Medin 2003) showed that the two factors that had most effect in counteracting rising emissions in the period 1980-1996 were more efficient use of energy and increasing use of technology to control emissions. Changes in the energy mix also helped to moderate the growth in emissions, whereas changes in the relative size of production sectors tended both to speed up and slow down the growth in emissions.

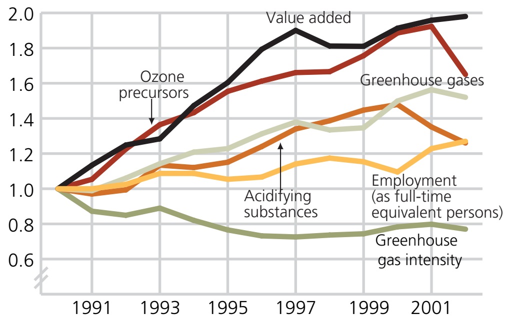
### General economic developments

Measured in constant prices, Norway's gross domestic product (GDP) has grown every year since 1990. The Norwegian economy passed a cyclical peak in 1998, and since then growth has been weaker than it was in the mid-1990s. According to the national accounts, mainland GDP expanded by 0.6 per cent in 2003.

## Mining and extraction of crude oil and natural gas

In the period 1990-2002, value added in this sector rose by 98 per cent, and this in itself would tend to cause a rise in emissions. In 2002, these industries accounted for 13.4 per cent of Norway's value added. They also generated 10 per cent of Norway's emissions of acidifying substances, 19 per cent of its greenhouse gas emissions and 29 per cent of emissions of ozone precursors (Statistics Norway 2004). For more information, see Chapter 2: Energy and Chapter 6: Air Pollution and Climate Change.

**Figure 1.19. Economic, air emission[1] and greenhouse gas intensity trends for mining and quarrying and the extraction of crude oil and natural gas. 1990-2002*. Index: 1990=1**




[1] The calculations for ozone precursors include $NO_x$, NMVOC, CO and $CH_4$.
Source: National accounts and environment statistics, Statistics Norway.

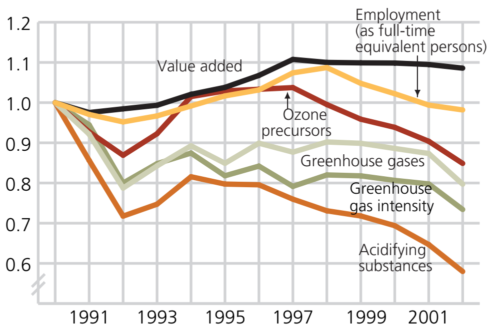
## Mining and extraction of crude oil and natural gas: Environmental and economic indicators

- The Norwegian authorities have focused on reducing emissions to air from this sector for many years. Even so, emissions of greenhouse gases and acidifying gases have risen, but more slowly than value added. It is only recently that measures to reduce emissions have begun to give results. The considerable drop in total emissions of ozone precursors continued in 2002 (see box 6.13).
- Greenhouse gas intensity (measured as emissions per NOK of value added) gives an idea of the eco-efficiency of production. There was a general improvement in the efficiency of this sector in the period 1990-2002. There was then a brief downturn, followed by a certain improvement again from 2001 to 2002 (greenhouse gas intensity dropped by about 4 per cent).

## Manufacturing

Value added in manufacturing reached a peak in 1998, and is now showing a weak downward trend. This in itself may have reduced some environmental problems associated with emissions of pollutants. In 2002, manufacturing generated 7 per cent of Norway's emissions of acidifying substances, 23 per cent of its greenhouse gas emissions and 6 per cent of emissions of ozone precursors, and accounted for 11.3 per cent of Norway's total value added.

**Figure 1.20. Economic, air emission[1] and greenhouse gas intensity trends for manufacturing in Norway. 1990-2002*. Index: 1990=1**




[1] The calculations for ozone precursors include $NO_x$, NMVOC, CO and $CH_4$.
Source: National accounts and environment statistics, Statistics Norway.

### Manufacturing: Environmental and economic indicators

- Preliminary figures 2002 for manufacturing show that all types of emissions have dropped. This was because there still was a decline in activity in certain types of manufacturing, and production was therefore lower.
- The drop in greenhouse gas emissions in recent years is explained by the closure of one of Norway's three oil refineries and the closure of plants in the ferro-alloy industry and primary production of magnesium.
- Emissions of acidifying substances from manufacturing are showing a long-term downward trend. This is largely due to lower $SO_2$ emissions as a result of technological improvements and the use of fuel with a lower sulphur content.
- The greenhouse gas intensity index dropped from 100 to 73 in the period 1990-2002, indicating that there at least is a weak decoupling of value added from greenhouse gas emissions in manufacturing as a whole (*decoupling* is a term that is used to describe a situation where economic growth is clearly greater than the growth in emissions or environmental pressure).

**Box 1.4. Does stricter environmental regulation reduce productivity growth?**

It has been claimed that environmental regulation can reduce productivity growth, and there is some empirical support for this internationally. However, these empirical studies are based on traditional measures of productivity growth that do not include environmental factors. By making more productive use of market-traded factor inputs, enterprises can reduce their costs, but this does not in itself provide an incentive for reductions in emissions. This may mean that productivity growth measured in terms of traditional factor inputs is higher than if environmental factors are included in the index for productivity growth. On the other hand, strict environmental regulation pressures enterprises into using technologies that reduce emissions per unit of production. It is therefore unclear whether stricter environmental regulation will tend to increase or reduce productivity growth as measured by an index that includes both traditional and environmental factor inputs.

A study by Statistics Norway analysed the relationship between regulatory stringency and two measures of productivity growth, a traditional productivity index and an environmental productivity index. The traditional productivity index only takes the traditional factor inputs into account (labour, capital and intermediate goods), while the productivity index including environmental factors also includes emissions of various kinds of pollutants. The most polluting Norwegian industrial enterprises were studied using data from the period 1992-2000. The stringency of environmental regulation can be measured in several ways. In this analysis, enterprises that were inspected once or more than once by the Norwegian Pollution Control Authority in the course of a year were considered to be more stringently regulated than other enterprises.

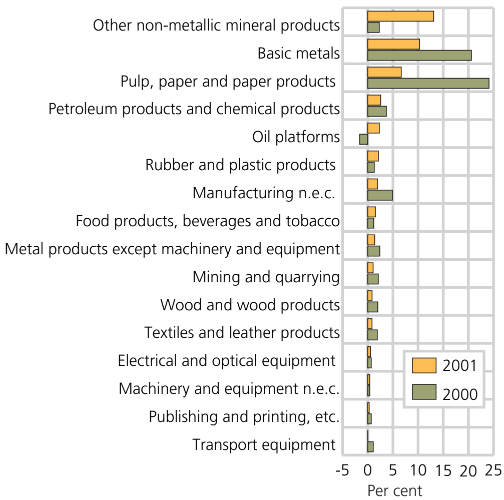
No clear relationship was found between the stringency of environmental regulation and productivity growth measured by the traditional productivity index. However, there was a positive relationship between stringent environmental regulation and the environmental productivity index. This suggests that enterprises that are subject to stringent environmental regulation are able to maintain a reduction in emissions relative to production. Even though the environmental productivity index is an interesting long-term measure of economic progress, it should be noted that such improvements in productivity growth are liable to involve financial costs for enterprises, at least in the short term.

For more information see: Telle, K. and J. Larsson (2004): Do environmental regulations hamper productivity growth? How accounting for improvements of firms' environmental performance can change the conclusion, Discussion Papers no. 374, Statistics Norway.

## Environmental protection expenditure in manufacturing industries

In 2001, 3.5 per cent of expenditure in mining and manufacturing was on environmental protection, as against 5.2 per cent in 2000. Manufacturing industries invested a total of NOK 586 million in end-of-pipe equipment. This is equipment to treat, prevent, control or measure pollution. In the mining sector (excluding petroleum extraction), environmental protection expenditure was NOK 5.7 million (see Appendix, table A1).

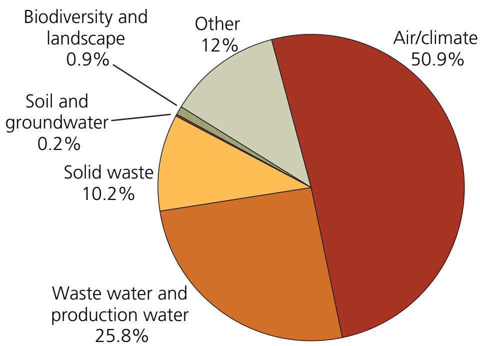
**Figure 1.21. Investment in environmental protection measures (equipment for emission reduction and pollution treatment), as a percentage of each industry's gross investments. 2000 and 2001**




Source: Environmental protection expenditure statistics, Statistics Norway.

- A little over 10 per cent of the metal industry's investments in 2001, or NOK 284 million, were in environmental protection measures, while the corresponding figures for the pulp and paper industry were almost 7 per cent and NOK 46 million. Both these industries experienced a drop in investments in environmental protection measures compared with the year before.
- In enterprises producing glass, cement and ceramic products, investments in environmental protection measures accounted for 13 per cent of total investments.
- In most other industries, this type of expenditure makes up 1-2 per cent of total gross investments.

**Figure 1.22. Investment in environmental protection measures (equipment for emission reduction and pollution treatment), according to environmental domain. 2001. Manufacturing and mining and quarrying. Percentages**




Source: Environmental protection expenditure statistics, Statistics Norway.

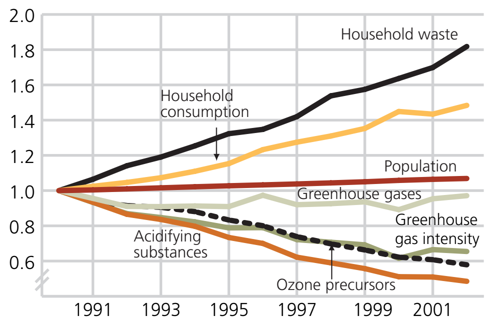
- Environmental protection expenditure is classified on the basis of the type of pollution or problem area it is related to: air/climate, waste water (including production water), waste, soil and groundwater, biodiversity and landscape and other pollution. In the 2001 survey, companies specified a larger proportion of their environmental protection expenditure by environmental domain, but some investments are still classified as "other" for various reasons. A large proportion of the expenditure is related to measures to reduce emissions to air, and another important area is reduction of discharges in waste water.

- The data do not include all types of environmental protection expenditure in manufacturing industries. When investments are made in new or modified production processes where environmental protection equipment is integrated into the production process, it is difficult to determine and quantify the proportion of the expenditure that is for environmental purposes. However, data for such expenditure have been collected, and were published in autumn 2004 (http://www.ssb.no/english/subjects/01/06/20/miljokostind_en/).

## Households

Some environmental problems are closely related to household consumption, but the relationships are not clear-cut. In 2002, households accounted for 4 per cent of Norway's emissions of acidifying substances, 12 per cent of emissions of ozone precursors and 9 per cent of greenhouse gas emissions. Household consumption in 2002 was NOK 567 billion.

**Figure 1.23. Consumption, waste generation, air emission[1] and greenhouse gas intensity trends for households. 1990-2002*. Index: 1990=1**




[1] The calculations for ozone precursors include $NO_x$, NMVOC, CO and $CH_4$.
Source: National accounts and environment statistics, Statistics Norway.

### Households: Environmental and economic indicators

- Household consumption has risen by 48 per cent during the period 1990-2002. Generation of household waste has also risen throughout the period, and at a faster pace than consumption (80 per cent rise).
- Emissions to air from transport are an important source of direct emissions from households. There has been a marked increase both in the number of private cars and in the total distance driven since 1990. Improvements in technology help to reduce emissions from cars, but this is offset by the rise in the distance driven.
- Greenhouse gas intensity (measured as emissions of greenhouse gases per unit consumption) is dropping. This is mainly because household consumption includes imported products, so that consumption by Norwegian households results in emissions in the countries where these goods are produced, and these emissions are not included in the current analysis (see box 1.5).

**Box 1.5. Environmental policy and emission leakages to other countries**

Studies have shown that many aspects of environmental quality in rich countries like Norway improve with economic growth. One explanation for this relationship may be that the population becomes more willing to pay for environmental quality, and that this translates into stricter environmental policy measures through political channels. On the other hand, strict environmental policy measures in a rich country can transfer environmental burdens to countries where environmental regulation is less strict. This can happen if rich countries increase imports and cut exports of goods whose manufacture causes pollution. There has been considerable concern about the burden this may put on poor countries. If such emission leakages do occur, national emission figures will underestimate the total environmental load caused by a country.

More direct economic costs may also be shifted to other countries. The market shares of polluting enterprises operating in countries where the environmental policy regime is relatively mild may well increase. However, environmental regulation involves costs for the country that enforces the regime, resulting in lower domestic demand. This will also affect foreign suppliers. Higher costs will also have an adverse effect on the current account balance of the country enforcing regulation, and it is reasonable to assume that this will sooner or later push down domestic prices and thus weaken market positions of foreign firms, particularly in markets for non-polluting products.

These relationships were studied in an analysis of the effects of pursuing a stricter Norwegian climate policy by imposing a tax on all $CO_2$ emissions and raising it steadily to about three times the current level by 2030. The calculations confirmed that raising the Norwegian tax rate unilaterally might lead to some emission leakages, but this effect would be considerably smaller than the positive environmental effects in Norway. Since most Norwegian trade is with other rich countries, emission leakages would have a limited impact on poor countries. Although foreign production of relatively "dirty" products was found to rise, production of many services and labour-intensive goods was found to drop, so that overall production abroad would be lower. However, the impacts were found to be small compared with those on Norwegian industry.

All in all, it was concluded that the consequences of this unilateral change in Norwegian climate policy would be less favourable in a global than in a national context. This conclusion was strengthened when other emissions to air and the financial effects on enterprises in other countries were included in addition to $CO_2$ emissions. This shows that there are several arguments for coordinating different countries' climate policies.

For more information:

Bruvoll, A. and T. Fæhn (2004): Transboundary environmental policy effects: markets and emission leakages, Discussion Papers no. 384, Statistics Norway.

Straumann, R. (2003): *Exporting Pollution? Calculating the embodied emissions in trade for Norway*, Reports 2003/17, Statistics Norway.

Straumann, R. (2003): Forurenser vi i andre land? (Do we pollute other countries?), *Economic Analyses* 4/2003, Statistics Norway.

The remaining chapters of this publication and the appendix of tables provide further information on Norway's natural resources and the environment and describe how they are affected by the activities of various economic operators.

## References

BP (2004): Statistical Review of World Energy, British Petroleum (downloaded from http://www.bp.com/centres/energy/)

Bruvoll, A. and H. Medin (2003): Factors Behind the Environmental Kuznets Curve: A Decomposition of the Changes in Air Pollution. *Environmental and Resource Economics* **24**: 27-48.

Bruvoll, A. and T. Fæhn (2004): Transboundary environmental policy effects: markets and emission leakages, Discussion Papers no. 384, Statistics Norway.

EEA (2002a): *Environmental signals 2002. Benchmarking the millennium.* European Environment Agency, Copenhagen.

EEA (2002b): *TERM 2002 - Paving the way for EU enlargement - Indicators of transport and environment integration*. European Environment Agency, Copenhagen.

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

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 2004/43, Statistics Norway.

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

Finstad, A. (2003): Kraftig nedgang i bruk av kreftfremkallende produkter (Use of products containing carcinogenic chemicals greatly reduced). http://www.ssb.no/ english/magazine/, Statistical Magazine, Statistics Norway.

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

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, Paris: Organisation for Economic Co-operation and Development.

Michalsen, K. (ed.) (2004): Havets ressurser 2004 (Marine Resources 2004). *Fisken og havet*, Special issue 1-2004, Bergen: Institute of Marine Research.

Ministry of the Environment (2003): 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).

Norwegian Institute for Air Research (2004): *Overvåking av ozonlaget og naturlig ultrafiolett stråling. Årsrapport 2003* (Monitoring of the ozone layer and natural ultraviolet radiation. Annual report 2003). Report 905/04.

Norwegian Institute for Water Research (2003): Government programme for pollution monitoring – input of nutrients to Norwegian coastal areas in 2002, calculated using the input model TEOTIL. NIVA report nr. 4771-2003. Norwegian Institute for Water Research (NIVA).

Norwegian Pollution Control Authority (2004): State of the Environment Norway (http://www.environment.no/).

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): *OECD 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.

Rosendahl, K. E. (2000): *Helseeffekter og kostnader av luftforurensning i Norge* (Health effects and costs of air pollution in Norway). SFT report 1718/2000, Oslo: Norwegian Pollution Control Authority.

SINTEF (2003): Nasjonale mål for industristøy - beregninger av SPI basert på nye bransjeregistre.(National target for industrial noise. Calculations of the noise annoyance index based on new data) Rapport STF40 A03022. Foundation for Scientific and Industrial Research.

SSB/SFT/DN (1994): *Naturmiljøet i tall 1994* (The natural environment in figures 1994). Oslo: Scandinavian University Press.

Statistics Norway (2004): *Nasjonalregnskap og miljø, 1990-2002. Økonomien vokste mer enn utslippene* (National accounts and the environment, 1990-2002. Higher economic growth than increase in air emissions). Dagens statistikk (Today's statistics) 29 March 2004. http://www.ssb.no/english/subjects/09/01/nrmiljo_en/

Straumann, R. (2003): *Exporting Pollution? Calculating the embodied emissions in trade for Norway.* Rapporter 2003/17, Statistics Norway.

Straumann, R. (2003): Forurenser vi i andre land? (Do we pollute other countries?) *Economic Analyses 4/2003,* Statistics Norway.

Telle, K. and J. Larsson (2004): Do environmental regulations hamper productivity growth? How accounting for improvements of firms' environmental performance can change the conclusion. Discussion Papers no. 374, Statistics Norway.

# 2. 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. 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 2003, extraction of energy commodities in Norway was more than 9 times higher than domestic consumption. Most of this is extraction of oil and gas, which accounted for 95 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 8 years' time and the gas reserves in 27 years' time. The lifetime of the remaining resources depends on the rate of extraction, on new finds, on decisions concerning the development of proven fields and on whether a larger proportion of the oil and gas is extracted from fields that are on stream. Norway has 0.9 per cent of the world's oil reserves, but accounted for 4.1 per cent of world oil production in 2003. The Norwegian oil reserves are thus being exhausted more rapidly than those in the rest of the world. The high rate of extraction means that this is the industry in Norway that generates most foreign exchange earnings. According to the national accounts, petroleum extraction accounted for about 17 per cent of GDP and 43 per cent of Norway's export revenues in 2003. This is only a small change from the year before.

Hydropower is Norway's other major energy resource, although electricity production from this source corresponded to only about 4 per cent of petroleum extraction in 2003, expressed as energy content. However, hydropower is a renewable energy source, unlike petroleum resources, which are depleted as they are extracted. In 2003, Norway produced 107 TWh of electricity, as against 131 TWh the year before. In addition, 7.8 TWh was imported. Autumn 2002 was very dry, and this combined with the high level of production in 2002 resulted in water levels in the reservoirs reaching an all-time low in autumn-winter 2002-2003. The degree of filling increased during autumn 2004, but at the beginning of October it was still well below the median for the period 1990-2003.

Consumption of energy commodities (the energy sector included) increased moderately in 2003. In the last 20-30 years, energy use has grown considerably more slowly than general economic growth (see Chapter 1.4 on the relationship between environment and economy).

Energy production and use has major environmental impacts. In 2002, extraction of oil and gas generated 27 per cent of Norway's total greenhouse gas emissions. Hydropower developments in watercourses have a significant impact on biological diversity, the cultural landscape and outdoor recreation. About 63 per cent of Norway's hydropower potential has now been developed.

## 2.1. Resource base and reserves

### World fossil energy reserves

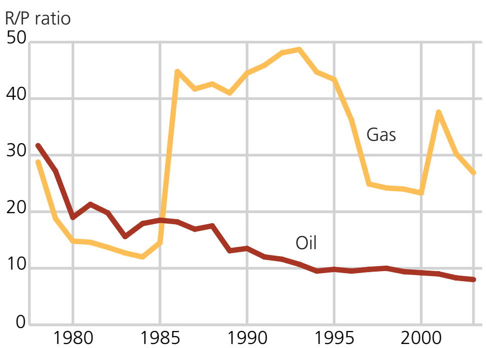
- Reserves are defined here as resources that are fairly certainly recoverable given the current economic and technological framework.
- BP (2004) quotes the following R/P ratios (estimates for the length of time remaining reserves will last at the current rate of production) for the whole world at the end of 2003: oil 41.0 years, natural gas 67.1 years and coal 192 years. The two countries with the largest oil and gas reserves, Saudi Arabia and Russia, each have about a quarter of the world total.

**Table 2.1. World reserves of fossil energy commodities as of 1 January 2004**

| | Oil | | Gas | | Coal | |
|---|---|---|---|---|---|---|
| | Billion tonnes | Per cent | Billion tonnes o.e. | Per cent | Billion tonnes | Per cent |
| **World** | **156.7** | **100.0** | **158.2** | **100.0** | **984.5** | **100.0** |
| North America[1] | 8.8 | 5.6 | 6.6 | 4.2 | 257.8 | 26.2 |
| Latin America | 14.6 | 9.3 | 6.5 | 4.1 | 21.8 | 2.2 |
| Europe incl. former Soviet Union | 14.5 | 9.3 | 56.1 | 35.4 | 355.4 | 36.1 |
| Middle East | 99.0 | 63.2 | 64.5 | 40.8 | 1.7 | 0.2 |
| Africa | 13.5 | 8.6 | 12.4 | 7.8 | 55.4 | 5.6 |
| Asia og Oceania | 6.4 | 4.1 | 12.1 | 7.7 | 292.5 | 29.7 |
| OPEC | 120.4 | 76.8 | .. | .. | .. | .. |
| OECD | 11.7 | 7.5 | 13.9 | 8.8 | 445.8 | 45.3 |
| Norway | 1.4 | 0.9 | 2.2 | 1.4 | .. | .. |

[1] Including Mexico. Source: BP 2004.

**Figure 2.1. R/P ratio[1,2] for Norwegian oil and gas reserves. 1978-2003**




[1] The R/P ratio, or the ratio between reserves and 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.

### Norwegian petroleum reserves

- Resources include all estimated petroleum deposits, whereas reserves include only recoverable resources in fields that are already developed or where development has been approved. The estimates of reserves are revised annually, and new fields are included in the estimates almost every year (see Appendix, tables B1 and B2). Norway started production of crude oil and natural gas in 1971, and by 31 December 2003, a total of 3 779 million $Sm^3$ o.e. oil and gas had been sold and delivered from the Norwegian continental shelf. The remaining reserves are calculated at 4 074 million $Sm^3$ o.e. (Norwegian Petroleum Directorate 2004).
- According to the Petroleum Directorate's figures, the R/P ratios for Norway's reserves were 8.0 years (oil) and 26.9 years (gas).

## Box 2.1. Energy content and energy units

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

| Energy | 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/tonne = 36.0 GJ/m³ | 0.85 tonne/m³ | .. | .. | .. |
| Refinery gas | 48.6 GJ/tonne | .. | 0.95 | .. | 0.95 |
| Natural gas (2003)[2] | 40.1 GJ/1000 Sm³ | 0.85 kg/Sm³ | 0.95 | .. | 0.95 |
| Liquefied propane and butane (LPG) | 46.1 GJ/tonne = 24.4 GJ/m³ | 0.53 tonne/m³ | 0.95 | .. | 0.95 |
| Fuel gas | 50.0 GJ/tonne | .. | .. | .. | .. |
| Petrol | 43.9 GJ/tonne = 32.5 GJ/m³ | 0.74 tonne/m³ | 0.20 | 0.20 | 0.20 |
| Kerosene | 43.1 GJ/tonne = 34.9 GJ/m³ | 0.81 tonne/m³ | 0.80 | 0.30 | 0.75 |
| Diesel oil, gas oil and light fuel oil | 43.1 GJ/tonne = 36.2 GJ/m³ | 0.84 tonne/m³ | 0.80 | 0.30 | 0.70 |
| Heavy distillate | 43.1 GJ/tonne = 37.9 GJ/m³ | 0.88 tonne/m³ | 0.80 | 0.30 | 0.70 |
| Heavy fuel oil | 40.6 GJ/tonne = 39.8 GJ/m³ | 0.98 tonne/m³ | 0.90 | 0.30 | 0.75 |
| Methane | 50.2 GJ/tonne | .. | .. | .. | .. |
| Wood | 16.8 GJ/tonne = 8.4 GJ/solid m³ | 0.5 tonne/solid m³ | 0.65 | - | 0.65 |
| Wood waste (dry wt) | 16.8 GJ/tonne | .. | .. | .. | .. |
| Black liquor (dry wt) | 14.0 GJ/tonne | .. | .. | .. | .. |
| 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).
Sources: 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 | MSm³ o.e. oil | MSm³ 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 | 1.055 | 0.040 |
| 1 Mbarrels | 5.65 | 1.57 | 0.13 | 1 | 0.16 | 0.141 | 0.0054 |
| 1 MSm³ o.e. oil | 36.0 | 10.0 | 0.9 | 6.4 | 1 | 0.90 | 0.034 |
| 1 MSm³ o.e. gas | 40.1 | 11.1 | 0.9 | 7.1 | 1.12 | 1 | 0.038 |
| 1 quad | 1 053 | 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 $m^3$)

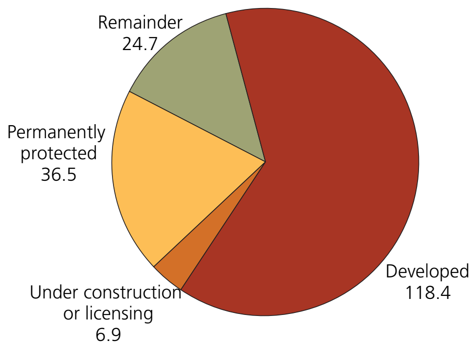
1 $MSm^3$ o.e. oil = 1 million $Sm^3$ oil

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 2.2. Norway's hydropower resources as of 1 January 2004. TWh per year**

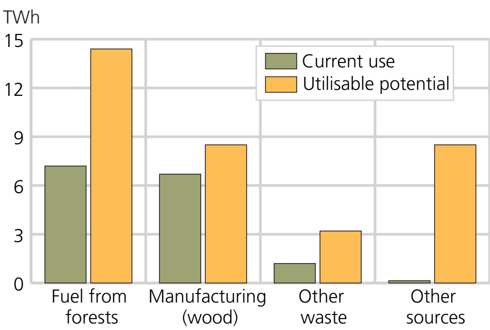



Source: Norwegian Water Resources and Energy Directorate.

## Norwegian hydropower resources

- As of 1 January 2004, Norway's hydropower potential totalled 186.5 TWh per year (see Appendix, table B3), and 63 per cent of this has been developed.
- Hydropower accounts for almost 100 per cent of electricity production in Norway, 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 six in the world by absolute hydropower production.
- Hydropower developments have a significant impact on biological diversity, the cultural landscape and opportunities for outdoor recreation. The only large river in Norway that is untouched by hydropower developments is the Tana in Finnmark.

**Figure 2.3. Bioenergy in Norway. Current use and utilisable potential**



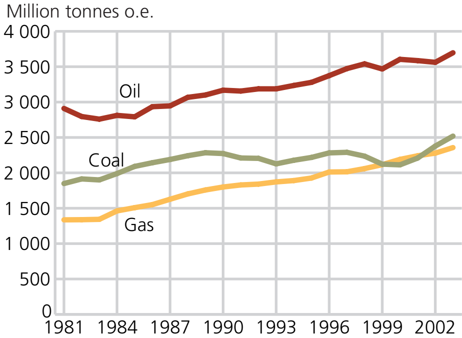

Source: Eid Hohle 2001.

## Bioenergy resources in Norway

- Annual consumption of bioenergy resources in Norway is about 15 TWh, and the utilisable potential is calculated to be about 35 TWh (Eid Hohle 2001). 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).
- 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.

## 2.2. Extraction and production

**Figure 2.4. World production of coal, crude oil and natural gas. 1981-2003**




Source: BP 2004.

### World production of fossil energy commodities

- In 2003, total global extraction of fossil energy commodities increased by 4 per cent from the year before to 8 600 million tonnes oil equivalents. This is 19 per cent higher than in 1993. Oil accounted for 43 per cent of the total, while coal and natural gas accounted for 29 and 27 per cent respectively.
- The USA is one of the three largest producers of all three fossil energy commodities (see table 2.2).
- Since 2000, there has been a considerable increase in coal production in China, which now accounts for one third of world coal production. 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.

**Box 2.2. Commonly used prefixes**

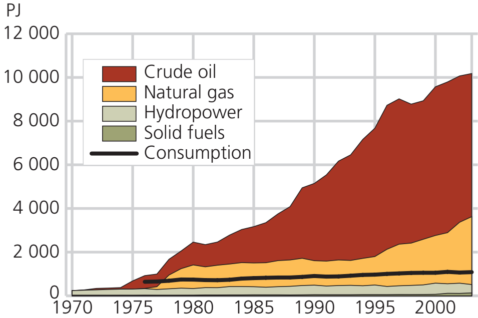
| Name | Symbol | Factor |
|---|---|---|
| Kilo | k | $10^3$ |
| Mega | M | $10^6$ |
| Giga | G | $10^9$ |
| Tera | T | $10^{12}$ |
| Peta | P | $10^{15}$ |
| Exa | E | $10^{18}$ |

**Table 2.2. World production of fossil energy commodities in 2003**

| | Oil | | Gas | | Coal | |
|---|---|---|---|---|---|---|
| | Million tonnes | Per cent | Million tonnes o.e. | Per cent | Million tonnes o.e. | Per cent |
| **Regions** | | | | | | |
| World | 3 697.0 | 100.0 | 2 618.5 | 100.0 | 2 518.7 | 100.0 |
| OPEC | 1 466.9 | 39.7 | .. | .. | .. | .. |
| OECD | 997.5 | 27.0 | 1 093.0 | 41.7 | 984.3 | 39.1 |
| North America[1] | 671.8 | 18.2 | 766.3 | 29.3 | 589.6 | 23.4 |
| Latin America | 339.5 | 9.2 | 118.6 | 4.5 | 39.2 | 1.6 |
| Europe incl. former Soviet Union | 818.0 | 22.1 | 1 023.9 | 39.1 | 434.0 | 17.2 |
| Middle East | 1 093.7 | 29.6 | 257.7 | 9.8 | 0.6 | 0.0 |
| Africa | 398.3 | 10.8 | 141.4 | 5.4 | 137.5 | 5.5 |
| Asia og Oceania | 375.8 | 10.2 | 310.5 | 11.9 | 1 317.7 | 52.3 |
| **Major producers** | | | | | | |
| *Oil* | Mill.tonnes | Per cent | | | | |
| Saudi-Arabia | 474.8 | 12.8 | | | | |
| Russia | 421.4 | 11.4 | | | | |
| USA | 341.1 | 9.2 | | | | |
| Iran | 190.1 | 5.1 | | | | |
| Mexico | 188.8 | 5.1 | | | | |
| China | 169.3 | 4.6 | | | | |
| Venezuela | 153.4 | 4.1 | | | | |
| Norway | 153.0 | 4.1 | | | | |
| Canada | 141.9 | 3.8 | | | | |
| *Gas* | Mill.toe | Per cent | | | | |
| Russia | 578.6 | 22.1 | | | | |
| USA | 549.5 | 21.0 | | | | |
| Canada | 180.5 | 6.9 | | | | |
| UK | 102.7 | 3.9 | | | | |
| Algeria | 82.8 | 3.2 | | | | |
| Iran | 79.0 | 3.0 | | | | |
| Norway | 73.4 | 2.8 | | | | |
| Indonesia | 72.6 | 2.8 | | | | |
| Saudi-Arabia | 61.0 | 2.3 | | | | |
| *Coal* | Mill.toe | Per cent | | | | |
| China | 842.6 | 33.5 | | | | |
| USA | 551.3 | 21.9 | | | | |
| Australia | 188.7 | 7.5 | | | | |
| India | 172.2 | 6.8 | | | | |
| South Africa | 134.6 | 5.3 | | | | |
| Russia | 124.9 | 5.0 | | | | |
| Poland | 70.8 | 2.8 | | | | |
| Indonesia | 70.5 | 2.8 | | | | |
| Germany | 54.1 | 2.1 | | | | |

[1] Including Mexico.
Source: BP 2004.

**Figure 2.5. Extraction and consumption[1] of energy commodities in Norway. 1970-2003***

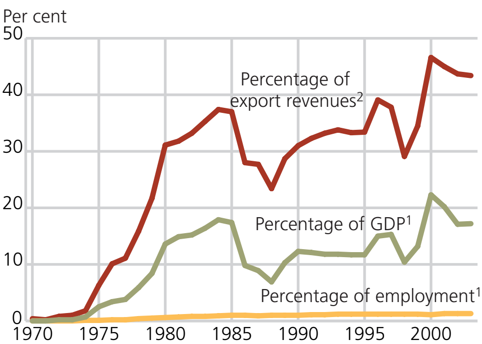



[1] Including the energy sectors, excluding international maritime transport.
Source: Energy statistics, Statistics Norway, Norwegian Petroleum Directorate and Norwegian Water Resources and Energy Directorate.

## Total extraction of energy commodities in Norway

- There was a slight increase in total extraction of energy commodities in Norway from 2002 to 2003. Gas production reached record levels in these two years, and rose by 11 per cent from 2002, while crude oil production dropped by 2 per cent. Oil and gas extraction accounted for 95 per cent of the total in 2003. In 2003, extraction of solid fuels was more than 20 per cent higher than the year before as a result of high coal production in Svalbard (see separate paragraph below).
- The level of hydropower production in 2003 was the lowest since 1996 and 18 per cent lower than in 2002. However, production in 2002 was the second highest ever recorded.
- In 2003, extraction of primary energy commodities was nine times higher than domestic consumption (see Appendix, table B11).

**Figure 2.6. Oil and gas extraction. Percentage of exports, gross domestic product (GDP) and employment. 1970-2003***

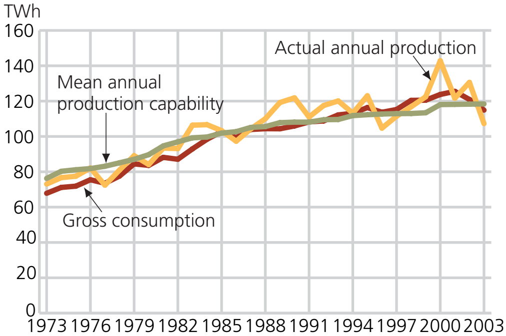



[1] Including services.
[2] Oil and gas only.
Source: National Accounts, Statistics Norway.

## 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 2003, oil and gas accounted for over 43 per cent of the value of the country's total exports. The volume of exports dropped by 2.5 per cent from the year before, while the value was about the same as in 2002.
- Value added in the petroleum sector corresponded to 17 per cent of GDP, but only about 1 per cent of total labour input was directly related to oil and gas extraction.

**Figure 2.7. Mean annual production capability, actual hydropower production and gross electricity consumption in Norway. 1973-2003**

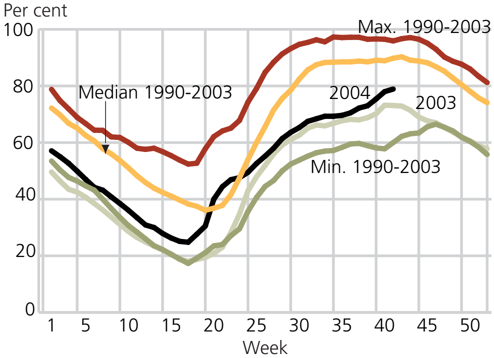



Source: Norwegian Water Resources and Energy Directorate and Energy statistics, Statistics Norway.

## Electricity

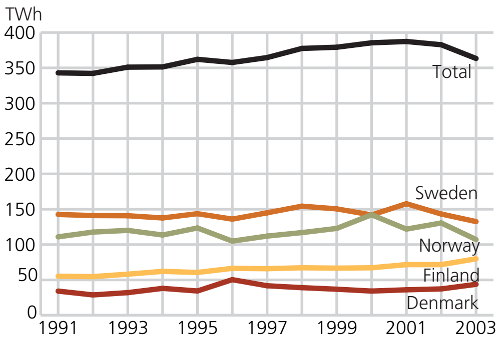
- Electricity production in Norway in 2003 totalled 107 TWh, a drop of 18 per cent from the year before, and the lowest since 1996, which was also a very poor year (see Appendix, table B8).
- Production was 11 TWh lower than the mean annual production capability (i.e. production in a year with normal precipitation). The mean annual production capability rose by only 0.14 TWh from the year before.
- In 2003, there was an import surplus of 7.8 TWh, which is more than in any other year than 1996.
- Two new wind farms were opened in Møre og Romsdal and Finnmark, resulting in a substantial increase in wind power production from 75 GWh in 2002 to 222 GWh in 2003.

**Figure 2.8. Degree of filling of Norway's reservoirs during the year, 2003 and 2004. Minimum, maximum and median values for the period 1990-2003. Percentages**




Source: Energy statistics, Statistics Norway, based on figures from the Norwegian Water Resources and Energy Directorate.

**Figure 2.9. Electricity production in the Nordic countries. 1991-2003**




Source: Nordel's secretariat (various years).

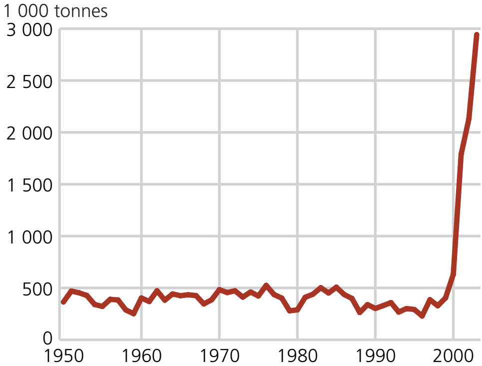
## Degree of filling of the reservoirs

- 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.
- At the beginning of 2004, the total energy capability of Norway's reservoirs was about 84 TWh, or about 2/3 of annual mean production (Ministry of Petroleum and Energy 2004).
- The degree of filling of the reservoirs varies a great deal through the year, and is lowest in spring before the snow melts. It can also vary considerably from one year to another because of variations in precipitation and the demand for electricity. A dry autumn and high production resulted in particularly low water levels in the reservoirs in winter 2002-2003. Since then the degree of filling has increased somewhat, but has generally been well below the median for the period 1990-2003.

## Electricity production in the Nordic countries

- The energy balance in Norway influences electricity production in the other Nordic countries. In 2002, Norway was a net exporter. In 2003, production in Norway and Sweden dropped because of low reservoir levels after a cold, dry autumn in 2002. This meant that both countries needed to import electricity, and electricity production in Denmark and Finland increased considerably in response.
- The Norwegian import surplus of 7.8 TWh in 2003 consisted of 3.8 TWh from Sweden, 3.8 TWh from Denmark, 0.1 TWh from Finland and 0.2 TWh from other countries.

**Figure 2.10. Extraction of coal in Svalbard. 1950-2003**




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

## Norwegian extraction of coal in Svalbard

- In 2003, Norwegian coal production in Svalbard reached 3 million tonnes, a rise of 38 per cent from the year before and more than seven times the 1999 level. A new monthly production record of 460 000 tonnes was set in October 2003; this is more than the total annual production at any time during the 1990s. If the 2003 extraction rate is maintained, the coal resources currently considered to be recoverable will last for 15 years. In 2003, a new national park was established in Nordenskiøld Land, and this will prevent mining operations in areas that have previously been considered to of interest for future expansion of the industry. However, it has been decided to start exploration for coal in other areas.
- Ordinary production at the Svea Nord mine began in 2002, after a decision by the Storting in December 2001 to continue Norwegian coal mining. The company responsible is Store Norske Spitsbergen Grubekompani, a newly-established subsidiary of Store Norske Spitsbergen Kulkompani, which was founded in 1916 to engage in coal mining in Norway. The new company made a profit during the first year of ordinary production, whereas Norwegian coal production had always previously been dependent on government support. In 2003, the profit increased even further.
- Only 5 per cent of the coal sold in 2003 was delivered to Norway, mainly to the cement industry. The rest was exported to about ten different European countries. Almost half of the coal was used for energy production, and the rest in manufacturing industries.

## 2.3. Environmental impacts of production and use of energy

**Table 2.3. Emissions to air from the energy sectors as a proportion of total Norwegian emissions. 2002*. Percentages**

| | |
|---|---|
| **Greenhouse gases (expressed as $CO_2$ equivalents)** | **27** |
| Carbon dioxide ($CO_2$) | 34 |
| Methane ($CH_4$) | 10 |
| Nitrous oxide ($N_2O$) | 1 |
| **Acidifying substances (expressed as acid equivalents)** | **21** |
| Sulphur dioxide ($SO_2$) | 12 |
| Nitrogen oxides ($NO_X$) | 28 |
| Ammonia ($NH_3$) | 0 |
| **Heavy metals** | |
| Lead (Pb) | 8 |
| Cadmium (Cd) | 6 |
| Mercury (Hg) | 6 |
| Arsenic (As) | 3 |
| Chromium (Cr) | 3 |
| Copper (Cu) | 3 |
| **POPs** | |
| Total PAH | 2 |
| Dioxins | 11 |
| **Other pollutants** | |
| Non-methane volatile organic compounds (NMVOCs) | 67 |
| Carbon monoxide (CO) | 2 |
| Particulate matter | 1 |

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 (see Chapter 6: Air pollution and climate change).
- The most important source of $CO_2$ and $NO_x$ emissions in the energy sectors is gas turbines on offshore installations. In the period 1990-2000, annual $CO_2$ emissions from this source were 5-7 million tonnes, but from 2000 to 2003, they rose by 20 per cent to 8.8 million tonnes. Annual emissions of $NO_x$ from this source have increased correspondingly, and reached 32 000 tonnes in 2003.
- 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 a reduction in the quantity of oil loaded and a rise in the amount of oil loaded at facilities with VOC recovery systems. In 2003, emissions totalled 165 000 tonnes, 34 per cent less than in 2001.

**Box 2.3. Environmental pressures caused by the extraction and use of energy**

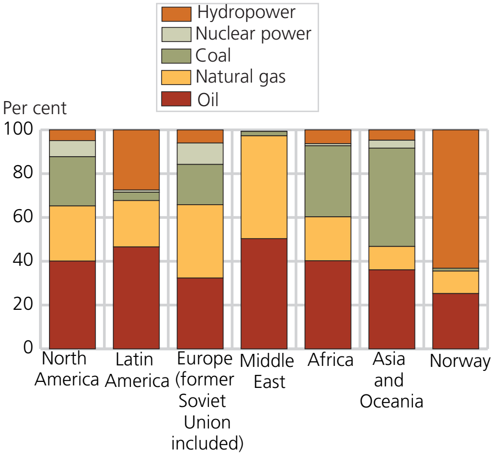
**Emissions to air** occur during the extraction, transport and use of oil and gas products. These can result in climate change, acidification, the formation of ground-level ozone and local air pollution (see Chapter 6: Air pollution and climate change). Emissions to air from the energy sectors in 2002 are shown in table 2.3.

**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.

## 2.4. Energy use

**Figure 2.11. Energy use by energy carrier (excluding bioenergy) in different regions. 2003**

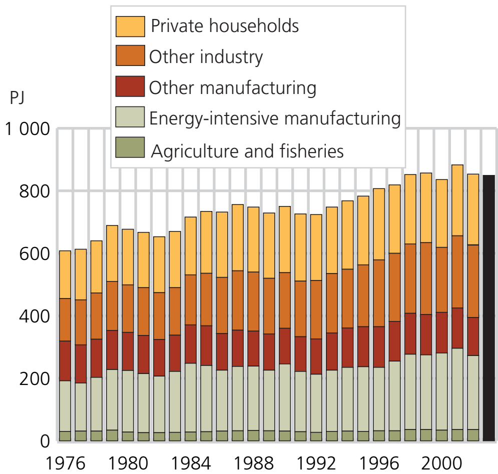



Source: BP 2004.

### World energy use

- In 2003, global consumption of energy commodities (excluding bioenergy) totalled 9 741 million tonnes oil equivalents. Europe (including the former Soviet Union), North America and Asia/Oceania each accounted for about 30 per cent of this (BP 2004). The USA alone accounted for almost one quarter of the total, twice as much as China, which ranked second in total energy use. Energy use is rising fastest in China, where it was 55 per cent higher in 2003 than 10 years earlier, and rose by 14 per cent from 2002 to 2003. The energy commodity that showed the largest rise in consumption from 2002 to 2003 was coal (7 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 2003, Asia/Oceania accounted for half of all coal consumption, while 80 per cent of all nuclear power and 70 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 (63 per cent), followed by Brazil, where hydropower was also the most important element of the energy mix, and accounted for 38 per cent of total consumption.
- 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 2001).

**Figure 2.12. Domestic energy use[1] by consumer group. 1976-2003***




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

## Energy use in total and split by consumer group

- In 2003, Norway's total energy use (including energy commodities used as raw materials, excluding international maritime transport) was 1 071 PJ, including 222 PJ in the energy sectors (see Appendix, tables B5 and B6).
- Consumption of energy commodities, excluding the energy sectors and international maritime transport, totalled 849 PJ in 2003, a slight decrease from the year before.
- Energy use rose by an average of 1.2 per cent per year from 1976 to 2003. In the same period, GDP excluding the oil and gas sector expanded 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 1976-2002. 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 remained almost unchanged.

### Box 2.4. Oil market perspectives

During the past year, oil prices have been very high compared with the preceding 15-20 years. This is advantageous for Norwegian export revenues, but the question is whether the price level will remain high over the next few years. One important reason why oil prices have been relatively high in recent years compared with the 1990s is OPEC's decision in 2000 to stabilise prices at around USD 25 per barrel. In the 1990s, the nominal price was about USD 18 per barrel. In addition, oil consumption has risen faster than expected in the past year, especially in China, which is now the second-largest oil consumer in the world. The tense situation in the Middle East generally and in Iraq in particular has of course contributed to the high oil prices.

To understand developments in the oil market, it is important to look at both geopolitical and economic driving forces. In several recent analyses, Statistics Norway focuses on the behaviour of different actors from an economic point of view. Box 2.6 describes how the demand for different oil products is affected by oil prices in the short and long term. Below, we first discuss the supply side of the oil market and then possible developments in the market up to 2025.

As indicated above, OPEC plays a key role in the oil market, and it accounts for 35-40 per cent of total world oil production. However, it is difficult to identify the reasons behind OPEC's decisions. Over the years, many empirical analyses have been made of whether OPEC's behaviour is consistent with that of a dominant producer, i.e. a producer that maximises overall profit, taking the behaviour of other producers into account. In a new analysis by Statistics Norway, the behaviour of OPEC and sub-groups of OPEC since 1973 has been tested using an improved method and better data. Although the results confirm that OPEC exercises market power, the hypothesis that OPEC or sub-groups of OPEC behave as dominant producers is rejected. This may be because OPEC members are a very heterogeneous group of countries and because domestic policy and geopolitical considerations play a central role in the market.

In the short term, high oil prices are in OPEC's favour, even if they are a result of reduced production by the cartel itself. One reason for this is that oil production in non-OPEC countries is relatively inflexible in the short term, because it comes largely from fields that are producing virtually at full capacity. However, high oil prices can lead to the development of new oil fields, since higher profitability may be expected. Statistics Norway has carried out an empirical analysis of how oilrig activity in different regions is influenced by oil prices. Oilrig activity includes both exploration and the development of new fields. The results of the analysis show that oilrig activity is highly sensitive to the price of oil, particularly in countries such as the USA and the UK. In the USA in particular, oilrig activity responds both rapidly and sharply to price changes. In Norway, the relationship between oil prices and oilrig activity is less clear. This may be because the petroleum industry in Norway is more closely regulated by the authorities than it is in other Western countries. Another possible explanation is the fact that Norwegian oil fields are relatively large and are all offshore, which generally means that developments have a longer time frame.

Oil prices have remained high throughout 2004, and there have been indications that OPEC's price target may be raised to about USD 30 per barrel. Statistics Norway has used a recently-developed model for the global oil market (FRISBEE) to analyse whether OPEC can achieve such a high oil price without losing market shares. As indicated above, there is reason to expect higher production in non-OPEC countries in addition to a reduction in demand, at least in a few years' time. The analysis suggests that OPEC's market share may drop by a few percentage points up to 2010. After this, the cartel's market share is expected to rise and to pass 50 per cent in about 2020. This is because, even if oil prices are relatively high, there will be fewer and fewer remaining oil fields in non-OPEC countries as time goes on, despite the discovery of new fields. Even with optimistic estimates for new discoveries, OPEC will be able to combine a high oil price with relatively high market shares. The same is true if taxes on oil products are raised as part of international climate policy in the future. The analysis thus suggests that high oil prices will not be a problem for OPEC unless some members of the cartel lose patience and wish to increase OPEC's market shares in the immediate future.

Read more in: Aune, F.R., S. Glomsrød, L. Lindholt and K.E. Rosendahl (2005): The oil market towards 2025 - can OPEC combine high oil price with high market share?, to be published in Discussion Papers, Statistics Norway.
Glomsrød, S. and L. Lindholt (2004): The petroleum business environment: A reader's digest, Documents 2004/5, Statistics Norway.
Hansen, P.V. and L. Lindholt (2004): The market power of OPEC 1973-2001, Discussion Papers 385, Statistics Norway.
Ringlund, G.B., K.E. Rosendahl and T. Skjerpen (2004a): Does oilrig activity react to oil price changes? An empirical investigation, Discussion Papers no. 372, Statistics Norway.

**Box 2.5. Technological developments and liquefied natural gas**

A large proportion of the world's known gas fields are too far away from the markets for pipeline transport to be viable. This applies for example to Norwegian gas from the Barents Sea, which has to be transported to consumers in the USA and continental Europe. In such cases, the most appropriate solution is liquefaction (to produce liquefied natural gas, or LNG) and transport by ship. Liquefaction involves cooling natural gas to -161°C. This is a very costly and capital-intensive process.

Nevertheless, the prospects for LNG seem to be better then ever. There are several reasons for this: Gas is generally becoming increasingly popular as an energy carrier, and deregulation of the major gas markets is making it easier to sell LNG. However, perhaps the most important reason is that the gas industry itself believes that costs in the LNG supply chain (liquefaction, transport and regasification) will continue to fall. For liquefaction only, unit production costs have been cut by half in the last 10 years.

In a number of cases, LNG projects have come to nothing precisely because of excessive costs, but there have been few studies of developments in production costs for LNG. Statistics Norway therefore carried out an analysis to answer the following two questions: what are the factors driving the fall in liquefaction costs, and is it likely that the costs of liquefaction will continue to fall further?

The conversion of gas to LNG is based on relatively "new" technology. Although the first LNG plant started operating in 1964, there were still only 18 plants in operation in the world in 1999 (however, each of these often consists of several process trains). Many empirical studies have shown that production costs for new technologies tend to fall dramatically as cumulative production using the new technology rises. This relationship is often expressed in the form of learning or experience curves. For example, experience curves for wind power show that the price of wind power has dropped by 18 per cent for each doubling of cumulative production (IEA 2000).

To try to answer the questions set out above, experience curves for the construction of LNG liquefaction plants were estimated. The hypothesis that it is the cumulative number of LNG process trains that results in the drop in costs, and not for example the number of years since construction started, is based on the idea that only actual experience of construction provides for learning that results in more efficient employees, more rational construction techniques, knowledge of alternative processing methods, more highly-trained management, and so on. On the other hand, an observed drop in costs need not necessarily be the result of more experience. The main reason for this is that the data generally used in such analyses are price data, i.e. the price paid for a production plant, and not actual cost data. Thus, a drop in price may be the result of more intense competition and not of learning, as is generally assumed.

This was precisely what was indicated by the results of this analysis. In the 40-year history of LNG production, the number of suppliers of liquefaction plants has varied. To begin with, five different technologies were available. After this, one supplier virtually had a monopoly on all new plants for about 25 years. It is only recently that new suppliers of LNG technologies have entered the market, and the monopoly has now developed into an oligopoly with four competitors.

The analysis shows that the fluctuations in the number of competitors explain most of the apparent fall in costs. In fact, no experience effect at all was demonstrated. This may be because the de facto monopoly weakened the incentives for organisational and technological improvements, or because the total number of LNG trains constructed is still too small to produce any experience effect. It is also possible that there is no great potential for cost reductions through learning. However, it was possible to identify a reduction in costs due to general technological advances, i.e. progress that has taken place independently of the number of process trains.

It is therefore uncertain whether a further drop in costs can be expected in the future. The effect of general technological advances is very weak, corresponding to about 0.5 per cent per year. The effect of greater competition between different technologies is temporary. The price dropped as the market changed from a monopoly to an oligopoly, but will probably not drop much more even if competition between different suppliers of LNG technology increases further. Any future drop in costs will therefore be dependent on learning. Since this appears to have had no significant effect earlier, it is difficult to make any predictions about learning effects in the future.

Read more in: Greaker, M. and E. L. Sagen (2004): Explaining experience curves for LNG liquefaction cost: Competition matters more than learning. Discussion Papers no. 393, Statistics Norway.

## Box 2.6. Energy demand elasticities in OECD countries

Price and income elasticity are two of the most important concepts for explaining what actually happens in a market. They describe the percentage change in the demand for a commodity in response to a one per cent change in the price of the commodity or in income.

Consumption habits and technical and institutional factors generally make it difficult for energy consumers to adjust their demand immediately after a drop in prices or increase in income. It is therefore reasonable to assume that the absolute values of price and income elasticity will be lower in the short term than in the long term.

Estimates of energy demand elasticities in the literature vary widely because of differences in the methods and data used. A recent study by Statistics Norway used an advanced dynamic panel data approach to estimate price and income elasticities for energy demand in OECD countries in the period 1978-1999. This method has not previously been used for studies of energy elasticities.

It was found that for electricity, natural gas and fuel oil, price elasticities were generally higher and GDP/income elasticities lower in the household sector than in the industrial sector. For example, a 1 per cent rise in the price of electricity was estimated to result in a reduction in household demand of 0.03 per cent in the short term and 0.16 per cent in the long term (see table 1). The corresponding figures for the industrial sector were 0.01 per cent in the short term and 0.04 per cent in the long term (see table 2). For an increase of 1 per cent in per capita GDP or income, it was estimated that household demand for electricity would rise by 0.06 per cent in the short term and 0.30 per cent in the long term. The corresponding figures for demand in the industrial sector were 0.30 per cent in the short term and 1.04 per cent in the long term.

Price and income elasticities were also found to be different for the different energy commodities. For example, in the household sector, both price and income elasticity were lower for electricity than for petrol (see table 1). This may mean that it is more difficult for households to adjust electricity demand than to adjust petrol demand in response to changes in prices or income.

The study gave lower estimates of price elasticities than those found in previous studies. However, the significant long-term GDP/income elasticities are in agreement with the results of earlier studies and are generally close to unity.

**Table 1. Price and income elasticities for energy commodities in the household sector in OECD countries**

| | Price elasticity | | Income elasticity | |
|---|---|---|---|---|
| Commodity | Short term | Long term | Short term | Long term |
| Electricity | -0.030 | -0.157 | 0.058 | 0.303 |
| Natural gas | -0.102 | -0.364 | 0.137 | 0.490 |
| Coal | 0.000 | 0.001 | -1.148 | -2.243 |
| Fuel oil | -0.143 | -0.318 | 0.030 | 0.066 |
| Petrol[1] | -0.191 | -0.600 | 0.196 | 0.614 |

[1] Petrol consumption at national level.

**Table 2. Price and income elasticities for energy commodities in the industrial sector in OECD countries**

| | Price elasticity | | Income elasticity | |
|---|---|---|---|---|
| Commodity | Short term | Long term | Short term | Long term |
| Electricity | -0.013 | -0.044 | 0.300 | 1.035 |
| Natural gas | -0.067 | -0.243 | 0.376 | 1.363 |
| Coal | 0.162 | 0.589 | 1.155 | 4.203 |
| Fuel oil | 0.043 | 0.127 | 0.529 | 1.557 |
| Diesel (transport)[1] | -0.094 | -0.268 | 0.425 | 1.207 |
| Heavy fuel oil | -0.167 | -0.516 | -0.084 | -0.260 |

[1] Diesel consumption at national level.

Read more in: Liu, G. (2004): Estimating Energy Demand Elasticities for OECD Countries - A dynamic Panel Data Approach, Discussion Papers no. 373, Statistics Norway.

### Box 2.7. Variations in the price of electricity – wet, dry, cold and hot weather and dominant producers

In autumn and winter 2002-2003, Norwegian consumers experienced just how much variations in precipitation and inflow to reservoirs can affect electricity production and prices, when a very dry autumn and low water levels resulted in extraordinarily high electricity prices. What is it that makes electricity prices fluctuate so much, and is there anything that can be done to reduce these variations?

Prices depend mainly on consumers' price reactions and on the response of thermal power producers (using coal, oil and gas) and nuclear power producers. In addition, demand varies with the temperature. Consumption rises at low temperatures, resulting in higher prices. If higher prices in turn result in a drop in consumption and a rise in thermal power production, prices may remain relatively stable even if inflow to storage reservoirs drops considerably.

In reality, however, the response by consumers is fairly small. The thermal power producers respond by increasing production, but each extra unit of energy produced is more expensive than the previous one. The demand for electricity from hydropower producers is found by subtracting the supply of thermal power from total consumption. It is this demand that determines how much prices vary between dry and wet years. In a study of the relationship between uncertainty and market power in a hydropower-based system, Statistics Norway analysed the case where prices rise more in dry years than they drop in wet years. Increasing the difference between wet years and dry years resulted in a higher average price, even though mean hydropower production was the same over time.

The study also included an analysis of the relationship between variations in inflow and the extent to which major producers can influence prices. This showed that uncertainty in inflow gave dominant producers more opportunity to exercise market power. This can result in greater fluctuations in prices.

Effective competition between the producers is therefore important as a means of reducing price fluctuations. On the supply side, the development of new production capacity may make it unnecessary to use costly peak load capacity to produce base load power in dry years. However, this may not be the cheapest way of reducing price fluctuations. Investments on the demand side to allow consumers to use energy sources other than electricity would have the same effect and would reduce the producers' market power. It would be of interest to look more closely at these aspects in further studies.

Read more in: Hansen, P.V. (2005): Stochastic water inflow and water use over time in imperfect markets, to be published in the series Discussion Papers, Statistics Norway.

**Box 2.8. Effects of introducing a differentiated electricity tax for households**

Statistics Norway carried out this analysis for a committee appointed by the Ministry of Finance in 2003 to assess the effects on energy use and the distributional effects of introducing a differentiated electricity tax on a revenue-neutral basis, i.e. so that overall tax revenues remain unchanged. This distinguished the effect of a differentiated electricity tax from the effect of increasing the average tax level. The committee asked for an assessment of several models in which the tax rate was differentiated according to electricity consumption, or consumption combined with the number of people in the household or the temperature zone. In addition, the committee asked for an analysis of the effects of increasing the current proportional or flat tax to illustrate the distributional effects of increasing the tax rate and to compare the effects of a differentiated electricity tax with those of combining a rise in the flat tax with income distribution policy instruments.

The analysis was based on data from Statistics Norway's survey of consumer expenditure. According to the analysis, the introduction of a revenue-neutral differentiated electricity tax alone would not result in a reduction in mean consumption, because the introduction of a differentiated tax did not raise the average tax rate. A household that had to pay a higher tax rate would reduce its consumption, whereas one that experienced a cut in the tax rate would increase consumption. Whether a household would increase or decrease its electricity consumption would depend on the original level of consumption, which in turn depends on various characteristics of the dwelling and the household, such as income, the number of people in the household and the type of dwelling and its area. The effects on consumption of fuelwood, kerosene and fuel oil were negligible.

The analysis also showed that introducing a differentiated electricity tax tended on average to equalise the change in expenditure as a proportion of household income when household income was divided into different income groups. Moreover, the differentiated electricity tax also tended on average to have an equalising effect when household equivalent income, i.e. the income of each household corrected for the number of people in the household was divided into different bands. These equalising effects on income distribution arose because the proportion of households experiencing a rise in the tax rate rose in pace with household income.

Since there are many characteristics of a household and its dwelling that influence the level of energy use (income, household size, dwelling size, whether it is possible to substitute one energy source for another), the relationship between electricity consumption and for example income varies widely from one household to another. Even though a differentiated electricity tax on average had positive effects on low-income households, some low-income households would be strongly affected by the change in the tax rate, i.e. low-income households with such a high consumption level that they would be subject to a higher tax rate. The tax rise as a proportion of household income was higher for these households than for wealthier households paying a higher tax rate. Because of the wide variations, a differentiated electricity tax where the tax rate is based on household consumption would not be a very precise instrument for correcting adverse distributional effects for households with different income levels. This is because there are some large, low-income households that have a high level of electricity consumption. In the sample used in this analysis, approximately one in five of the households in the lowest income group would have to pay a higher tax rate if a differentiated electricity tax was introduced without raising the taxation level.

Decisions on which groups of households to favour are a political issue, and distributional effects according to criteria other than income were therefore also studied. The changes in expenditure were analysed for households of different sizes, for different types of dwellings, different temperature zones and for urban and rural municipalities. Differentiating the tax according to electricity consumption has negative distributional effects if the target group is families with children, since electricity consumption

*Cont.*

*Cont.*

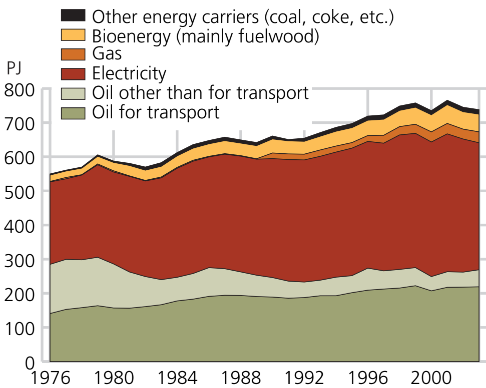
rises with the number of people in the household. The analysis showed that a proportional increase in the electricity tax did not have negative effects on large households to the same extent. Differentiating the electricity tax according to temperature zone or applying different tax rates in urban and rural municipalities only resulted in small differences between groups.

The committee also asked for an analysis of a model where the tax was differentiated according to a combination of the number of people in the household and electricity consumption. The consumption levels at which higher tax levels were introduced were higher for large households, which need large amounts of electricity, while for small households, they were lower than for average-sized households. Correction of the differentiated tax in this way ensures that the impact of the differentiated taxation system is roughly the same for households of all sizes, and on average has a redistributive effect across income groups, i.e. the rise in tax level is greater for high-income groups than for low-income groups.

On average, differentiating the electricity tax according to consumption levels would be advantageous for low-income households, but would not be sufficient on its own to reduce electricity consumption. It is not possible to reduce electricity consumption and achieve the distributional effects required by differentiating the electricity tax unless the tax level is also changed. A proportional increase in the tax would reduce consumption, but would on average have most welfare impact on low-income households, because the proportion of a household budget used for electricity drops as income rises. To avoid unwanted distributional effects across income groups, a proportional tax increase can be combined with various income policy instruments. As an example of this type of combination, an analysis was made of a proportional tax increase combined with returning the entire tax revenue to households in the form of higher family allowance. This combination was found to have a very accurate distributional effect (since funds are transferred directly to the households that the measure is intended to benefit) and it also reduced consumption, even if the changes were made on a revenue-neutral basis.

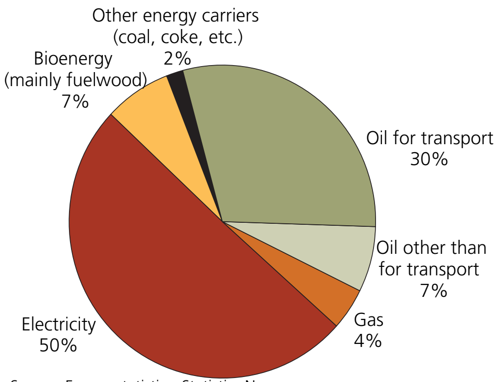
Read more in: Halvorsen, B. and R. Nesbakken (2004): Effekter på energiforbruk og fordeling av å differensiere el-avgiften for husholdningene, Vedlegg 2 i NOU 2004:8, Differensiert el-avgift for husholdninger (Effects on energy use and distributional effects of introducing a differentiated electricity tax for households. Appendix 2 of Official Norwegian Report 2004:8 Differentiated electricity tax for households).

**Figure 2.13. Energy[1] use by energy carrier. 1976-2003***




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

**Figure 2.14. Energy use by energy carrier. Percentages of total. 2003***

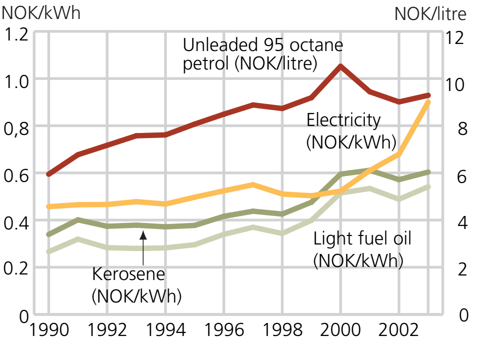



Source: Energy statistics, Statistics Norway.

## Consumption by energy commodity

- Total oil consumption, excluding the energy sectors and international maritime transport, dropped by about 9 per cent in the period 1976-2003, despite a rise of 58 per cent in the consumption of oil for transport in the same period (see Appendix, table B5).
- Transport now accounts for 82 per cent of total oil consumption, as compared with 47 per cent in 1976. Consumption of transport oils had been decreasing for several years, but has now risen again.
- Consumption of oil for stationary purposes had dropped to less than one third of the 1976 level by 1992. There was also a downward trend from the mid-1990s, but from 2002 to 2003 consumption rose again by more than 6 per cent.
- Electricity consumption has risen from 241 PJ in 1976 to 372 PJ in 2003. This is a rise of 54 per cent. The rise has been greatest for households and service industries, especially because there has been a changeover from oil to electricity for heating purposes. However, total electricity consumption dropped by 4.5 per cent from 2002 to 2003. Electricity consumption by households and service industries also decreased. This is partly a result of high electricity prices, but is also partly explained by above-average temperatures. See Appendix, table B8.

**Figure 2.15. Price trends for electricity, kerosene, fuel oil and petrol. 1990-2003. NOK per kWh and litre, current prices**




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

## Prices

- The listed prices (average prices from the Norwegian Petroleum Industry Association) of both heating kerosene and light fuel oil rose from 2002 to 2003. However, during this period the price of these heating products per energy unit was lower than that of electricity. The high electricity price led to a certain changeover from electricity to kerosene and light fuel oil.
- Lower taxes resulted in a drop in the price of petrol and autodiesel from 2000 to 2002. From 2002 to 2003, taxes on these products were raised, and prices therefore increased again.

**More information:** Lisbet Høgset, Trond Sandmo and Henning Høie.

## 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/centres/energy/
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 (2004): Statistical Review of World Energy (downloaded from http://www.bp.com/).

David, P. A. (1997): Path Dependence and the Quest for Historical Economics: One more Chorus of the Ballad of QWERTY, Discussion Papers in Economic and Social History, No. 20, University of Oxford.

Eid Hohle, E. (ed.) (2001): Bioenergi. Miljø, teknikk og marked (Bioenergy. Environment, technology and markets), Brandbu: Energigården.

Glomsrød, S. and L. Lindholt (2004): The petroleum business environment: A reader's digest, Documents 2004/5, Statistics Norway.

Greaker, M. and E. L. Sagen (2004): Explaining experience curves for LNG liquefaction cost: Competition matters more than learning. Discussion Papers no. 393, Statistics Norway.

IEA (2000): Experience Curves for Energy Policy, OECD/IEA.

Liu, G. (2004): Estimating Energy Demand Elasticities for OECD Countries - A dynamic Panel Data Approach, Discussion Papers no. 373, Statistics Norway.

Ministry of Petroleum and Energy (2004): Faktaheftet 2004 om energi- og vassdragsvirksomheten (Facts 2004. The Energy Sector and Water Resources in Norway 2004), Oslo.

Norwegian Petroleum Directorate (2004): Norsk Sokkel 2004. Oljedirektoratets årsberetning (The Norwegian Continental Shelf 2004. Annual report), Stavanger.

Ringlund, G.B., K.E. Rosendahl and T. Skjerpen (2004a): Does oilrig activity react to oil price changes? An empirical investigation, Discussion Papers no. 372, Statistics Norway.

Store Norske (2004): Årsberetning og regnskap 2003 (Annual report and accounts). Longyearbyen.

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

# 3. Agriculture

**The total size of agricultural areas in use has remained stable at a time when the importance of agriculture to the national economy has declined. There have been major structural changes in farming that have affected the relationship between agriculture and the environment.**

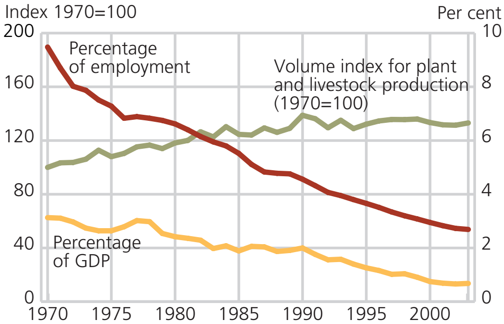
Agriculture interacts with the environment in many ways. Farming results in environmental changes both to farmed land, such as alterations in biotopes and landscapes, and to adjacent areas in the form of runoff of nutrients into water bodies and emissions to air from agricultural processes. There has been a particular focus on eutrophication of water bodies caused by nutrient enrichment. The open cultural landscape has largely been created by farming, and is continuously being formed by the farming methods used. 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 that modern farming methods can put at risk. 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 outside environmental pressures such as pollution, including ozone and heavy metals, and pressures to convert farmland for development, resulting in conflicts over land use.

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. The impact of farming methods on the quality of agricultural products and thus on human health - involving factors such as the nutritional content of food, pesticide residues and animal diseases that are transmissible to humans - must also be taken into consideration in agricultural policy.

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.

**Figure 3.1. Trends in agricultural production volume (index 1970=100) and share of employment and GDP. 1970-2003***



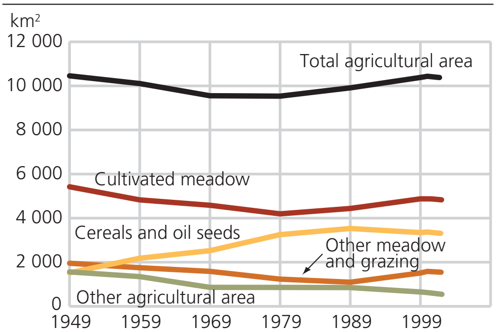

Source: Budget Committee for Agriculture (2004) and Norwegian National Accounts, Statistics Norway.

## 3.1. Main economic figures for agriculture

### Agriculture in an economic perspective

- From 1970 to 2003, employment fell by over 60 per cent (from over 140 000 to 52 800 normal full-time equivalents). In comparison, manufacturing employment fell by approximately 39 per cent.
- Agriculture's share of GDP fell from 3.1 to 0.7 per cent. In comparison, manufacturing declined from 19 to 9 per cent.
- Agricultural production has increased by about 33 per cent (Budget Committee for Agriculture 2004). However, production volume has not increased since 1990.

**Figure 3.2. Agricultural area in use. 1949-2003***



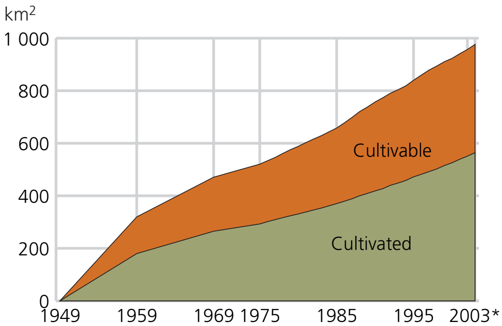

Source: Agricultural statistics, Statistics Norway.

## 3.2. Land resources

### Agricultural area

- Since 1949, total agricultural area has varied between 8 700 and 10 500 km². The current area is about 10 400 km².
- At the end of the 1990s, there was a substantial increase in the area of surface cultivated meadow and fertilised pasture. This was probably related to stricter requirements with regard to the minimum area for manure spreading and the transition from support based on production to support based on the area farmed.

**Figure 3.3. Accumulated conversion of cultivated and cultivable land[1]. 1949-2003***



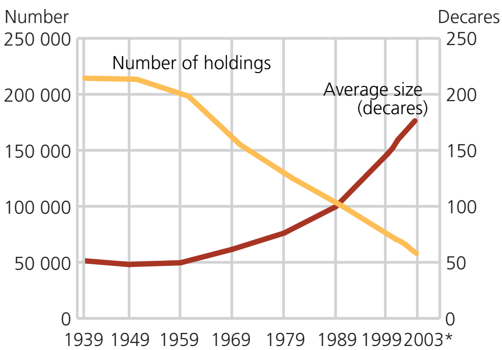

[1] For the period 1949-1975 data is only available for cultivated areas that were converted. The area of cultivable land converted in this period has been estimated on the basis of the ratio between cultivable and cultivated land converted 1976-1997.
Source: Agricultural censuses, Statistics Norway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

### Conversion of cultivated and cultivable land and new cultivation

- The most important threat to agricultural land resources is its conversion for purposes that prevent future agricultural production.
- An estimated 976 km$^2$, or about 5 per cent of the total area suitable for agriculture, has been converted for such purposes since 1949.
- Due to new cultivation, the total agricultural area has not decreased. 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, and the annual average for the years 1999-2001 was somewhat less than 12 000 decares.

## 3.3. Size of holdings and cultural landscape

**Figure 3.4. Number of holdings and their average size of utilized agricultural area (decares[1]). 1939-2003***




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

### Holdings – number and size

- The number of holdings in Norway has been reduced by more than two thirds since 1960; this is equivalent to a loss of 9 holdings a day. Figures for the last two to three years indicate a rising rate of farm closures.
- The average size has more than tripled, as the total agricultural area in use shows little change. Much of the land on abandoned holdings is initially taken over as additional land by the remaining holdings, often as rented area. In 2001, 33 per cent of agricultural area in use was rented, an increase of 2 percentage points since 1999.

**Box 3.1. 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 divided among 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.

## 3.4. Pollution from the agricultural sector

**Table 3.1. Emissions to air from agriculture. Greenhouse gases and acidifying substances. 2002***

| | Emissions from agriculture. 1 000 tonnes | Percentage of total emissions in Norway |
|---|---|---|
| **Greenhouse gases** | 5 303[1] | 9.9[1] |
| Carbon dioxide ($CO_2$) | 403 | 1.0 |
| Nitrous oxide ($N_2O$) | 9.3 | 50 |
| Methane ($CH_4$) | 95.5 | 29 |
| **Acidifying substances** | 1.3[2] | 19.3[2] |
| Ammonia ($NH_3$) | 19.7 | 89 |
| $NO_X$ | 5.5 | 2.6 |
| $SO_2$ | 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. Calculations of nitrous oxide emissions from agriculture show a high level of uncertainty (see Chapter 6).
- *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 3.2. 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 8). In 2002, agriculture accounted for about 47 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 8. 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.

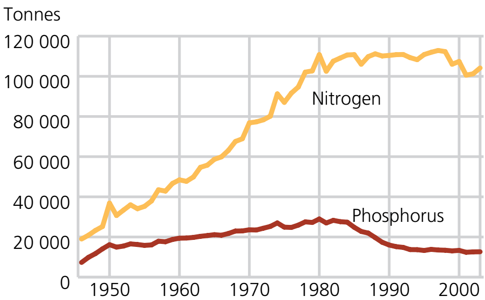
Farming also makes a substantial contribution to emissions of ammonia ($NH_3$), methane ($CH_4$) and nitrous oxide ($N_2O$) to air (see Appendix, tables F3-F5). Emissions of ammonia result in acid rain, while methane and nitrous oxide are greenhouse gases (see Chapter 6). No measures have as yet been implemented to reduce emissions to air from the agricultural sector. The use of pesticides in farming also results in various forms of pollution.

**Box 3.3. 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 3.5. Sales of nitrogen and phosphorus in commercial fertilisers. 1946-2003**

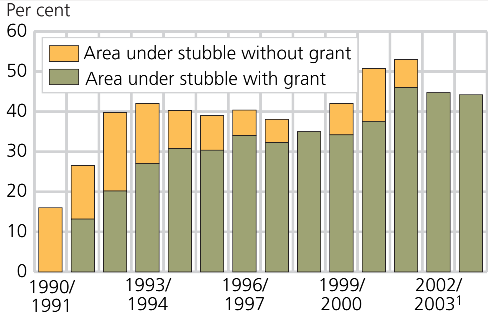



Source: Agricultural statistics, Statistics Norway, and Norwegian Agricultural Inspection Service.

## Application of commercial fertiliser

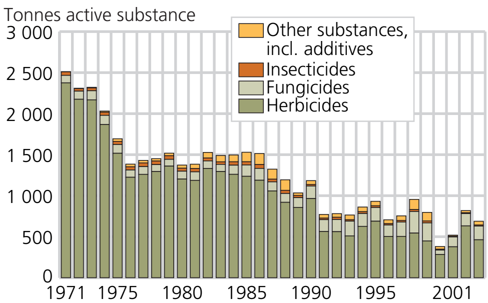
- As a rule, heavy application of fertiliser results in poor utilisation of the nutrients and may therefore increase pollution in lakes and rivers. The amount of fertiliser applied is therefore increasingly determined on the basis of soil samples and recommended standards. Since 1998 a fertilisation plan has been mandatory for holdings that apply for production grants.
- Since the early 1980s, the use of phosphorus fertiliser has been halved. In 2000 and 2001, the amount of nitrogen fertiliser used was 10 per cent lower than in the peak years 1996-1998, but showed a moderate rise again in 2003.

**Figure 3.6. Proportion of cereal acreage left under stubble[1] in autumn. 1990/1991-2003/2004***



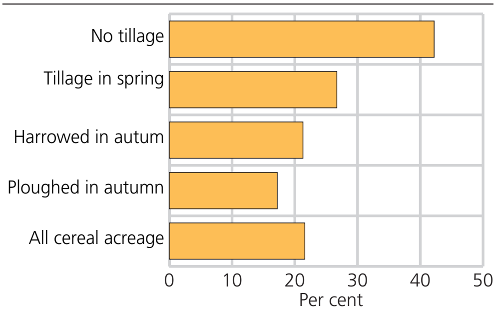

[1] Total area under stubble not recorded in 1998/99, 2002/03 and 2003/04.
Source: Agricultural statistics, Statistics Norway, and Ministry of Agriculture and Food.

**Figure 3.7. Sales of chemical plant protection products, measured in tonnes of active substance. 1971-2003**




Source: Norwegian Agricultural Inspection Service.

**Figure 3.8. Percentage of cereal acreage sprayed for couch grass after various forms of soil management. Average for the period 1992/93-2001/2002**




Source: Result Control Agriculture, Statistics Norway.

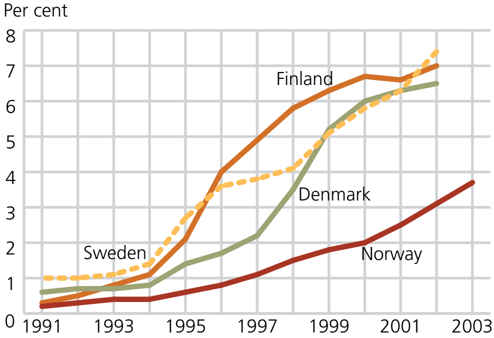
## Soil management

- 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 increase in 2000-2001 and 2001-2002 may perhaps have been a result of weather conditions that made tillage difficult.

## Use of plant protection products

- Sales trends over the last three or four years must be seen in the context of an increase in taxes on plant production products in 2000. This probably meant that stocks were built up before the year 2000 and have been used subsequently.
- In 2003, 463 tonnes of herbicides, 167 tonnes of fungicides, 14 tonnes of insecticides and 45 tonnes of other substances including additives were sold.
- There is a clear relationship between the soil management regime and spraying against perennial weeds. The more tillage of the soil is reduced or postponed, the larger the proportion of the area that is sprayed.
- With current agricultural practices, the environmental cost of reducing soil loss by limiting tillage is greater use of pesticides.

**Figure 3.9. Areas farmed ecologically or in the process of conversion in the Nordic countries. Percentage of total agricultural area. 1991-2003**




Source: Debio (Norway), KRAV (Sweden), Statistics Denmark (Denmark), KTTK Plant Production Inspection Centre (Finland).

## 3.5. Ecological farming

### Ecologically cultivated area in the Nordic countries

- Ecological farming increased in all the Nordic countries in the 1990s. Norway, with somewhat below 4 per cent, has the lowest percentage, as against 6-7 per cent in the other Nordic countries.
- The Norwegian authorities' target is that 10 per cent of the agricultural area is to be ecologically farmed by 2009.

**Box 3.4. 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 (environmental impacts of agriculture) and Ole Rognstad (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/
Centre for Soil and Environmental Research: http://www.jordforsk.no/
Debio: http://www.debio.no/
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 Crop Research Institute: http://www.planteforsk.no/
Norwegian Institute for Land Inventory: http://www.nijos.no/

## References

Budget Committee for Agriculture (2004): *Volum- og prisindekser for jordbruket. Regnskapsåra 1959-2003* (Volume and price indices for agriculture. Accounting years 1959-2003). Norwegian Agricultural Economics Research Institute.

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

# 4. Forest and uncultivated land

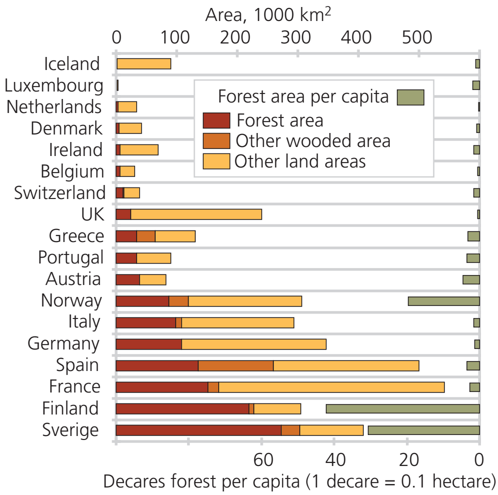
**The Norwegian forest contains a wide variety of resources and environmental qualities. In terms of the economy, forests are primarily important as a source of raw materials for the sawmilling and pulp and paper industries. The forest, with its biological diversity, also has considerable intrinsic value 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.**

Interests in forests and forest resources continue 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 45 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.

## 4.1. Distribution of forests in Norway and Europe

**Figure 4.1. Forest area and total land area in EU and EFTA countries**




Source: UN-ECE/FAO (1995).

### Forested area

- There is about 75 000 km² of productive forest in Norway (Norwegian Institute of Land Inventory 1999), or 24 per cent of the total land area of Norway. Almost half of this forested area is managed in combination with agricultural operations.
- About 1.1 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 4.1. 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 900 of these are rare or endangered (Directorate for Nature Management 1997). 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.

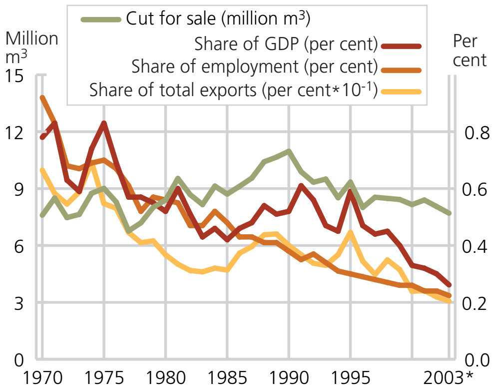
At the end of 2003, a total of 2 323 km² of forest in Norway was protected, of which 764 km² was productive forest. Included in this figure is 570 km² of productive coniferous forest or about 1 per cent of the total productive coniferous area. In addition, some broad-leaved and mixed forest is protected, and some forest areas will naturally be included in new national parks because of their location (Directorate for Nature Management 2004).

By comparison, 3.6 per cent of the total area of productive forest in Sweden was protected in 1996. The corresponding figure for Finland was 4.1 per cent in 2002 (National Board of Forestry, Sweden 2000 and METLA 2003).

In November 2003, the Norwegian Parliament discussed Report No. 25 (2002-2003) to the Storting *The Government's environmental policy and the state of the environment in Norway*. This report includes plans for a further increase in the protection of forests.

## 4.2. Forestry

**Figure 4.2. Forestry: share of exports, employment and GDP. Annual roundwood removals. 1970-2003***

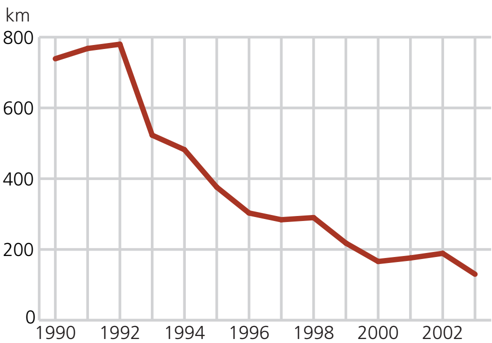



Source: National accounts and forestry statistics, Statistics Norway.

### Roundwood removals and economic importance

- In 2003, forestry's share of total employment was 0.22 per cent. This is equivalent to 4 400 full-time equivalents, down from 13 700 in 1970. Employment declined in relative terms by about the same as in agriculture.
- Forestry's share of Norway's GDP dropped from 0.78 per cent in 1970 to 0.26 per cent in 2003. Forestry's share of GDP has declined less sharply than that of agriculture.
- The gross value of the roundwood removed for commercial purposes in 2003 was NOK 2.2 billion, and wood and wood processing products worth NOK 13.2 billion were exported from Norway.

**Figure 4.3. Annual construction of new forest roads for year-round use. 1990-2003**



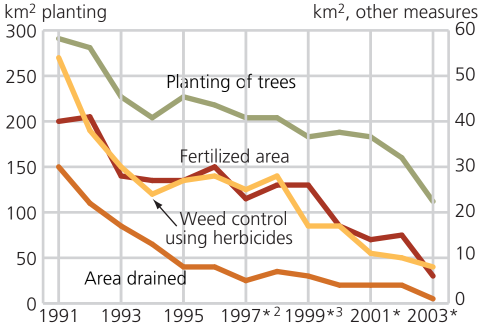

Source: Forestry statistics, Statistics Norway.

### 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).
- However, the rate of construction of forest roads has dropped from 780 km forest roads for year-round use in 1992 to 130 km in 2003.
- A total of NOK 149 million was invested in forest roads in 2003, and NOK 55 million of this was in the form of public grants, NOK 14 million less than in 2002.

For the size of wilderness-like areas, see Chapters 1 Status and important trends and 9 Land use.

**Figure 4.4. Silviculture measures[1] that have an environmental impact. 1991-2003***




[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.
[3] No figures are available for the county of Troms.
Source: Forestry statistics, Statistics Norway.

## Silviculture

- There has been a decrease in silviculture activities since the beginning of the 1990s. Public funding for such activities was discontinued in 2003.
- The planting of trees is the largest single silviculture investment. A total of NOK 77 million was invested in planting in 2003, and 117 km² were 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 and reductions in grants.
- The county of Nord-Trøndelag accounted for 50 per cent of all forest drainage in 2003.

**Box 4.2. Environmental inventories in forests - biodiversity**

Forestry planning and sufficient 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. In spring 2000, the registration project (coordinated by Skogforsk, a key forestry research institute under the Ministry of Agriculture and Food) presented the results of three years' field work and analyses relating to biodiversity in forests. 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 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 after three seasons about 14 million decares had been registered. In 2004, NOK 25 million was allocated for forestry planning.

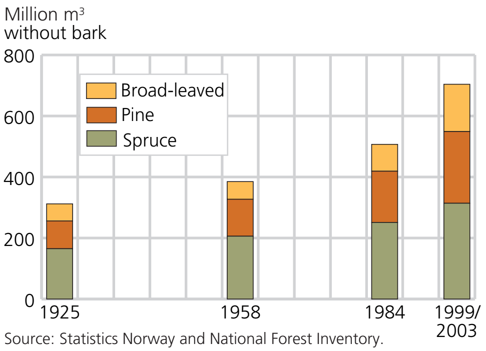
A booklet is available describing the registration method and courses have been held for forestry planners and other users. The Norwegian Institute of Land Inventory (NIJOS) has contributed to the establishment of a practical registration procedure. NIJOS has also evaluated some of the registrations carried out so far in order to improve the registration instructions. The booklet is available on the Skogforsk website (http://www.skogforsk.no/files/71.pdf).

The registration procedure is based on identifying the areas of most importance for biodiversity and obtaining qualitative information at population level for species that are not concentrated in specific areas. Localities are identified using 12 defined environmental elements, such as the quantity of dead wood on the ground or the number of old trees. These environmental elements are also classified into 29 different habitats on the basis of nutrient status and moisture. The localities are ranked in relation to each other, with the most important qualifying for possible action. The methodology is being continuously improved.

The work carried out under the project can be expected to provide new knowledge that will be of value to the forestry industry in the environmental adjustments made in compliance with government policy and in relation to the Living Forests Standards. The project's work is also relevant to the development of a national programme to survey and monitor biological diversity (Ministry of Agriculture and Food 2004).

## 4.3. Increment and uptake of $CO_2$ by forest

**Figure 4.5. Volume of the growing stock. 1925, 1958, 1984 and 1999/2003**

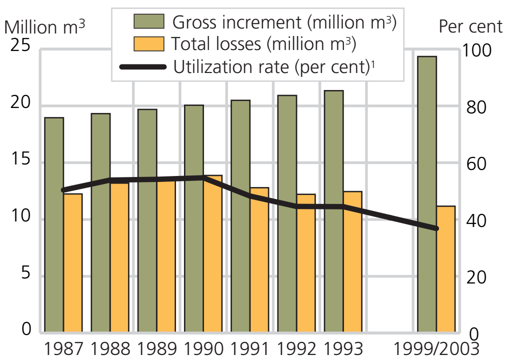



Source: Statistics Norway and National Forest Inventory.

### Total growing stock

- Data from inventories carried out by the Norwegian Institute of Land Inventory and calculations carried out by Statistics Norway show that in the period 1999/2003 the volume of the growing stock in Norway was 704 million $m^3$.
- The volume of the growing stock below the coniferous forest line has more than doubled since 1925.

**Figure 4.6. Gross increment, total losses and utilization rate of the growing stock[1]. 1987-1999/2003**



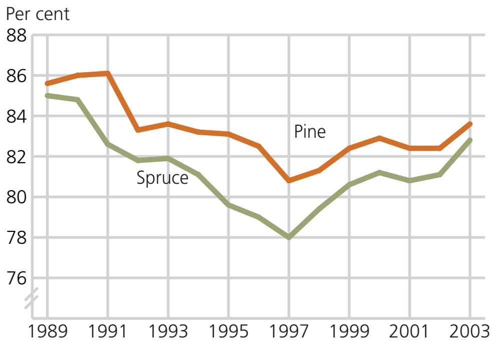

[1] Utilization rate is defined here as the volume of roundwood removals in relation to gross increment.
Source: Forestry statistics, Statistics Norway.

### Increment and utilization rate of the growing stock

- In 2002, the net increment (annual increment minus roundwood removals and calculated natural losses) in the growing stock was 13.2 million $m^3$, or 1.8 per cent of the total volume (see Appendix, table D1).
- The increase in the biomass (branches and roots included) of forests in 2002 resulted in an uptake of carbon by forest that corresponded to about 45 per cent of the total anthropogenic $CO_2$ emissions in Norway.

## 4.4. Forest damage

**Figure 4.7. Mean crown condition for spruce and pine. 1989-2003**



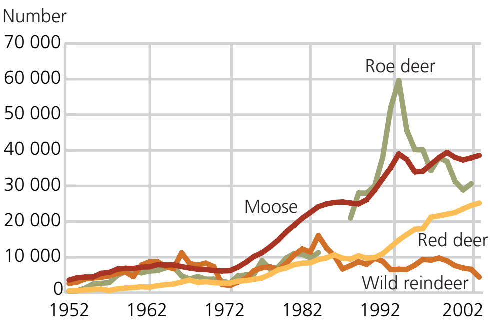

Source: Norwegian Institute of Land Inventory (2003).

### Forest damage in Norway

- Crown condition is an indicator of the forest's state of health. The crown condition for both spruce and pine improved in the period from 1998 to 2000.
- A slight decline was recorded for both species in 2001. In 2002 there was a small increase for spruce, and no change for pine. Mean crown condition for spruce was 81.1 per cent and 82.4 per cent for pine. In 2003 an increased crown density for both spruce and pine was recorded. Mean crown density for spruce was 82.8 per cent and 83.6 per cent for pine.
- The crown colour of both pine and birch was greener in 2003 compared with the year before, while the status for spruce was recorded as unchanged.

## 4.5. Game species

**Figure 4.8. Number of moose, red deer, wild reindeer and roe deer killed. 1952-2003**

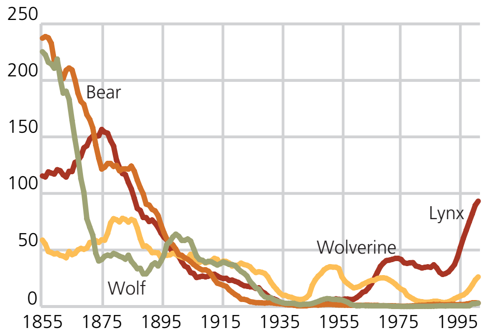



Source: Hunting statistics, Statistics Norway.

### 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 2003 was 5 111 tonnes of moose meat, 1 453 tonnes of venison and 146 tonnes of wild reindeer meat (see also Appendix, table D3).

**Figure 4.9. Number[1] of predators killed. 1885-2002**



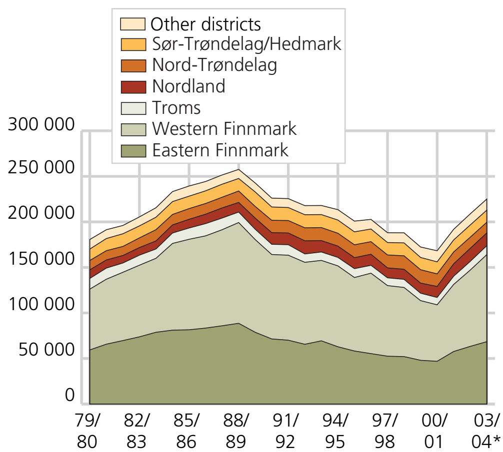

[1] Average number past ten years.
Source: Hunting statistics, Statistics Norway.

## 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, licensed hunters are permitted to take wolverines in Norway, and lynx hunting is regulated by means of quotas (see also Appendix, table D4).

# 4.6. Reindeer husbandry

**Figure 4.10. Trends in the size of the spring herd. 1979/80-2003/04***

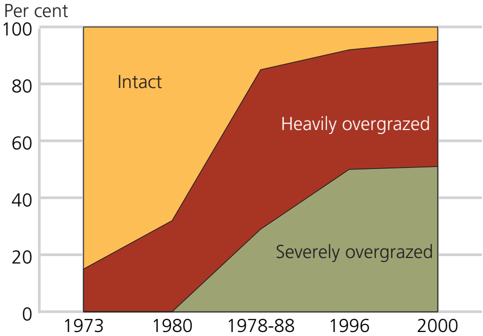



Source: Norwegian Reindeer Husbandry Association.

## 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 several winters with difficult climatic conditions at the end of the 1990s. In the past three years, the size of the reindeer stock in Finnmark has increased substantially due to good calving seasons, primarily due to very favourable climatic conditions during the winter season.

**Figure 4.11. State of lichen resources in Finnmark. 1973-2000**




Source: NORUT.

## Reindeer husbandry and the environment

- Parts of Finnmark have been so overgrazed that both the environment and the future of the industry are threatened.
- In 2000, half of the grazing areas were defined as severely overgrazed, more than 40 per cent as heavily overgrazed and only 5 per cent as intact. This indicates a dramatic deterioration compared with previous measurements, although the methods used are not entirely comparable.

# 4.7. Management of uncultivated areas

**Table 4.1. Processing of applications for exemptions[1] under the Act relating to motor traffic on uncultivated land and in water courses. Whole country**

| | Number of applications processed by the municipalities | Number approved | Percentage approved |
|---|---|---|---|
| 2001 | 12 674 | 11 863 | 94 |
| 2002 | 14 186 | 13 255 | 93 |
| 2003 | 13 208 | 12 557 | 95 |

[1] In reporting municipalities.
Source: Statistics Norway 2004.

## 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 government 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, 95 per cent of all applications for exemption were granted in 2003. The number of applications processed was unevenly distributed among the municipalities, but this had little effect on the share of exemptions granted.
- See also Chapter 9, Land use, where municipal land use management and building activity in the coastal zone (100-metre belt) is described.

**More information:** : Britta Hoem (forest balance), Astri Kløvstad (forest and game), Svein Homstvedt (reindeer), and Henning Høie (management of uncultivated areas).

## Useful websites

Directorate for Nature Management: http://english.dirnat.no/
Norwegian Forest Research Institute: http://www.nisk.no/
Norwegian Institute for Land Inventory: http://www.nijos.no/
Norwegian Reindeer Husbandry Association: http://www.reindrift.no/
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/
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 (2004): The Directorate's website (http://english.dirnat.no) and Asbjørn Tingstad, pers. comm, August 2004 (protected forest areas).

METLA (2003): *Skogstatistisk årsbok* (Statistical Yearbook of Forestry). Helsinki: Finnish Forest Research Institute.

Ministry of Agriculture and Food (2004): The text on registration of biological diversity in forests in Box 4.2 has been prepared by the Ministry of Agriculture and Food, Department for Forest and Resource Policy.

Norwegian Institute of Land Inventory (1999): *SKOG 2000. Statistikk over skogforhold og -ressurser i Norge* (Forests 2000. Statistics on forests and forest resources in Norway). NIJOS report 7/1999.

Norwegian Institute of Land Inventory (2004): L*andsrepresentativ overvåkning av skogens vitalitet i Norge 1989-2003*. Rapport 1/04 (Nationwide representative monitoring of forest vitality, 1989-2003), Ås.

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.

Statistics Norway (2004): Lett å få lov til å kjøre med motor i utmark (Exemptions for motor traffic in uncultivated areas usually granted), *Today's statistics*, 08 July 2004 (http://www.ssb.no/english/subjects/01/miljo_kostra_en/)

Swedish National Board of Forestry (2000): *Skogstatistisk årsbok 2000* (Statistical Yearbook of Forestry).

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.

UN-ECE/FAO (1995): *Forest Resource Assessment 1990*. Rome: Global synthesis, United Nations Economic Commission for Europe / Food and Agriculture Organization of the United Nations.

# 5. Fisheries, sealing, whaling and fish farming

**Stocks of several important demersal fish species in the North Sea are now at an all-time low, and the Barents Sea capelin stock has collapsed once again. On the other hand, the spawning stock of Norwegian spring-spawning herring is at a relatively high level. The spawning stock of Northeast Arctic cod is still considered to be well within safe biological limits. In 2003, production of farmed salmon passed 500 000 tonnes for the first time.**

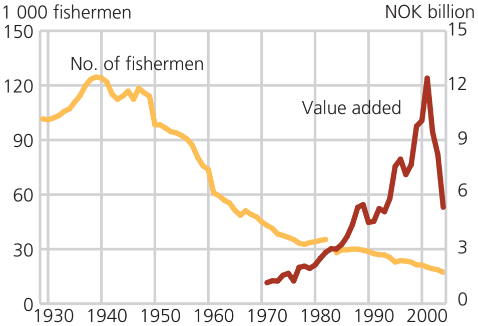
In its report *Marine Resources 2004* (Michalsen 2004), the Institute of Marine Research states that there is still a need to exercise considerable caution in the harvesting of a number of Norway's important fish species. This applies particularly to demersal species in the North Sea, whereas several pelagic stocks, such as Norwegian spring-spawning herring, North Sea herring and Northeast Atlantic mackerel, are in a better state.

The total world catch from marine fisheries was 84 million tonnes in 2002. According to FAO, about 47 per cent of major fish stocks for which data is available are fully exploited, while 18 per cent are overexploited. It is estimated that 10 per cent of the fish stocks have been substantially depleted. The remaining 25 per cent are regarded as moderately exploited or underexploited, and this is where there is a potential for the expansion of marine fisheries.

Several recent studies indicate that overfishing has led to severe reduction of the oceans' fish resources, and has created substantial imbalances in marine ecosystems. Myers and Worm (2003) estimates that overfishing has reduced the size of large predatory fish stocks by 90 per cent during the last 50 years.

The International Council for the Exploration of the Sea (ICES) defines ecosystem-based management as "integrated management of human activities based on knowledge of ecosystem dynamics to achieve sustainable use of ecosystem goods and services and maintenance of ecosystem integrity (structure and function)". The Norwegian authorities' objectives for ecosystem-based management of resources and the environment in our marine areas are outlined in Report No. 12 (2001-2002) to the Storting Protecting the riches of the seas. The Norwegian Institute for Marine Research has recently been reorganised to improve its capacity to carry out research and provide advisory services based on the ecosystem approach.

**Figure 5.1. Value added[1] in the fishing, sealing and whaling industry 1970-2003, and number of fishermen 1926-2003**



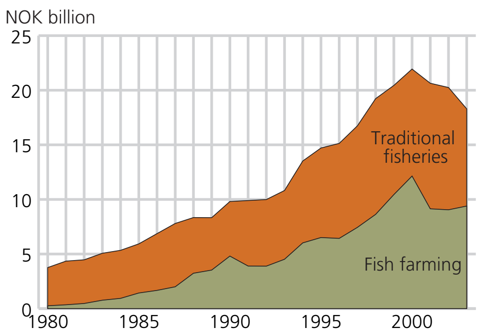

[1] Value added in basic values. Current prices.
Source: Directorate of Fisheries and National Accounts, Statistics Norway.

## 5.1. Principal economic figures for the fisheries

### GDP and employment

- According to the Norwegian national accounts, fishing, sealing, whaling and fish farming contributed NOK 4.8 billion, or 0.3 per cent, to Norway's gross domestic product (GDP) in 2003.
- The fishing industry accounted for 0.7 per cent of total employment in 2003. At the end of 2003, 17 259 fishermen were registered in Norway. The number of fishermen has dropped by about 85 per cent since the late 1930s. The fish farming industry employs about 4 000 people.

**Figure 5.2. First-hand values in traditional fisheries and fish farming. 1980-2003**



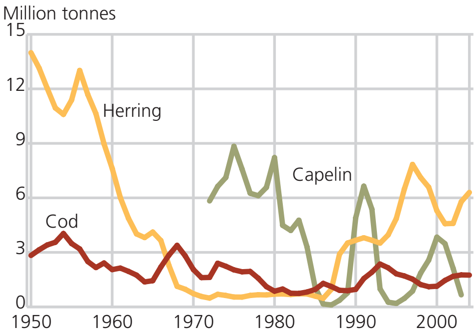

Source: Directorate of Fisheries and Fisheries statistics, Statistics Norway.

### Production and prices

- 2003 and to some extent 2002 were difficult years for the Norwegian fishing industry. A general fall in demand and a strong Norwegian krone have put increased pressure on income (Statistics Norway 2004a).
- Figures from the national accounts indicate that production dropped by 13.6 per cent from 2002 to 2003 (measured in constant prices) in the traditional fisheries, whereas it increased by almost 16 per cent in the fish farming industry.
- In 2003, the first-hand value of catches in the traditional fisheries declined by 20 per cent, whereas it increased by about 4 per cent in the fish farming industry (salmon and trout).

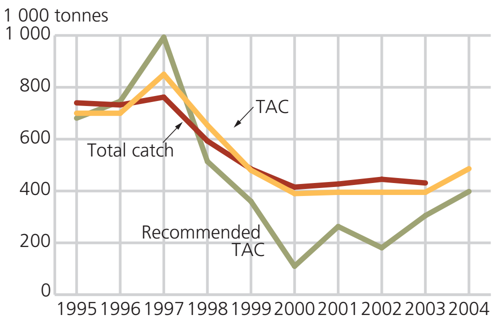
## 5.2. Trends in stocks

**Figure 5.3. Trends for stocks of Northeast Arctic cod[1], Norwegian spring-spawning herring[2] and Barents Sea capelin[3]. 1950-2004**



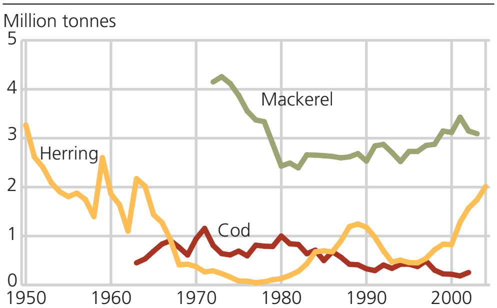

[1] Fish aged three years and over. [2] Spawning stock. [3] Fish aged one year and over.
Source: ICES and Institute of Marine Research, Bergen.

**Figure 5.4. Recommended TACs, TACs actually set and catches[1] of Northeast Arctic cod. 1995-2004**




[1] In both 2002 and 2003, unreported catches have been estimated at 90 000 tonnes.
Source: ICES and Institute of Marine Research, Bergen.

**Figure 5.5. Trends for stocks of cod in the North Sea[1], North Sea herring[2] and mackerel[2,3]. 1950-2004**




[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

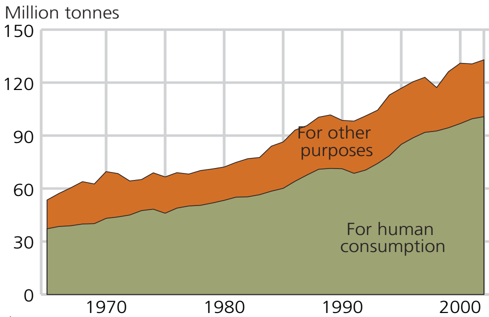
- The spawning stock of Norwegian spring-spawning herring in 2004 was estimated to be 6.3 million tonnes. The stock is within safe biological limits.
- The total stock of capelin in the Barents Sea in autumn 2003 was estimated to be 0.6 million tonnes, and the stock is therefore considered to have collapsed again. This 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 1.8 million tonnes in 2004.
- Since 1998, the TAC (total allowable catch) for Northeast Arctic cod has been considerably higher than the level recommended by marine scientists. The recorded catches correspond fairly closely to the TACs.
- The TAC for 2004 is 486 000 tonnes. This is 88 000 tonnes higher than the level recommended by the International Council for the Exploration of the Sea (ICES).

### North Sea

- In recent years, the North Sea herring stock has developed satisfactorily. The spawning stock in 2004 was estimated to be about 2.2 million tonnes.
- The cod stock is still low. The total stock is estimated to be about 200 000 tonnes.
- The total spawning stock of mackerel has developed satisfactorily in recent years, and is now estimated to be over 3 million tonnes.

## 5.3. Fisheries

**Figure 5.6. World fisheries production[1], by main uses. 1965-2002**




[1] Production data does not include marine mammals (seals, whales, etc.) or plants. Aquaculture is included.
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 133 million tonnes in 2002.
- The proportion used for human consumption in 2002 was 76 per cent. Table 5.1 shows production split by type.
- The species with the highest catch figures in 2002 was Peruvian anchovy (*Engraulis ringens*) at 9.7 million tonnes.

### Box 5.1. 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, it is considered to be outside safe biological limits, and 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 2003.

| Stock | $B_{lim}$ (critical reference point) 1 000 tonnes | $B_{pa}$ (precautionary reference point) 1 000 tonnes | Estimated spawning stock 2003 1 000 tonnes |
|---|---|---|---|
| Northeast Arctic cod | 220 | 460 | 653 |
| Northeast Arctic saithe | 89 | 150 | 437 |
| Norwegian spring-spawning herring | 2 500 | 5 000 | 5 200 |
| North Sea herring | 800 | 1 300 | 1 170 |
| North Sea cod | 70 | 150 | $< B_{lim}$ |
| North sea saithe | 106 | 200 | 440 |
| Whiting | 225 | 315 | Not estimated |
| Mackerel (total stock) | No biological basis for definition of limit | 2 300 | 3 091 |

Source: Institute of Marine Research and ICES.

**Table 5.1. World fisheries production. 2002**

| | 1 000 tonnes | Per cent |
|---|---|---|
| **Total production** | **132 989** | **100** |
| Marine fisheries | 84 452 | 63.5 |
| Freshwater fisheries | 8 738 | 6.6 |
| Aquaculture (fish, crustaceans, etc.) in marine waters | 16 835 | 12.7 |
| Aquaculture (fish, crustaceans, etc.) in inland waters | 22 964 | 17.3 |

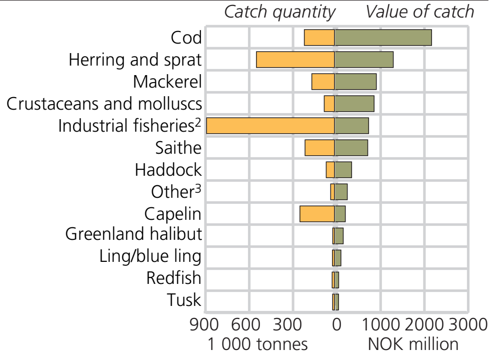
Source: FAO.

## Box 5.2. More about stock trends

- In 2004, the stock of N*orwegian spring-spawning herring* is well above the precautionary level defined by marine scientists. Recruitment from the 1999 year class and individual growth have contributed to an increase in the spawning stock.
- The decline in the total stock of *Barents Sea capelin* from 2002 to 2003 is due to weak recruitment, increased natural mortality and reduced individual growth. This collapse of the stock is not conside-red 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 has, as recommended by the ICES Advisory Committee on Fishery Management, decided to close the fishery for Barents Sea capelin in winter 2004.
- The spawning stock of *Northeast Arctic cod* – around 850 000 tonnes in 2004 - is well above the precautionary level. One important reason for the increase in spawning biomass after 2000 is earlier maturation.
- The stock of *coastal cod* is declining. The size of the stock has dropped from about 330 000 tonnes in 1994 to 90 000 tonnes in 2003. Unless harvesting is reduced considerably over the next few years, the total stock and the spawning stock are both expected to decline further. ICES recommended zero fishing in 2004, but the Joint Norwegian-Russian Fisheries Commission nevertheless set a quota of 20 000 tonnes.
- The spawning stock of *North Sea herring* was substantially depleted in the period 1989-1993, from a level of about 1.2 million tonnes to 470 000 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 well above the precautionary level.
- 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. The spawning stock of *whiting* is also outside safe biological limits, but the stocks of whiting and had-dock have shown positive trends in recent years. The Advisory Committee on Fisheries Management (ACFM) has recommended closure of all cod fisheries in the North Sea, but Norway and the EU have nevertheless set quotas.
- 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 one stock (North-east 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. Both the southern and western components are currently at a high level. On the other hand, the level of the North Sea component, the smallest of the three, is still low, although it showed signs of growth in 2002 for the first time for 25 years.

Source: Marine Resources 2004 (Michalsen 2004). See also Box 5.1 and Appendix, table E1.

**Figure 5.7. Norwegian catches[1] by groups of fish species, molluscs and crustaceans. 2003**




[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.

## Norwegian catches

- In 2003 the total catch in Norwegian fisheries (including crustaceans, molluscs and seaweed) was 2.7 million tonnes, and the value of the catch was NOK 8.9 billion. The total catch was about 225 000 tonnes lower than in 2002, and the value was about NOK 2.2 billion lower.
- Cod is the species with the highest catch value.
- Measured by catch size, industrial fisheries for species such as Norway pout, blue whiting and sandeels dominated in 2003. The catch of blue whiting reached a record high of 851 000 tonnes.

### Box 5.3. World catches and Norwegian catches

Total catches in the world's marine fisheries in 2002 remained at about the same level as in 2001. The same was true of inland fisheries.

The catches in the Southeast Pacific increased by over 1 million tonnes, after a drop of over 3 million tonnes between 2000 and 2001.Total landings of *anchoveta* increased by 2.5 million tonnes, whereas the catch of *Chilean jack mackerel* decreased by about 750 000 tonnes. There were no dramatic changes in catches in other marine areas. Total catches in the Northeast Atlantic have remained at about 11 million tonnes for a number of years.

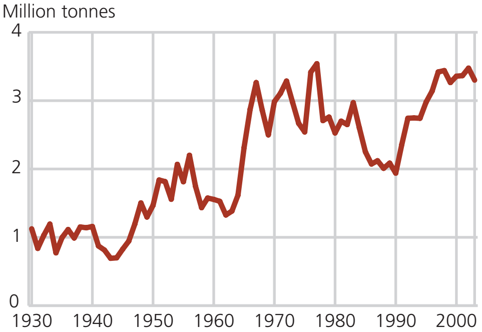
According to FAO (2003), 47 per cent of major fish stocks for which data is available are fully exploited, while 18 per cent are overexploited. It is estimated that 10 per cent of the fish stocks have been depleted or are recovering from depletion. In 2002, world aquaculture production (excluding plants) rose by 2 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 2.7 million tonnes in 2002. At the head of the list are China (16.6 million tonnes), Peru (8.8 million tonnes), the USA (4.9 million tonnes), Indonesia (4.5 million tonnes) and Japan (4.4 million tonnes). See also Appendix, tables E7 and E8. According to the FAO yearbook of fisheries statistics (FAO 2003a), Chinese capture data is considered to have been overestimated since the early 1990s. The data is now being reviewed and may be revised downwards.

In the Norwegian fisheries, the catch of herring was about the same in 2003 as the year before. However, value of the catch dropped by about NOK 640 million to NOK 1.4 billion. The catch of cod decreased by about 10 000 tonnes from 2002, and the value of the catch dropped by about NOK 500 million to NOK 2.3 billion. The mackerel catch dropped by about 20 000 tonnes and its value was NOK 1.0 billion. The catch of capelin dropped from 522 000 tonnes to 249 000 tonnes with a value of NOK 360 million. The shrimp catch was 67 000 tonnes and its value was NOK 818 million. The Norwegian catch of blue whiting was about 0.8 million tonnes. There is no international agreement regulating fishing for blue whiting in international waters, so that the fishery has been almost unregulated. Total landings therefore reached a record high of 2.3 million tonnes in 2003. The catch of sandeels dropped sharply in 2003 to about 30 000 tonnes.

See also figures 5.6 and 5.8 and Appendix, table E2.

**Figure 5.8. Total production[1] in Norwegian fisheries. 1930-2003**

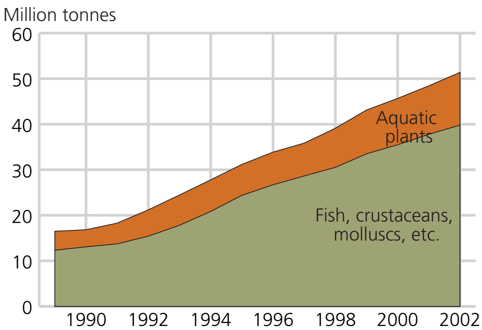



[1] Fish farming production is included.
Source: Directorate of Fisheries and Fisheries statistics, Statistics Norway.

- The total catch in Norwegian fisheries is now 2-3 times higher than in the 1930s.
- Total production in the fisheries and fish farming in 2003 was about 3.3 million tonnes, of which 2.7 million tonnes was in traditional fisheries.
- The highest level of catches in the traditional fisheries in the period since 1930 was 3.5 million tonnes in 1977. In the same year, more than 2 million tonnes capelin was caught.

## 5.4. Aquaculture

**Figure 5.9. World aquaculture production. 1989-2002**

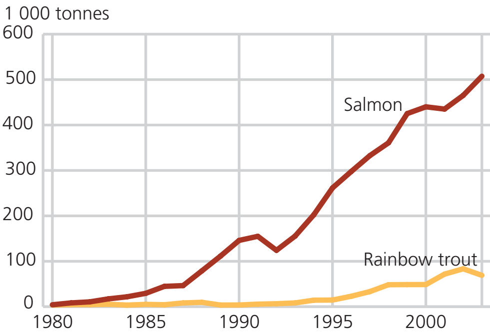



Source: FAO.

### World aquaculture production

- In 2002, world aquaculture production totalled 39.8 million tonnes fish, crustaceans, molluscs, etc. corresponding to about 43 per cent of the total catch in marine and inland fisheries for that year.
- Production of aquatic plants totalled 11.6 million tonnes in 2002.
- World aquaculture production has trebled since 1989.

**Figure 5.10. Fish farming. Volume of salmon and rainbow trout sold. 1980-2003**




Source: Fisheries statistics, Statistics Norway.

## Salmon and trout farming in Norway

- Production of farmed salmonids has increased dramatically since the industry was established in the early 1970s. In 2003, salmon production (sold quantity) totalled 507 000 tonnes. Prices were generally poor in 2003.
- Production of trout was about 69 000 tonnes in 2003.
- In 2002, 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.

### Box 5.4. More about aquaculture production

In 2002, world aquaculture production of fish, crustaceans, molluscs, etc. totalled almost 40 million tonnes, and freshwater production accounted for 60 per cent of this (see also table 5.1). In addition, 11.6 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 2002.
The species farmed in the largest volume was the Pacific oyster (4.2 million tonnes), followed by a number of species of carp. On a list of 28 farmed species of which over 150 000 tonnes were produced in 2002, Atlantic salmon ranked tenth and mussels nineteenth.

The aquaculture industry in Norway has been facing some of the same problems as the traditional fisheries. The industry is highly dependent on exports, and a strong Norwegian krone in 2002 and parts of 2003 had a negative effect on the competitive position of Norwegian salmon and trout producers. The export volume continued to grow despite this, but the average price of fresh salmon, which is the most important export commodity, has dropped every year since 2000. A weak rise in the export prices of frozen salmon and trout was registered from 2002 to 2003. The special agreement on farmed salmon between Norway and the EU, which entered into force in 1997, was terminated in 2003 after being extended several times. The agreement included provisions on export duties, the volume of salmon exports and minimum prices. The decision to terminate the agreement meant that the EU would not initiate new investigations before May 2004 unless circumstances changed. In autumn 2003, the EU imposed an anti-dumping duty on Norwegian rainbow trout in response to a complaint lodged by the Finnish fish farming industry (Statistics Norway 2004a). The EU initiated new anti-dumping proceedings concerning imports of Norwegian farmed salmon in September 2004.

On 14 August 2004, the EU Commission published a regulation imposing provisional safeguard measures against imports of farmed salmon (fresh, chilled and frozen, and both filleted and non-filleted) in the form of a system of tariff quotas for the period 15 August 2004 to 6 February 2005. The Norwegian tariff quota is 163 997 tonnes. Once this quota has been filled, an additional duty corresponding to 17.8 per cent will be imposed on any further exports.

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. The production in 2003 was 1 370 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, 386 000 tonnes of mussels were produced on a global basis in 2002.

Production of other fish species than salmon and trout for human consumption is still relatively modest in volume. In 2003, 270 tonnes of farmed Arctic char, 2 160 tonnes of cod and 430 tonnes of halibut were sold in Norway (Statistics Norway 2004b).

**Box 5.5. Some important diseases and health problems associated with fish farming**

This information on the incidence of disease in salmon farming in 2003 is based on figures in *Annual Report on Aquaculture 2004* (Agnalt et al. 2004). Serious diseases include the following:

- Furunculosis, caused by the bacterium *Aeromonas salmonicida* (new cases registered in 2003: 2 fish farms).
- Bacterial kidney disease (BKD), caused by the bacterium *Renibacterium salmoninarum* (new cases registered in 2003: 1 fish farm).
- Infectious salmon anaemia (ISA), a virus disease (new cases registered in 2003: 8 fish farms).
- Infectious pancreatic necrosis (IPN), a virus disease (new cases registered in 2003: 178 fish farms).

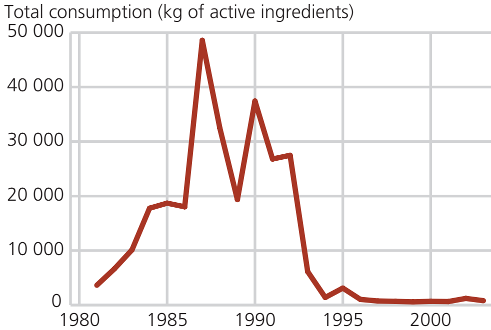
New diseases have also emerged, such as heart and skeletal muscle inflammation in salmon. This disease was first diagnosed in 1999, and there have been around 12-15 outbreaks per year. In 2002, the number of cases diagnosed rose to 24 (Ervik et al. 2003). There seems to have been a considerable increase in the number of cases of this disease and in its distribution in 2003, when it was one of the most serious health problems for the industry (Agnalt et al. 2004). Pancreas disease (PD) attacks the pancreas and the heart and skeletal muscle. This disease seems to be spreading, and there was a marked increase in the number of registered cases in 2003. The disease was also registered at fish farms in Northern Norway for the first time. Pancreas disease results in mortality, reduced growth and poorer-quality meat, and can cause very high losses for fish farms.

The *salmon louse* (a parasitic crustacean which lives in salt water and drops off the salmon after a short period in fresh water) is still an important cause of losses in the salmon farming industry. Salmon lice can cause poor growth, injury to salmon and secondary infections followed by outbreaks of disease. The parasite can also be a threat to wild salmon and sea trout stocks. It is particularly dangerous to smolt (young salmon) as they migrate from the rivers into the fjords.

There were no new records of the parasite *Gyrodactylus salaris* in rivers or fish farms in 2003.

According to the fisheries statistics (Statistics Norway 2004b), sea-water rearing units lost 15 million fish (13.5 million salmon and 1.5 million trout) to disease in 2003. Total losses were 35 million fish (31 million salmon and 4 million trout), which included 240 000 salmon and 130 000 trout that were reported to have escaped from fish farms. Other reasons for losses include injury, predators, discards due to wounds or defects, theft, etc.

**Figure 5.11. Consumption of medicines[1] (antibacterial agents) in fish farming. 1982-2003**



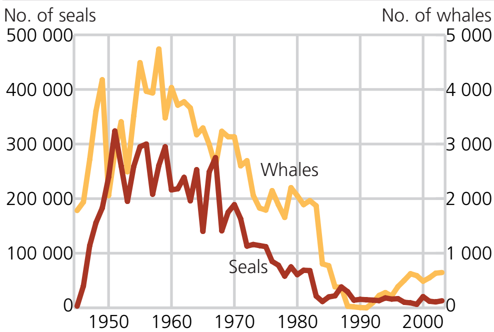

[1] Based on sales figures from pharmaceutical wholesalers and feed suppliers.
Source: Norwegian Institute of Public Health.

### 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 antibacterial agents was highest in 1987, when it reached 49 tonnes. Consumption in 2003 was 809 kg, which is a decrease of about 400 kg from 2002 and equivalent to between 1 and 2 g per tonne slaughtered fish (see Appendix, table E3).

## 5.5. Sealing and whaling

**Figure 5.12. Norwegian sealing and whaling[1]. 1945-2003**




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

- In 2003, the total seal catch was 12 870 animals (7 575 harp seals and 5 295 hooded seals). The catch in the West Ice includes both hooded seals and harp seals (2 277), whereas in the East Ice it consists entirely of harp seals (5 298). The value of the catch in 2003 was NOK 4.2 million.
- The quota for the small whale hunt in 2003 was 711 animals, and the catch was 646 animals. The quota for 2004 was set at 670 animals. The value of the small whale catch in 2003 was about NOK 26 million.

**Box 5.6. 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 350 000 year-old and older animals in the West Ice and about 1.8 million in the East Ice. The stock of hooded seals in the West Ice number about 120 000 animals (Michalsen 2004). Since the early 1980s, catches of seals have been small, varying between 10 000 and 40 000 animals per season.

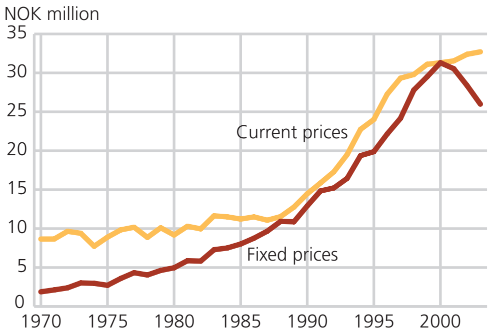
Norwegian catches of *small* whales have consisted mainly of minke whales. The traditional commercial hunt was discontinued after the 1987 season, but was resumed in 1993, when 226 whales were taken.

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 (Michalsen 2004).

In 2004, the Norwegian government presented the white paper *Norway's policy on marine mammals* (Report No. 27 (2003-2004) to the Storting). Its purpose is to present a proposal for a new, coherent, active management regime for marine mammals, based on modern principles for the management of species, habitats and ecosystems. It also forms part of Norway's efforts to implement the ecosystem approach to the management of its marine resources.

## 5.6. Exports

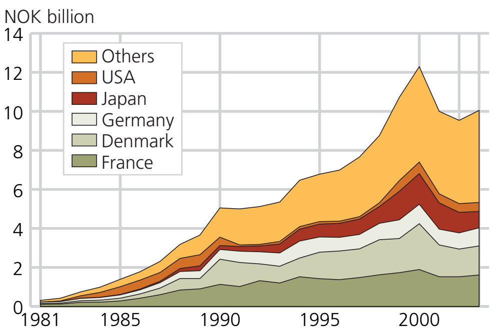
**Figure 5.13. Value of Norwegian fish exports. Current and fixed prices (2000 NOK). 1970-2003**




Source: National accounts, Statistics Norway.

- In 2003, Norway exported about 2.2 million tonnes of fish and fish products to a value of NOK 26.4 billion (see Appendix, tables E4 and E5). Exports to EU countries accounted for 56 per cent of the total.
- According to FAO, Norway was in 2002 the world's third largest exporter of fish in terms of value behind China and Thailand, and ahead of the United States, Canada, Denmark and Vietnam. The value of Norway's fish exports corresponded to about 6 per cent of the value of total world fish exports (see Appendix, table E7).

**Figure 5.14. Exports of salmon[1], by main importing countries. 1981-2003. Current prices**




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

- Salmon exports totalled NOK 10 billion in 2003. This is an increase of NOK 0.5 billion from 2002 (see Appendix, table E6).
- Denmark and France have for a number of years been the most important importers of farmed salmon. Exports to Denmark (NOK 1.5 billion) and France (NOK 1.6 billion) increased moderately from 2002 to 2003.
- China is a new, interesting market for salmon, although the value of exports in 2003 was only NOK 81 million.

**More information:** Frode Brunvoll.

## 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

Agnalt, A., A. Ervik, T. S. Kristiansen and F. Oppdal (eds.) (2004): Havbruksrapport 2004 (Annual Report on Aquaculture 2004). *Fisken og havet,* Special issue 3-2004, Institute of Marine Research, Bergen.

Ervik, A., A. Kiessling, O. Skilbrei and T. van der Meeren (eds.) (2003): Havbruksrapport 2003 (Annual Report on Aquaculture 2003). *Fisken og havet,* Special issue 3-2003, Institute of Marine Research, Bergen.

FAO (2003a): *Yearbook. Fishery statistics. Capture production. 2001*. Vol. 90/1. FAO Fisheries Series No. 63, FAO Statistics Series No. 173, Food and Agriculture Organization of the United Nations.

FAO (2003b): *The state of world fisheries and aquaculture 2002*. Food and Agriculture Organization of the United Nations.

Michalsen, K. (red.) (2004): Havets ressurser 2004 (Annual Report on Marine Resources 2004). *Fisken og havet,* Special issue 1-2004, Institute of Marine Research, Bergen.

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. 27 (2003–2004) to the Storting: Norway's policy on marine mammals. Ministry of Fisheries and Coastal Affairs.

Statistics Norway (2004a): Økonomisk utsyn over året 2003 (Economic Survey 2003). *Økonomiske analyser* 2004, 1.

Statistics Norway (2004b): Fish farming statistics. Preliminary figures. Larger volume to a lesser price. *Today's statistics* 21 August 2003 (http://www.ssb.no/english/subjects/10/05/fiskeoppdrett_en/).

## Other literature

FAO (2003): Yearbook. Fishery statistics. Aquaculture production. 2001. Vol. 92/2. FAO Fisheries Series No. 64, FAO Statistics Series No. 174, Food and Agriculture Organization of the United Nations.

FAO (2003): Yearbook. Fishery statistics. Commodities. 2001. Vol. 93. FAO Fisheries Series No. 65, FAO Statistics Series No. 175, Food and Agriculture Organization of the United Nations.

FAO (2004): *The State of Food and Agriculture 2003-2004.* Food and Agriculture Organization of the United Nations.

Ministry of Fisheries and Coastal Affairs (1999): *Fiskeridepartementets miljøhandlingsplan 2000-2004* (Ministry of Fisheries' environmental action plan 2000-2004). Handlingsplaner (action plans) L-0503.

Report No. 45 (2003-2004) to the Storting: *Om dei fiskeriavtalane Noreg har inngått med andre land for 2004 og fisket etter avtalane i 2002 og 2003* (Concerning the fisheries agreements Norway has concluded with other countries for 2004 and fishing according to the agreements in 2002 and 2003). Ministry of Fisheries and Coastal Affairs.

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

Sjøtun, K. (ed.) (2004): Havets miljø 2004 (Annual Report on the Marine Environment 2004). *Fisken og havet,* Special issue 2-2004, Institute of Marine Research, Bergen.

# 6. Air pollution and climate change

**Preliminary calculations show that greenhouse gas emissions in Norway rose by 2 per cent from 2002 to 2003, to the same level as in 2001. A period of decline in some manufacturing sectors resulted in lower greenhouse gas emissions in 2002. There are several reasons for the rise in emissions in 2003; among other things, emissions from oil- and gas-related activities on the continental shelf and onshore have risen sharply. In addition, high electricity prices in 2003 resulted in a sharp rise in fuel oil consumption, which in turn resulted in substantial $CO_2$ emissions. Norwegian greenhouse gas emissions have risen by 8 per cent since 1990.**

Norwegian emissions of greenhouse gases, acidifying 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 6.2, 6.3, 6.8, 6.9, 6.11, 6.12 and 6.14).

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. The Kyoto Protocol requires the industrialised countries to reduce their aggregate emissions of greenhouse gases by just over 5 per cent from 1990 levels in the period 2008-2012. The Protocol (see box 6.5) may be the first step on the way to reduction of global greenhouse gas emissions. According to the Protocol, Norwegian greenhouse gas emissions may be a maximum of 1 per cent higher than the 1990 level in the period 2008-2012 after emissions trading and other mechanisms for reducing emissions have been taken into account. Norway has ratified the Kyoto Protocol, but before it can enter into force, the protocol must be ratified by industrialised countries that accounted for at least 55 per cent of the world's $CO_2$ emissions in 1990. The Storting has also decided that until the Kyoto Protocol enters into force, emissions are to be limited by means of a combination of a domestic emission allowance trading scheme, to be introduced in 2005, and a continuation of the current $CO_2$ tax.

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 ($NO_x$) and NMVOCs (non-methane volatile organic compounds). The Sofia Protocol laid down emission targets for NOx 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 commited 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 (box 6.1) 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.

### Box 6.1. 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 several persistent organic pollutants (POPs) and heavy metals. The inventory covers only anthropogenic emissions, not natural emissions for example from oceans and forests.

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 F8 and F9). 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.

In 2004, national emission figures for 2003 are being published. These are 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 2002 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 2002, which are being published now, and the final figures, which will be published in 2005.

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 Flugsrud et al. (2000): The Norwegian Emission Inventory. Reports 2000/1, Statistics Norway and Norwegian Pollution Control Authority. A new, updated documentation report is being drawn up and will be published early in 2005.

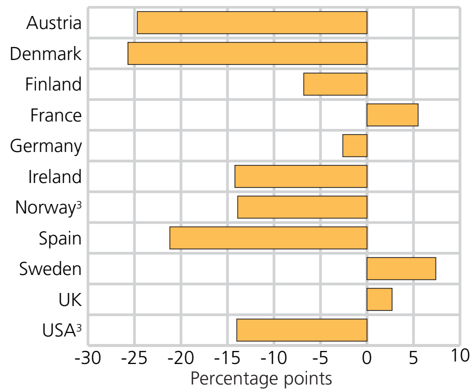
## Box 6.2. Environmental problems caused by air pollution

| | |
|---|---|
| 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 fluorine-containing 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 31, 151 and 17 per cent respectively (IPCC 2001). Norway's total greenhouse gas emissions are shown in figure 6.2. |
| Climate change | Anthropogenic emissions of greenhouse gases, $SO_2$ and particulate matter can alter the natural chemical composition of the atmosphere. This in turn may accelerate changes in the global climate system. It is difficult to quantify what proportion of climate fluctuations 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). Variations in global mean temperature are shown in Chapter 1. |
| Depletion of the ozone layer | 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 6.14. |
| 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/m$^3$. The number of pollution episodes[1] was lower in 2003 (13) than in 2002 (19). The highest hourly mean concentration in 2003 was 162 µg/m$^3$ (Norwegian Institute for Air Research 2004a). The Norwegian Pollution Control Authority's air quality criterion for health (80 µg/m$^3$, 8-hour mean) was frequently exceeded at all measuring stations, but WHO's air quality criterion of 120 µg/m$^3$ was only occasionally exceeded. |
| Acidification | Total emissions of $SO_2$ and $NO_x$ are lower in Norway than in most other European countries. Sulphur and nitrogen compounds acidify soils and water, and are also transported for considerable distances with air currents. 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 section 6.2. |

[1] Number of days when one measuring station records a maximum hourly mean concentration of 200 µg/m$^3$ or several measuring stations record an hourly mean concentration of more than 120 µg/m$^3$.

## 6.1. Greenhouse gases

**Figure 6.1. "Distance-to-target" for greenhouse gas[1] emissions in 2002 (deviation of actual emissions from Kyoto[2] targets)**

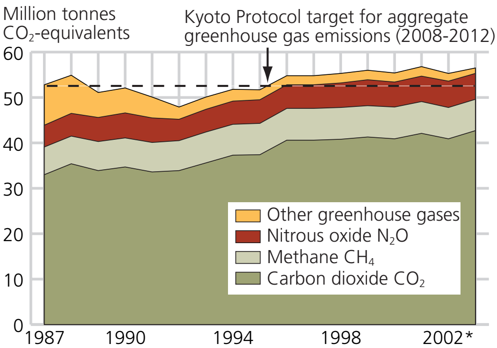



[1] Greenhouse gases included are $CO_2$, $CH_4$, $N_2O$.
[2] The USA has not ratified the Kyoto Protocol.
[3] Figures for the year 2000.
Source: UNFCCC (2003), EEA (2004).

### Greenhouse gas emissions in other countries

- Aggregate greenhouse gas emissions from EU states were reduced by 0.5 per cent from 2001 to 2002 (EEA 2004). 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. 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 2002, its emissions totalled 1 016 million tonnes $CO_2$ equivalents, a reduction of 19 per cent since 1990. Under the EU burden-sharing agreement, Germany has undertaken to reduce its greenhouse gas emissions by 21 per cent compared with the 1990 level.
- Greenhouse gas emissions in Spain, Ireland and the USA have risen by 39, 29 and 14 per cent respectively in the period 1990-2002 (USA 1990-2000). According to the EU burden-sharing agreement, emissions in Spain and Ireland may rise by 15 and 13 per cent respectively compared with the 1990 level.

**Figure 6.2. Total emissions of greenhouse gases in Norway. 1987-2003***




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

## Aggregate greenhouse gas emissions in Norway

- Greenhouse gas emissions in Norway rose by 2 per cent from 2002 to 2003. The overall rise since 1990, the base year for the Kyoto Protocol, is 8.3 per cent.
- The rise in 2003 was almost entirely due to a 4 per cent increase in $CO_2$ emissions (see Appendix, table F1). This in turn is explained by higher emissions from the oil and gas industry on the continental shelf and onshore. High electricity prices in 2003 resulted in a sharp rise in fuel oil consumption, which in turn resulted in substantial $CO_2$ emissions.
- Emissions from the use of autodiesel in cars and marine gas oil by domestic shipping are also rising.

**Box 6.3. 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: $CF_4$ and $C_2F_6$) | 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 6.4. Greenhouse gases and global warming potential**

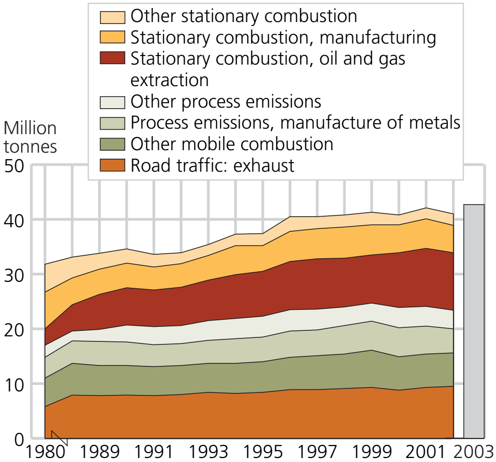
The three most important greenhouse gases are carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). Anthropogenic emissions of $CO_2$ are mainly associated with the combustion of fossil fuels, but are also generated by various chemical processes in manufacturing industries. Methane is 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 6.3. Emissions of $CO_2$ by source. 1980-2003***




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

## Carbon dioxide ($CO_2$)

- In 2003, $CO_2$ emissions totalled 42.7 million tonnes: this is a rise of 4 per cent from the year before. The overall rise since 1990 is 23 per cent.
- The most important sources of $CO_2$ emissions are oil and gas extraction and road traffic, which accounted for 26 and 23 per cent respectively of the total. Process emissions from metal production accounted for 11 per cent of emissions in 2002.
- In 2003, $CO_2$ accounted for 76 per cent of Norway's aggregate greenhouse gas emissions.

### Box 6.5. The Kyoto Protocol and the Kyoto mechanisms

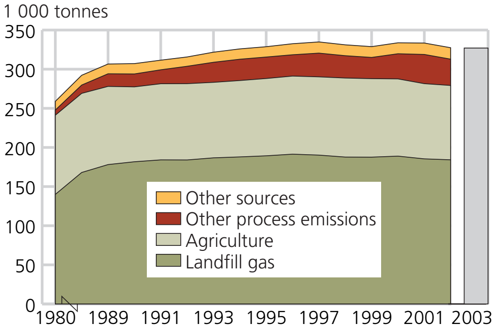
The Kyoto Protocol sets a ceiling for greenhouse gas emissions from industrialised countries for the period 2008-2012. Emissions from developing countries are not limited in this period, but negotiations on commitments for the period after 2012 are to start by 2005 at the latest. The protocol will enter 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.

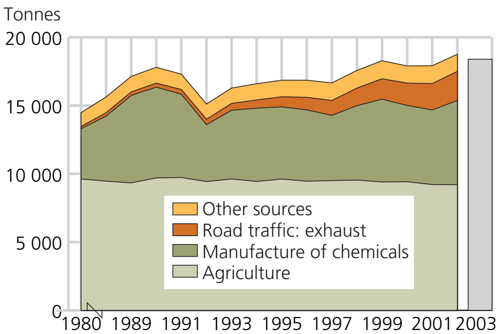
**The clean development mechanism (CDM)**
Similar to joint implementation, but CDM is applicable in cases where one party has undertaken a commitment to reduce emissions and the other has not.

**Figure 6.4. Emissions of $CH_4$ by source. 1980-2003***




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

**Figure 6.5. Emissions of $N_2O$ by source. 1980-2003***




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

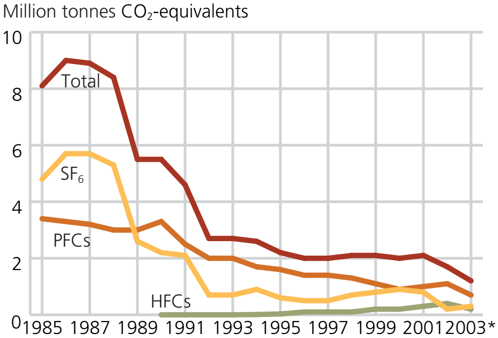
## Methane ($CH_4$)

- In 2003, $CH_4$ emissions totalled 327 200 tonnes, which is the same level as the year before. There has been a 7 per cent rise in emissions since 1990.
- The most important sources of $CH_4$ emissions are landfills, which account for more than half of Norwegian emissions, and agriculture (livestock and manure), which account for about 30 per cent.
- Other process emissions include methane emissions from oil and gas extraction. These have risen by more than 100 per cent since 1990.
- In 2003, $CH_4$ accounted for 12 per cent of Norway's aggregate greenhouse gas emissions.

## Nitrous oxide ($N_2O$)

- In 2003, $N_2O$ emissions totalled 18 400 tonnes, which is a drop of 2 per cent from 2002.
- 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 of nitrous oxide from fertiliser manufacturing rose in 2002, partly because of operational problems.
- Emissions from road traffic continued to rise because nitrous oxide emissions are higher from cars with catalytic converters than from those without, and because of the growing volume of traffic, particularly diesel vehicles.
- In 2003, $N_2O$ accounted for 10 per cent of Norway's aggregate greenhouse gas emissions.

**Figure 6.6. Total emissions of other greenhouse gases (HFCs, PFCs and $SF_6$). 1985-2003***




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 2003, emissions of sulphur hexafluoride ($SF_6$) totalled 11 tonnes, which is a rise of 10 per cent from the year before. The rise in emissions was from casting of resmelted magnesium. In 2002, emissions of $SF_6$ were reduced by two thirds as a result of discontinuation of primary production of magnesium.
- In 2003, emissions of perfluorocarbons (PFCs) from aluminium production dropped by 37 per cent to 106 tonnes. Emissions of hydrofluorocarbons (HFCs) dropped for the first time after rising substantially for the past ten years. HFC emissions totalled 128 tonnes, a drop of 28 per cent from the year before.
- Measured in $CO_2$ equivalents, these pollutants together accounted for 2 per cent of Norway's aggregate greenhouse gas emissions in 2003.

## Box 6.6. Norwegian climate policy instruments

Several different instruments are currently used to regulate greenhouse gas emissions in Norway. Some emissions are subject to a $CO_2$ tax, which is applied at different rates depending on which fuel and sector generates the emissions, see figure 1. However, many sectors, including energy-intensive manufacturing, have been exempted from the $CO_2$ tax to maintain their competitive position. A voluntary arrangement has instead been reached between the government and parts of the energy-intensive manufacturing sector containing targets for the emission reductions to be achieved. In some cases, the conditions laid down in discharge permits for individual enterprises result in restrictions on their greenhouse gas emissions. Finally, the Government has now introduced a Norwegian emissions trading scheme modelled on the EU scheme.

It is generally recognised that greenhouse gas emissions can only be reduced cost-effectively if the marginal cost of reducing emissions by one tonne is the same in all the different sectors. Given the variety of climate policy instruments in use at present, Norway is at present far from achieving a cost-efficient climate policy. How did this situation arise?

Norway started to introduce climate policy instruments at an early stage, and brought in the $CO_2$ tax in the early 1990s. It is true that the tax was graduated and that it did not apply to all emissions, but the intention was for the tax to be gradually harmonised at "an international level" and for the tax basis to be expanded as other countries introduced similar measures. However, this never happened, so that the structure of the tax is much the same as when it was introduced, with only small changes (see figure 1).

In late 1997, the international climate regulations resulted in adoption of the Kyoto Protocol and agreement on the basic features of its mechanisms. The Norwegian government subsequently proposed widening the $CO_2$ tax base. The proposal was rejected by the Storting (Norwegian parliament), which instead requested a review of the introduction of a domestic emissions trading scheme before the first commitment period under the Kyoto Protocol (2008-2012). The committee appointed to carry out the review concluded in year 2000 that almost 90 per cent of greenhouse gas emissions in 1997 would be suitable for inclusion in an emissions trading scheme (Official Norwegian Report, NOU 2000:1, A Quota System for Greenhouse Gases). The year after, in 2001, the government endorsed the principle that the scope of the emissions trading scheme should be as wide as possible, but nevertheless considered that some sources, such as landfills, would be difficult to include to start with. The scope of the scheme put forward by the government in a white paper was therefore somewhat narrower than that suggested by the committee (see Report No. 54 (2000-2001) to the Storting on Norwegian climate policy).

After a change of government, a supplementary white paper on climate policy was submitted the following year (Report No. 15 (2001-2002) to the Storting). Here, the government proposed exemption from the emissions trading scheme for companies that pay the $CO_2$ tax on most of their emissions. This reduced the scope of the scheme to only about 27 per cent of Norwegian emissions.

**Figure 1. $CO_2$-tax in constant prices**

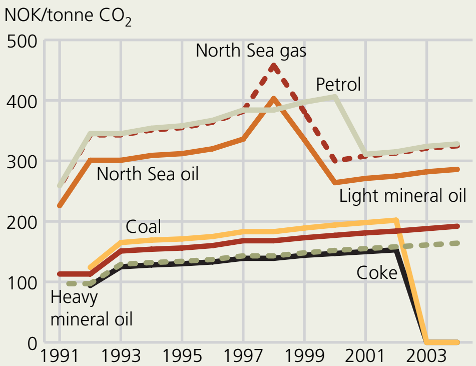
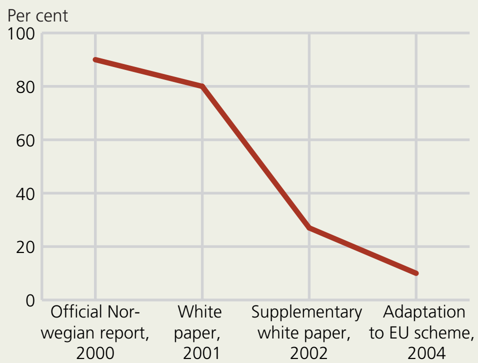



**Figure 2. Proportion of Norwegian emissions included in various proposals for a Norwegian emissions trading scheme**



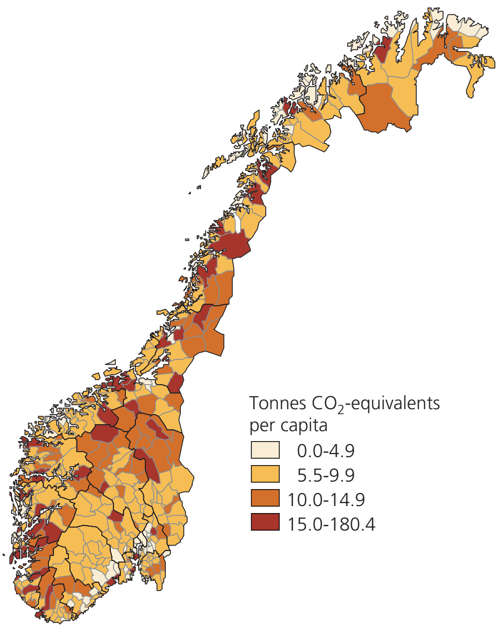

Cont.

Cont.

Since then, the EU has adopted its own regional emissions trading scheme, which applies only to emissions of $CO_2$ (i.e. no other greenhouse gases) from certain sectors, including large combustion plants, oil refineries, the pulp and paper industry, and iron, steel and cement production (Directive 2003/87/EC). In 2004, the government therefore proposed a Norwegian emissions trading scheme very similar to the EU scheme, but with certain exceptions for parts of the process industry, which have entered into a voluntary agreement to reduce their emissions, and for proposed gas-fired power plants. Thus, the proposed Norwegian emissions trading scheme, which entered into force on 1 January 2005, now applies to about 10 per cent of Norwegian emissions. Figure 2 illustrates the changes in the scope of the Norwegian scheme over time.

Based on: Nytt redskap i klimapolitikken (New climate policy instrument). Magazine 20 October 2004. http://www.ssb.no/magasinet/miljo/ , Statistics Norway.

**Figure 6.7. Per capita emissions of $CO_2$ by municipality. 2001**




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.
- Emissions of the three most important greenhouse gases, carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$), have risen by 11 per cent in Norwegian municipalities from 1991 to 2001. Most of the overall rise in emissions is explained by rising emissions from manufacturing and road traffic.
- About 40 per cent of Norway's $CO_2$ emissions take place at sea and in its airspace, and are generated mainly by the oil and gas industry, shipping and air traffic.

**Box 6.7. Is the Clean Development Mechanism (CDM) helping us to achieve a climate target?**

About 50 per cent of the total potential for CDM projects in developing countries is estimated to be in China, and most of this is energy-related. This is because China's energy use and $CO_2$ emissions are both the second-highest in the world, and the country has a long way to go as regards energy efficiency. Since 60-70 per cent of China's primary energy use is in the form of coal, much attention has been focused on lower and cleaner coal consumption, both in the country's energy policy and in the context of $CO_2$ emissions. One important aspect of this for China is that more efficient combustion of coal will reduce local air pollution, which is a serious problem in the major cities.

Coal cleaning both improves the efficiency of the combustion process and reduces emissions of particulate matter. Mechanical cleaning (washing) of coal removes dust and dirt, and gives a cleaner product with a higher carbon content. Cleaned coal burns more efficiently than raw coal, and transport costs are also reduced since a smaller volume of coal is needed to provide the same amount of energy. Thus, calculations show that $CO_2$ emissions per unit of energy used can be reduced.

Unfortunately, the cost of cleaning coal is higher than the savings in the form of greater energy efficiency and lower transport costs, calculated in current prices. However, as a CDM project, coal cleaning meets the additionality criterion - coal cleaning is not in itself economically viable, but in any scenario that includes coal combustion, it helps to reduce $CO_2$ emissions. When compensation for lower carbon emissions is included, coal cleaning appears to be promising, but indirect impacts in the economy as a whole must also be evaluated before its overall effect can be judged.

In a joint project involving Statistics Norway and the National Bureau of Statistics in China, a general equilibrium model for the Chinese economy was used as the framework for investigating the impact of coal cleaning projects. The analysis took into account the reduction in demand for raw coal resulting from the greater combustion efficiency of washed coal. The analysis showed that the price of raw coal dropped, and the demand for raw coal therefore rose somewhat, so that the initial energy savings resulting from the CDM project were counteracted by a rise in coal use by other consumers.

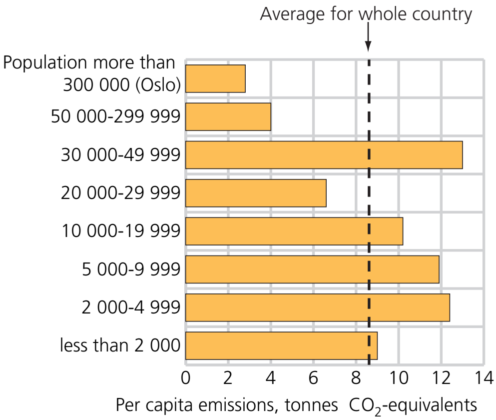
In addition to this spillover effect via the raw coal market, the analysis showed that there were substantial equilibrium effects linked to changes in the demand for transport. Most coal production takes place in northern and northwestern China, while the demand is greatest in the economically dynamic coastal regions. Transport costs therefore account for a substantial proportion of the purchase price of coal (50-60 per cent on average for the whole country). Coal cleaning therefore results in considerable savings and a reduction in demand in the energy-intensive transport market as well.

The overall findings of the analysis were that a CDM project to increase the efficiency of coal consumption in China would result in higher energy use, higher coal consumption and higher $CO_2$ emissions. In macroeconomic terms the project would be profitable - GDP was found to rise somewhat from the level in the baseline scenario (without the CDM project).

An unforeseen rise in carbon emissions in connection with a CDM project is called carbon leakage. In this case, $CO_2$ leakage was more than 100 per cent of the calculated emission reductions for the project, and even though the project appears to be suitable at the planning stage, it may in fact prove to be quite inappropriate as a climate measure under the Kyoto Protocol. It is paradoxical that all forms of energy efficiency measures related to coal consumption in China can be expected to result in similar high levels of $CO_2$ leakage. Other such projects may include investments to improve the efficiency of coal-based electricity production, or improvement of the combustion efficiency of boilers through better control of the combustion process. There are many ways of improving the efficiency of coal consumption in China, but they will all result in similar levels of carbon leakage in the markets for raw coal and transport.

Read more in: Glomsrød, S. and K. E. Rosendahl: Virker Den grønne utviklingsmekanismen mot sin hensikt? (Will Clean Development Mechanism projects be counterproductive?) *Økonomiske analyser* (Economic Analyses) 4/2004, Statistics Norway (In Norwegian), and Glomsrød, S. and T. Wei (2005): Coal cleaning: a viable strategy for reduced carbon emissions and improved environment in China? *Energy Policy* 33 (2005), p. 525-542.

**Figure 6.8. Average per capita greenhouse gas emissions in Norway, from municipalities grouped by population size. 2001. Tonnes $CO_2$ equivalents**




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

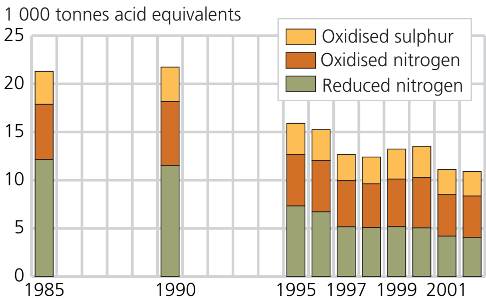
- Per capita greenhouse gas emissions average 3.6 tonnes in the ten municipalities with a population of more than 50 000 (including Oslo), and 13.0 tonnes $CO_2$ equivalents in municipalities with a population of 30 000-50 000. Per capita emissions for mainland Norway as a whole average 8.5 tonnes $CO_2$ equivalents.

- 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. Another factor of some importance is road traffic. 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.

## 6.2. Acidification

**Figure 6.9. Deposition of acidifying substances in Norway. 1985-2002**




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 2004a). A substantial proportion of Norwegian emissions is also deposited in Sweden.
- The UK, Germany and Russia are the countries outside Norway that make the largest contributions to the total deposition of acidifying substances in Norway.

**Table 6.1. Emissions and emission targets for $SO_2$ and $NO_x$ under the Gothenburg Protocol. 1 000 tonnes**

| | $SO_2$ | | | $NO_X$ | | |
|---|---|---|---|---|---|---|
| | Emissions | | Target | Emissions | | Target |
| Country: | 1990 | 2002 | 2010 | 1990 | 2002 | 2010 |
| UK | 3 721 | 1 002 | 625 | 2 771 | 1 582 | 1 181 |
| Germany | 5 326 | 611 | 550 | 2 845 | 1 499 | 1 081 |
| Russian Federation[1] | 4 671 | 2 130 | 2 343 | 3 600 | 2 566 | 2 653 |
| Sweden | 106 | 58 | 67 | 324 | 242 | 148 |
| Denmark | 77 | 25 | 50 | 283 | 200 | 127 |
| Norway | 52 | 22 | 22 | 224 | 213 | 156 |

[1] The figures apply to the European part, within the EMEP area.
Source: EMEP/MSC-W (2004 b) and UN/ECE (1999).

**Box 6.8. 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 | ØIncreases the risk of respiratory complaints. Acidifies soil and water and causes corrosion. |

[1] The table indicates important anthropogenic sources.

**Box 6.9. 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 ($NH_3$) 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.

## Box 6.10. Emissions of $NO_x$ from shipping

Emissions of nitrogen oxides from shipping in Norway are currently calculated on the basis of fuel consumption by a vessel type multiplied by a $NO_x$ factor specific for that vessel type. The sum of emissions for all vessel types gives the national emission figures.

The emission inventory needs to be improved in connection with the introduction of instruments to reduce $NO_x$ emissions from shipping. By revising the methodology, it will also be possible to reduce the uncertainty of the figures in the national emission inventory.

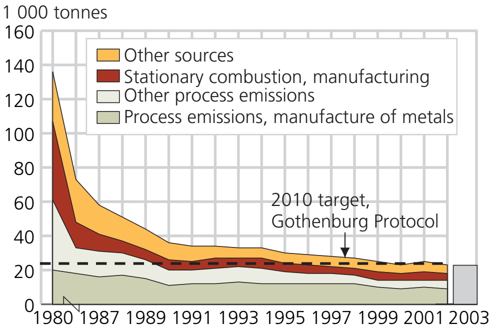
In 2003, MARINTEK and Statistics Norway were commissioned by the Ministry of the Environment to carry out a pilot project to review methods and data sources and to study the weaknesses of certain elements of the emission inventory.

The conclusions of the pilot project were:

- Today's model for the emission inventory is not well-designed for showing changes in the technological status of the fleet, regardless of which mechanisms bring about reductions in $NO_x$ emissions (improvements in new vessels or measures to reduce emissions from existing vessels). If the action taken to reduce $NO_x$ emissions is to be clearly shown in the inventory, the methodology must be revised.
- The aggregate effect of alternative sets of policy instruments can only be shown in an inventory if the methodology used is more accurate and distinguishes better between vessel and technology types.
- The effects of individual instruments must be verified by direct measurement in each case.

Read more in: Skjølsvik, K. et al. (2004): F*orprosjekt, forbedring av nasjonalt regnskap for utslipp av* $NO_x$ *fra skip*.(Pilot project, improvement of national emission inventory for $NO_x$ from shipping), Report MT28 F04-032.

**Figure 6.10. Emissions of $SO_2$ by source. 1980-2003***

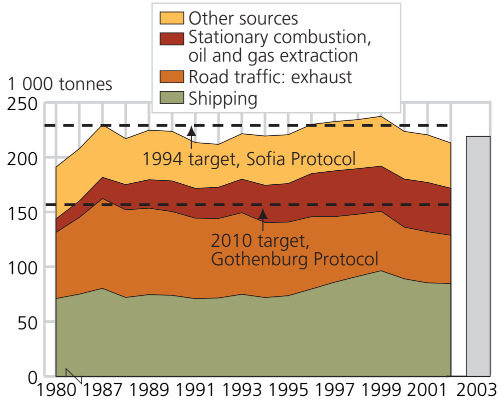



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

## Sulphur dioxide ($SO_2$)

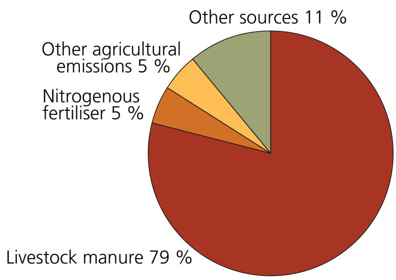
- After decreasing steadily for almost 20 years, $SO_2$ emissions increased by 3 per cent in 2003 to 22 800 tonnes. $SO_2$ emissions have been reduced by 56 per cent since 1990.
- The rise in 2003 was explained by higher sales of fuel for domestic shipping and a changeover to fuel types with a higher sulphur content. The sulphur content of the types of fuel used for shipping also rose last year. Under the Gothenburg Protocol, Norway has undertaken to ensure that its emissions do not exceed 22 000 tonnes in 2010.

**Figure 6.11. Emissions of $NO_x$ by source. 1980-2003***



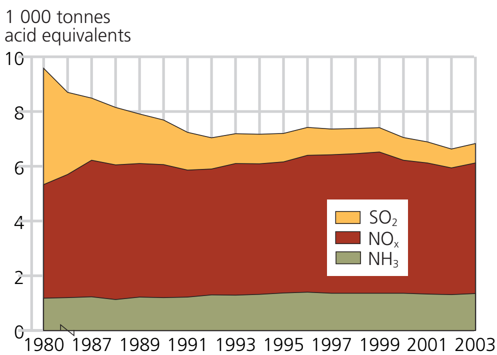

Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

**Figure 6.12. Emissions of ammonia by source. 2002*. Per cent**




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

**Figure 6.13. Emissions of acidifying substances in Norway. 1987-2003***




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

## Nitrogen oxides ($NO_x$)

- In 2003, $NO_x$ emissions totalled 220 000 tonnes, which is a rise of 3 per cent since 2002. The rise was greatest for emissions from shipping, the oil and gas industry and heating .
- The largest sources of $NO_x$ emissions are shipping (40 per cent), road traffic (21 per cent) and stationary combustion in the oil and gas industry (20 per cent).
- Total emissions must be reduced to 156 000 tonnes if Norway is to meet its commitment under the Gothenburg Protocol. Norway exceeded its emission ceiling under the Sofia Protocol in the period 1997-1999.

## Ammonia ($NH_3$)

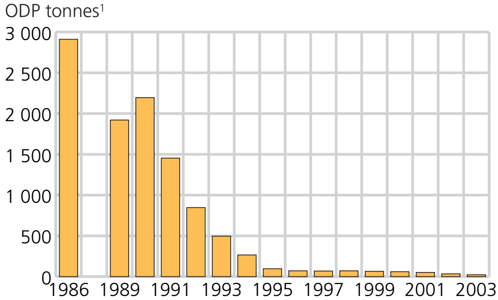
- In 2003, $NH_3$ emissions were almost unchanged from the year before at 22 900 tonnes. Under the Gothenburg Protocol, Norway has undertaken to meet an emission ceiling of 23 000 tonnes $NH_3$ in 2010.
- Agriculture generated 89 per cent of Norwegian emissions of ammonia in 2003. The main sources of ammonia emissions are livestock, the use of commercial fertiliser and treatment of straw with ammonia. The distribution of emissions by source has remained largely unchanged since the 1980s.

## Aggregate emissions of acidifying substances

- In 2003, Norway's aggregate emissions of acidifying substances, expressed as acid equivalents, amounted to 6 800 tonnes. $NO_x$ accounts for 70 per cent of the total.
- The level of emissions expressed as acid equivalents was 3 per cent higher than in 2002.
- The dispersal potential of $SO_2$ and $NO_x$ emissions is greater than that of $NH_3$ emissions.

## 6.3. Depletion of the ozone layer

**Figure 6.14. Imports of ozone-depleting substances to Norway. 1986-2003**




[1] 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.

- Norway imported a total of 23 ODP tonnes ozone-depleting substances in 2003. This is a drop of 32 per cent since 2002.
- Various HCFCs still dominate imports of ozone-depleting substances to Norway, and accounted for 94 per cent of the total (expressed as ODP tonnes) in 2003.
- It has been calculated that the thickness of the ozone layer above Oslo has been reduced by an average of 0.21 per cent per year since 1979 (Norwegian Institute for Air Research 2004b).

**Box 6.11. The ozone layer and ozone-depleting substances**

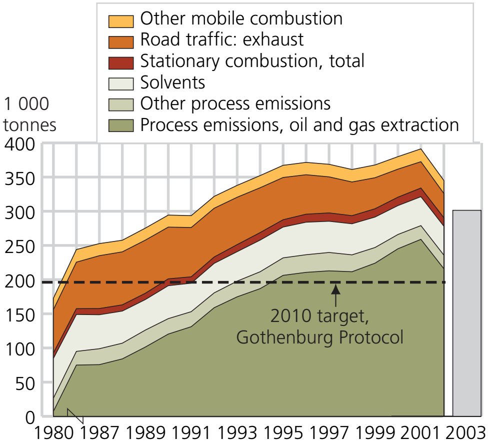
Substances that deplete the ozone layer include hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs) and other gases containing chlorine and bromine. Such gases have been used as cooling agents, propellants in aerosols and in the production of foam plastic. In new products, they are being replaced 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 CFCs, and there is a general prohibition against imports of CFCs (small quantities of CFCs are imported for necessary purposes such as laboratory analysis). 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 2004).

## 6.4. Formation of ground-level ozone

**Figure 6.15. Emissions of NMVOCs by source. 1980-2003***




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

### NMVOC

- In 2003, Norway's NMVOC emissions totalled 301 000 tonnes, which is a reduction of 13 per cent from 2002. More than half of these emissions are generated by evaporation during loading and storing of crude oil offshore. The reduction is explained by the fact that more oil is loaded at facilities with VOC recovery plants. Process emissions from the oil and gas industry were reduced by 17 per cent from 2001 to 2002.
- Other important sources are emissions from solvents (12 per cent) and road traffic (10 per cent).
- Under the Gothenburg Protocol, Norway has undertaken to meet an emission ceiling of 195 000 tonnes NMVOCs in 2010, which corresponds to a reduction of about 35 per cent from the current level.

**Box 6.12. Emissions that contribute to the formation of ground-level ozone. 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. |
| Ground-level ozone ($O_3$) | Formed by oxidation of $CH_4$, CO, NOx 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 6.13. Ozone precursors**

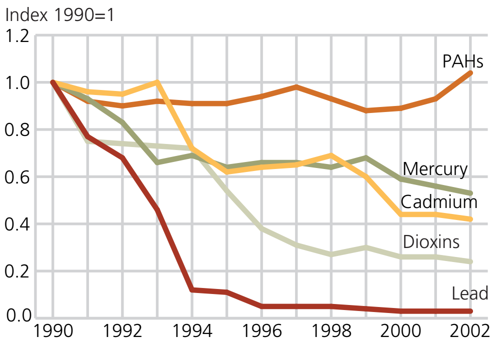
Ground-level or tropospheric ozone is formed by the oxidation of $CH_4$, CO, $NO_X$ and NMVOCs in the presence of sunlight. A weighting factor is defined for each of these precursors according to how much ground-level ozone it forms during a specific period of time. These are known as TOFP (Tropospheric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

| Substance: | TOFP factor (de Leeuw 2002): |
|---|---|
| $NO_X$ | 1.22 |
| NMVOC | 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 6 per cent in the period 1990-2003.

## 6.5. Persistent organic pollutants (POPs) and heavy metals

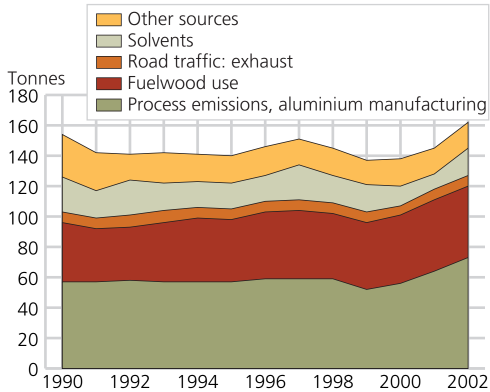
**Figure 6.16. Changes in emissions of lead, cadmium, mercury, total PAH and dioxins in Norway. Index 1990=1. 1990-2002***




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

- Emissions of POPs and heavy metals to air were substantially lower in 2002 than in 1990. The main reasons for this are the installation of equipment to control emissions and improvements in its operation, and the closure of plants in the chemical and metallurgical industry. Emissions from waste incineration have also been greatly reduced as a result of stricter emissions standards and the installation of equipment to control emissions.

**Figure 6.17. Emissions of total PAH to air by source. 1990-2002***

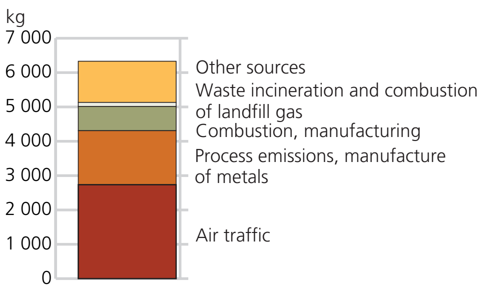



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

## PAHs

- In 2002, Norway's emissions of "total PAH" were 162 tonnes (PAH-4, which is the component regulated by the POPs Protocol under the LRTAP Convention, accounted for 16.6 tonnes of this). PAH emissions have increased by 12 per cent from 2001 to 2002.
- The largest sources of PAH emissions are fuelwood use in households and process emissions from aluminium production. These two sources accounted for 29 and 45 per cent respectively of the total in 2002. Process emissions accounted for 67 per cent of total PAH-4 emissions.
- Despite lower production, PAH emissions from aluminium production rose by 14 per cent from 2001 to 2002. This was mainly because of an accidental release of PAHs in connection with upgrading to a cleaner process at one plant.

**Figure 6.18. Emissions of lead to air by source. 2002***




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

## Lead (Pb)

- Lead emissions were reduced by 97 per cent in the period 1990 to 2002. This was mainly a result of the changeover to unleaded petrol.
- In 2002, emissions totalled 6.3 tonnes, a rise of 21 per cent from the year before. The rise was mainly due to higher sales of aviation fuel. However, it should be noted that the rise may be explained by large purchases of fuel for storage rather than by a rise in consumption in 2002.
- 43 per cent of the total is generated by domestic air transport. However, most of this (80 per cent) is emitted more than 1000 m above the ground. Process emissions from the manufacture of iron, steel and ferro-alloys accounted for 25 per cent.

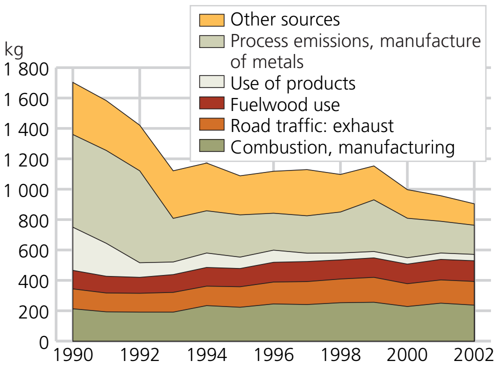
**Box 6.14. Harmful effects and sources of emissions for heavy metals, particulate matter, benzene and PAHs**

| Substance | Important sources[1] | Effects |
|---|---|---|
| Arsenic (As) | Chemical industry, pulp and paper industry, metal production and road traffic | Inorganic arsenic compounds (arsenates) 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. |
| 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. |
| Copper (Cu) | Road traffic and process industry | Liable to bioaccumulate. Some scopper compounds are acutely toxic or irritant in mammals. |
| 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 production 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 | 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 | Several are carcinogenic. 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 6.19. Emissions of mercury to air by source. 1990-2002***

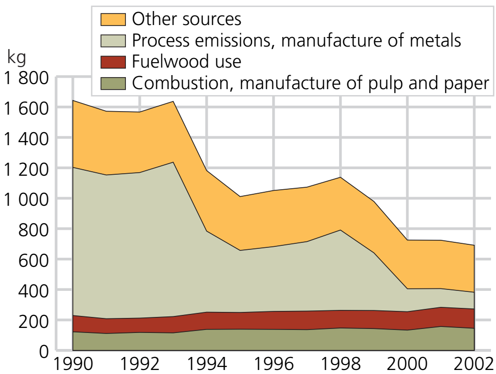



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

## Mercury (Hg)

- The largest sources of mercury emissions to air today are combustion emissions from manufacturing industries, process emissions from metal production and fuelwood use in households.
- In 2002, mercury emissions totalled 904 kg, a drop of 6 per cent from the year before.
- The drop in emissions since 1990 is mainly explained by a reduction in emissions from the manufacture of ferro-alloys, but emissions from the use of products (e.g. mercury thermometers) have also been substantially reduced.

**Figure 6.20. Emissions of cadmium to air by source. 1990-2002***

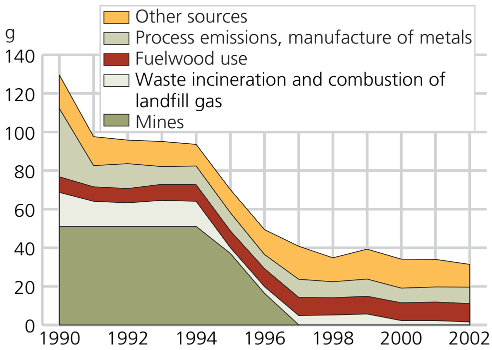



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

## Cadmium (Cd)

- In 2002, cadmium emissions totalled 691 kg, a drop of 5 per cent from the year before.
- The most important sources of cadmium emissions today are combustion of wood waste in manufacturing industries, fuelwood use by households and process emissions from metal production and the chemical industry.

**Figure 6.21. Emissions of dioxins to air by source. 1990-2002***

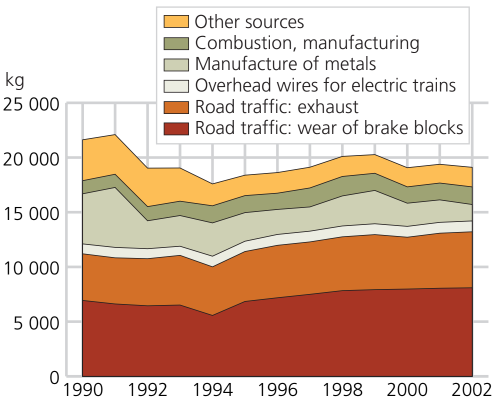



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

## Dioxins

- In 2002, emissions of dioxins totalled 31 g, a drop of 8 per cent since 2001. Most of the reduction can be explained by the closure of a wood processing plant. Emissions from waste incineration have also been cut by 30 per cent by the installation of flue gas treatment equipment. The large reduction since 1990 is mainly explained by the closure of an ore production plant in Syd-Varanger in Finnmark and the reduction of emissions from magnesium production.
- Various combustion sources now account for 55 per cent of all dioxin emissions to air, and dioxin emissions from fuelwood use by households account for 55 per cent of this. Another important source is combustion in the pulp and paper industry.

**Figure 6.22. Emissions of copper to air by source. 1990-2002***

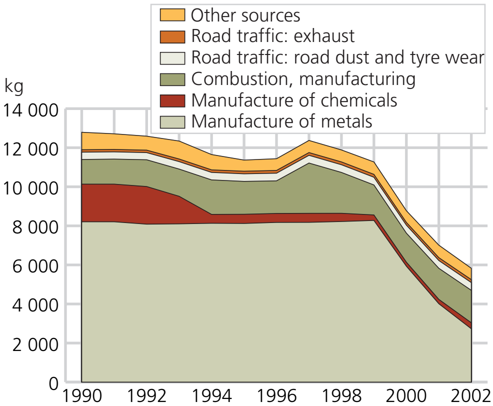



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

## Copper (Cu)

- In 2002, emissions of copper to air totalled 19.1 tonnes. Road traffic is by far the largest source of emissions. Wear of brake blocks accounted for more than 42 per cent of copper emissions in 2002, and exhaust emissions from petrol and diesel vehicles for 27 per cent. Emissions of copper from road traffic (exhaust) have risen by 20 per cent from 1990 to 2002.
- Process emissions from manufacturing and mining accounted for 10 per cent of the total in 2002. These emissions have been reduced by 12 per cent from 1990. The largest cuts have been in process industries, particularly the chemical and metallurgical industry, as a result of the reorganisation of production processes and the installation of equipment to control emissions.

**Figure 6.23. Emissions of chromium to air by source. 1990-2002***

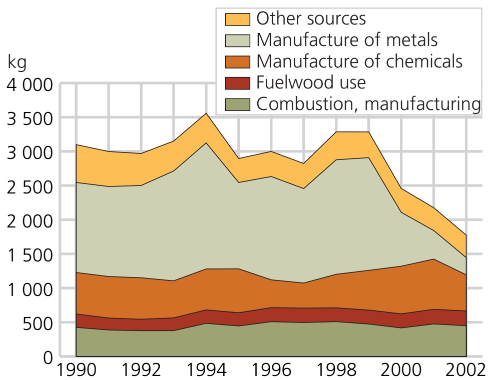



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

## Chromium (Cr)

- In 2002, emissions of chromium to air totalled 5.8 tonnes. These emissions have been reduced by 54 per cent since 1990 and 48 per cent since 1999. Cuts in emissions have been largest in the metallurgical industry, as a result of the installation of equipment to control emissions and the closure of a ferro-chromium plant. There has been little change in emissions at ground level.
- The ferro-alloy industry accounted for 47 per cent of chromium emissions. Other important sources are combustion in manufacturing industries (28 per cent) and road traffic (9 per cent). Road traffic includes road dust and wear and tear of tyres in addition to exhaust emissions.

**Figure 6.24. Emissions of arsenic to air by source. 1990-2002***




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

## Arsenic (As)

- In 2002, arsenic emissions totalled 1.8 tonnes, which is a drop of 43 per cent since 1990.
- Process emissions from carbide production are the most important source of emissions in Norway today, and made up 30 per cent of the total in 2002. Before 2000, emissions from the ferro-alloy industry dominated. Emissions from this source dropped by 85 per cent from 1999 to 2002 because one sintering plant was closed for most of this period. In 2002, they made up only 14 per cent of total emissions, as compared with 50 per cent in 1999.
- Other important sources of arsenic emissions are combustion in the pulp and paper industry and fuelwood use by households. Together, these accounted for 27 per cent of total emissions in 2002.

## Box 6.15. 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 a little more than half of all emissions of particulate matter in Trondheim in 2001 were generated by fuelwood use. In Bergen, fuelwood use accounted for 62 per cent of emissions of particulate matter in 2001. The other main source is road traffic. 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.

In autumn 2003, Statistics Norway carried out a comprehensive survey of fuelwood use in Trondheim and Bergen. This showed that 7 000 households in Trondheim and 8 600 households in Bergen had replaced old, polluting wood-burning stoves with new, less polluting stoves since 1998. The calculations show that emissions would have been about 25 per cent higher in 2002-2003 if none of the old wood-burning stoves had been replaced since 1998.

The survey showed that more people used wood-burning stoves and open fireplaces in winter 2002-2003 than in 2001-2002. In Bergen, there was a 6 per cent rise in the number of households using stoves and fireplaces for heating: in Trondheim, there was a 4 per cent rise. Of those who used these heat sources in 2002-2003 but not in 2001-2002, 29 per cent in Bergen and 54 per cent in Trondheim used new wood-burning stoves. The households who only used them in 2002-2003 include both those who had installed a new stove where there was none before, and those who already had stoves that were not in use the year before. If a rise in electricity prices and/or colder winters encourage people to use wood-burning stoves, the impact on pollution will be greatest in areas where there is a high proportion of old wood-burning stoves, which emit more particulate matter than new stoves.

There is still room for large reductions in emissions in Trondheim and Bergen. If all the old wood-burning stoves were replaced, emissions of particulate matter from this source would be reduced by a further 70 per cent, or 400 tonnes, provided that fuelwood consumption remained constant and the proportions burned in stoves and open fireplaces remained unchanged.

Fuelwood use in wood-burning stoves and open fireplaces has been calculated by means of a questionnaire-based survey. The calculations combine figures for fuelwood consumption with emission factors for Norwegian wood-burning stoves and open fireplaces. The survey will be used to improve the model-based calculations that are used to monitor progress towards the authorities' target for local air quality.

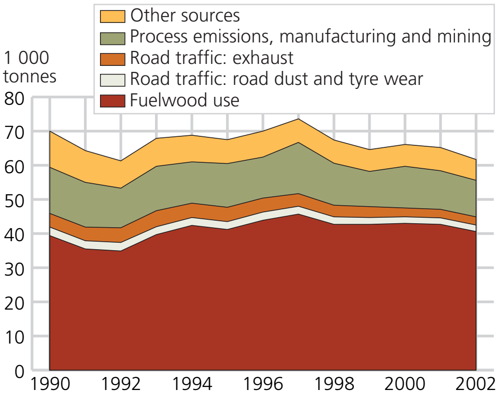
Read more in:

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, and 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.

## 6.6. 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

**Figure 6.25. Emissions of particulate matter ($PM_{10}$) to air by source in Norway. 1990-2002***

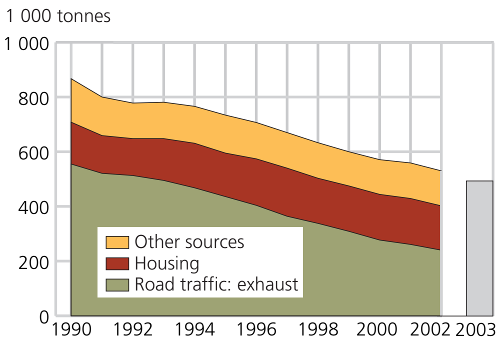



Source: Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

### 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 2002 were 77 100 tonnes, 61 600 tonnes and 55 300 tonnes respectively.
- Emissions from fuelwood use are the largest source of particulate matter, and accounted for 66 and 73 per cent respectively of emissions of $PM_{10}$ and $PM_{2.5}$ in 2002. For these two fractions, the next most important source of emissions is metal production.

**Figure 6.26. Emissions of carbon monoxide in Norway. 1990-2003***




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

### Carbon monoxide

- In 2003, emissions of carbon monoxide to air totalled 494 000 tonnes.
- The largest sources of CO emissions are road traffic and heating of housing, especially with fuelwood, and these accounted for 45 and 31 per cent respectively of the total in 2002.
- Since 1990, emissions of CO have been reduced by 43 per cent. The main reason is reduced emissions from road traffic due to catalytic converters in cars.

**More information:** Gisle Haakonsen, Ketil Flugsrud, Britta Hoem and Kristin Aasestad.

## Useful websites

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/
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/

## References

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 (2004): http://org.eea.eu.int/documents/newsreleases/tec2-2004-en (15.07.04)

EMEP/MSC-W (2004a): *Transboundary air pollution by main pollutants (S, N, $O_3$) and PM. Norway* MSC-W Data Note 1/2004, Norwegian Meteorological Institute. http://www.emep.int/reports/2004/Country_Reports/report_NO.pdf

EMEP/MSC-W (2004b): *Inventory Review 2004. Emission Data reported to CLRTAP and under the NEC Directive. EMEP/EEA JOINT REVIEW REPORT* . ISSN 0804-2446 http://www.emep.int/reports/2004/emep_technical_1_2004.pdf. Norwegian Meteorological Institute.

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.

Flugsrud, K., E. Gjerald, S. Holtskog, H. Høie, G. Haakonsen, K. Rypdal, B. Tornsjø and F. Weidemann (2000): *The Norwegian emission inventory*. Reports 2000/1, Statistics Norway and Norwegian Pollution Control Authority.

Glomsrød, S. and T. Wei (2005): Coal cleaning: a viable strategy for reduced carbon emissions and improved environment in China? *Energy Policy* 33 (2005), p. 525-542.

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.

IPCC (2001): *Third Assessment Report. Summary for Policymakers*. http://www.ipcc.ch/pub/un/syreng/spm.pdf, Intergovernmental Panel on Climate Change.

Norwegian Institute for Air Research (2004a): *Overvåking av langtransportert forurenset luft og nedbør, Atmosfærisk tilførsel, 2003* (Monitoring of long-range transport of polluted air and precipitation, atmospheric inputs, 2003). Report 903/2004.

Norwegian Institute for Air Research (2004b): *Overvåking av ozonlaget og naturlig ultrafiolett stråling. Årsrapport 2003* (Monitoring of the ozone layer and natural ultraviolet radiation). Report 905/04.

Norwegian Pollution Control Authority (2004): State of the environment Norway. http://www.environment.no/

Skjølsvik, K., Ø. Buhaug, O.A. Bergh, G. Haakonsen, K. Flugsrud and K. Aasestad (2004): *Forprosjekt, forbedring av nasjonalt regnskap for utslipp av* $NO_x$ *fra skip* (Pilot project on improvement of the national inventory of $NO_x$ emissions from shipping). Report MT28 F04-032. MARINTEK, Trondheim.

SSB/SFT/DN (1994): *Naturmiljøet i tall 1994* (The natural environment in figures 1994). Oslo: Scandinavian University Press.

UN/ECE (1999): New air pollution protocol to save lives and the environment. Press Release 24, November 1999. http://www.unece.org/press/99env11e.htm, United Nations/Economic Commission for Europe.

UNFCCC (2003): Greenhouse gas inventory database (GHG) http://ghg.unfccc.int/default1.htf?time=08%3A47%3A37+AM (23.05.2003)

# 7. Waste

**The total quantities of waste generated in Norway are rising, but strict emission standards and new technology have resulted in large reductions in many of the emissions associated with waste management. The environmental and social impacts of waste depend partly on how it is managed. Waste can cause health and environmental problems, but sound management can both provide useful resources and reduce the environmental problems. However, hazardous waste that is not dealt with through the proper channels is still considered to be a substantial problem.**

Waste consists of anything that is discarded after production and consumption. Various problems arise if waste is not managed appropriately, including pollution of soil and water, greenhouse gas emissions, health problems, littering and locally, unpleasant smells. One of the objectives of Norway's legislation on waste management is to prevent such problems from arising. The authorities also 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.) has been introduced. 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.

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. Detailed reports on such waste are also required to ensure control of the waste stream. Nevertheless, in 2003 almost 13 per cent of the hazardous waste generated was dealt with outside the hazardous waste management system, and some of this may in the worst case have been dumped in the environment.

In 2003, about 8.8 million tonnes of waste was generated in Norway, including 800 000 tonnes of hazardous waste. The percentage rise in waste generation was larger for households than for other sectors that generate large quantities of waste. Every Norwegian generated an average of 365 kg waste in 2003. This is 11 kg more than the year before, but nevertheless lower than in many comparable countries. A large proportion of what is discarded can be re-used, or can be processed to manufacture new products (material recovery) or used as a source of energy. In 2003, about 71 per cent of the total amount of waste for which we have information on the form of treatment or disposal was recovered. The Government's objective is to increase this proportion to 75 per cent by 2010.

## 7.1. Some environmental problems related to waste management

**Table 7.1. Emissions from waste incineration and landfills. Percentages of total Norwegian emissions in 2002 and change since 1990**

| | Percentage of total Norwegian emissions | Percentage change since1990 |
|---|---|---|
| **Incineration plants:** | | |
| Quantity of waste incinerated | | + 51 |
| Sulphur dioxide | 0.9 | - 47 |
| Nitrogen dioxide | 0.5 | + 6 |
| Carbon dioxide | 0.4 | + 50 |
| Particulate matter, $PM_{10}$ | 0.0 | - 99 |
| Lead | 1.9 | - 93 |
| Cadmium | 1.8 | - 86 |
| Mercury | 7.1 | - 62 |
| Arsenic | 0.4 | - 94 |
| Chromium | 0.9 | - 81 |
| Copper | 0.3 | - 74 |
| Total PAH | 0.5 | - 46 |
| Dioxins | 4.9 | - 91 |
| NMVOCs | 0.1 | + 46 |
| **Landfills:** | | |
| Methane (greenhouse gas)[1] | 7.2 | +1 |
| 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 heavy metals, PAHs and dioxins from waste incineration have dropped steeply since 1990, even though more waste is being incinerated.
- Emissions from waste incineration plants account for only a small proportion of national emissions. For example, emissions of cadmium, mercury and dioxins from fuelwood use are 3-4 times higher than those from waste incineration (see Chapter 6 Air pollution and climate change).
- Emissions of methane (a greenhouse gas) from rotting waste in landfills make a substantial contribution to Norway's total emissions. In 2002, methane emissions totalled 327 385 tonnes, and landfills accounted for 56 per cent of this, or about 7 per cent of Norway's aggregate greenhouse gas emissions.
- 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 small compared with those from other sources. The figures for leachate are uncertain, and recent surveys indicate that discharges of leachate from landfills may be larger than previously assumed (Norwegian Pollution Control Authority 2004b).

**Box 7.1. 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. This means that poor management of waste streams can result in environmental damage that in some cases is both serious and long-lasting, whereas good management helps to optimise the supply of resources and at the same time reduce extraction of virgin raw materials.

If organic waste is landfilled, it generates emissions of the greenhouse gas methane. Methane emissions from landfills account for 7 per cent of Norway's greenhouse gas emissions (measured as $CO_2$ equivalents) and contribute to global warming (see table 7.1). 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.

Composting is an environmentally sound method of treatment for wet organic waste, including park and garden waste, provided that it is successful. The main emissions are water vapour and CO2. If the process is unsuccessful, on the other hand, anaerobic conditions may develop in the compost, giving rise to unpleasant smells (for example from hydrogen sulphide) and leachate. Such problems may arise when a new composting system is being started up and before it is operating properly. They 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, 73 per cent of the heat generated by Norwegian incineration plants was utilised in 1999. 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 6). 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 that is not dealt with appropriately is a serious environmental problem. Some of the more common types of hazardous waste are *PCBs (polychlorinated biphenyls), waste oil, solvents and brominated flame retardants.*

*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. Their acute toxicity is not very high, but chronic exposure to PCBs, even at relatively low concentrations, can impair reproduction, disturb behavioural patterns, weaken the immune system and cause cancer (Thorsen 2000). 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 also includes paints, and may also contain both heavy metals and POPs. 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, for example in electronic circuit boards, textiles and fittings for vehicles, to prevent fire. 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 them in human breast milk have risen by a factor of 50 in the last 25 years. Some of them are suspected to be endocrine disruptors and to impair reproduction. The annual global consumption of brominated flame retardants is estimated at 200 000 tonnes (National Institute of Public Health 2002). 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 7.2. 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. The Norwegian General Standardizing Body 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 (the Y-list) and the Basel Convention have their own waste classification systems.

In the Pollution Control Act, waste has until now been 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. Industrial waste has 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. The term municipal waste is now in limited use in Norway, but is still used internationally, for example in various sets of environmental indicators.

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 7.3. 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:** Ordinary waste, including large items such as fittings and furnishings from private households, shops, offices, etc.

**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.

**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**: Waste from normal activities in private households.

**Industrial waste**: Waste generated by economic activities, both private and public. 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 above) 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 commercial activities and services which is significantly different in type or amount from consumer waste. Includes all waste that is not classified as consumer waste or hazardous 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.

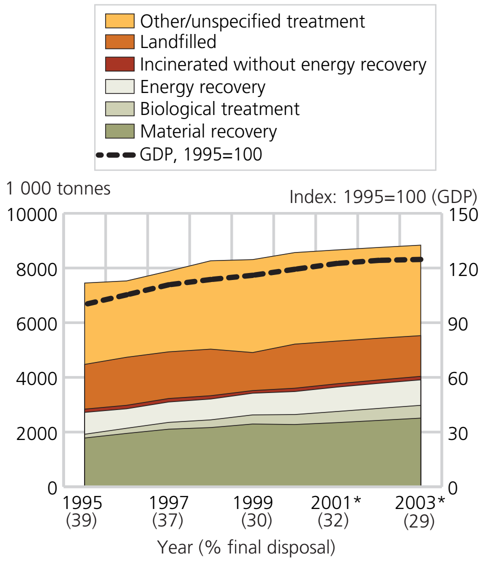
**Waste management**: Usually defined to include all operations from the moment when an object or substance is discarded until all treatment, recovery and disposal operations are completed.

**Waste recovery**: Includes re-use, material recovery, incineration combined with energy use and composting.

**Wet organic waste**: Readily degradable organic waste, e.g. food waste and slaughterhouse waste. Park and garden waste is included in wet organic waste in the waste accounts unless otherwise specified.

## 7.2. Waste accounts for Norway

**Figure 7.1. Waste quantities in Norway 1995-2003* according to method of recovery or disposal (1 000 tonnes) and GDP 1995-2003 (percentage change, 1995=100)**




Source: Waste accounts and national accounts, Statistics Norway.

### Waste quantities and form of treatment/disposal

- Preliminary figures show that from 1995 to 2003, annual waste generation rose from less than 7.5 to more than 8.8 million tonnes, a rise of 19 per cent. In the same period, GDP grew by 25 per cent. The rise in waste generation was considerably larger than population growth, which was 5 per cent in the same period.
- The quantity of waste delivered for final disposal dropped from 39 to 29 per cent of the waste for which we have information on the form of treatment or disposal. In 2003, treatment/disposal was unknown for 37 per cent of the total quantity of waste generated. 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.

## Box 7.4. Waste accounts and projections of waste quantities

**Waste accounts**
The waste accounts are being developed on the basis of traditional principles for natural resource accounting, 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
- product type
- source
- form of treatment/disposal

As a general principle, existing data sources such as statistics on external trade, production and waste have been used wherever possible, and new costly investigations have thus been avoided so far.

Two different methods have been 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 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.

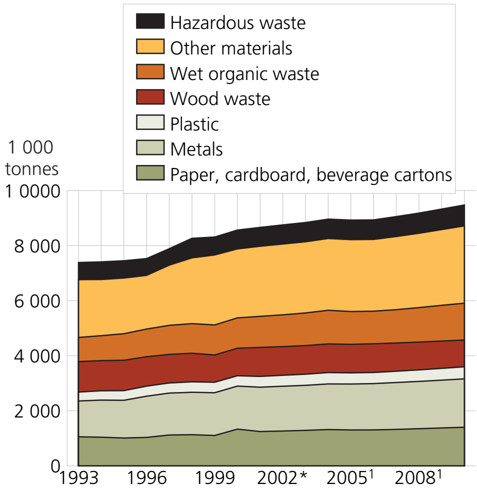
**Projections of waste quantities**
SSB har ved noen tidligere anledninger framskrevet avfallsmengdene i Norge på grunnlag av avfallsstatistikk oStatistics Norway has made projections of waste quantities in Norway several times previously, on the basis of waste statistics and economic projections in the macroeconomic model MSG (see Bruvoll and Spurkland 1995, Bruvoll and Ibenholt 1999, and Ibenholt 1999). In winter 2002-2003, Statistics Norway was commissioned by the Norwegian Pollution Control Authority to calculate projections of quantities of organic waste up to 2020 on the basis of projections of gross production and consumption in various sectors (Bruvoll and Skullerud 2004), using the macroeconomic model MODAG (Statistics Norway 2002) and waste statistics from the waste accounts. These projections have since been expanded to include all types of waste. The calculation method used was described in *Natural Resources and the Environment 2003*. Norway.

The results show that we can expect waste quantities to grow by about 8 per cent from 2002 to 2010. Household waste will account for about half of this growth, whereas the quantity of waste from manufacturing will hardly rise at all. Of material types, the organic fractions textiles, wet organic waste and paper are likely to increase most. These results are based on the assumption that the relationship between production and waste quantities will remain unchanged in the next ten years.

In other words, expected or possible changes in definitions or the introduction of policy instruments that will influence the relationship between production and waste quantities have not been taken into account in the calculations.

For more information, see: http://www.ssb.no/english/subjects/01/05/40/avfregno_en/

**Figure 7.2. Waste quantities in Norway, 1993-2003*. Projections for 2004-2010. By material. 1 000 tonnes**

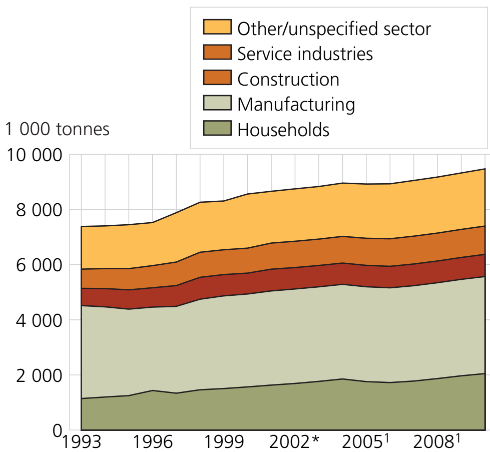



[1] Projections.
Source: Waste statistics, Statistics Norway.

## Materials in waste

- Waste quantities are rising each year. The most rapidly-growing fractions are paper, wet organic waste and textiles, which are largely found in household waste.
- If this trend continues, total waste generation will exceed 9 million tonnes in 2007, but waste generation will grow less than Statistics Norway's prognoses for GDP growth in the same period.
- Only wood and glass waste of the waste fractions specified in the waste accounts are expected to show a drop in the period up to 2010. For wood waste, this can probably be explained by lower activity in the wood and wood products industry.
- The category "other materials" includes organic and inorganic sludge, slag, rubber, glass, china and ceramics, and dust, but not soil, gravel, etc.

**Figure 7.3. Waste quantities in Norway, 1993-2003*. Projections 2004-2010. By source. 1 000 tonnes**

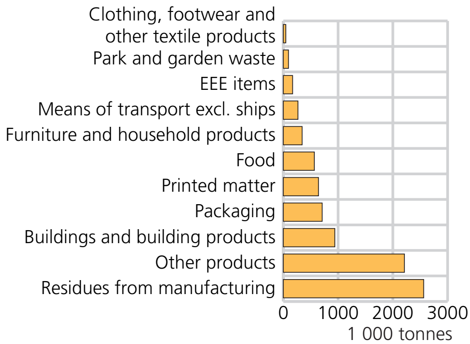



[1] Projections.
Source: Waste statistics, Statistics Norway.

## Sources of waste

- The quantity of household waste has risen more rapidly than consumption, and today this category accounts for about 20 per cent of the total quantity of waste. If this trend continues, the percentage will rise to almost 22 per cent in 2010.
- For waste from other sectors, the relationship between economic developments (measured as GDP) and waste generation is less clear or uncertain.
- Manufacturing waste accounted for 39 per cent of the total in 2003. Of this, more than 80 per cent was production waste.

**Figure 7.4. Waste by product type. 2000**



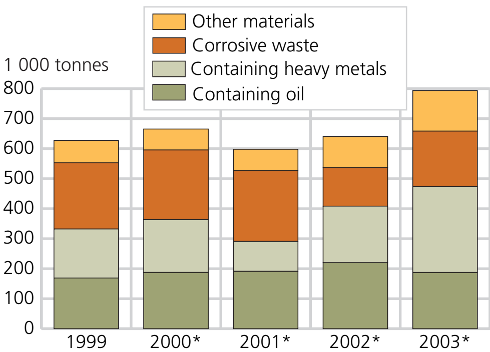

Source: Waste statistics, Statistics Norway.

### Product types

- The quantities of all fractions of waste by product type rose from 1995 to 2000.
- The product types *park and garden waste, packaging, means of transport* and *printed matter* rose most steeply from 1995 to 2000. For park and garden waste, only the proportion delivered is included. Ships of gross tonnage exceeding 100 t and large constructions are not included in the statistics.
- The category *other products* includes large quantities of hazardous waste and metal piping that has been used as oil and gas pipelines, etc.
- *WEEE* (waste electrical and electronic equipment) makes up only 2 per cent of the total, but often contains substances that are classified as hazardous waste.

## 7.3. Hazardous waste

**Figure 7.5. Hazardous waste by material. 1999-2003***

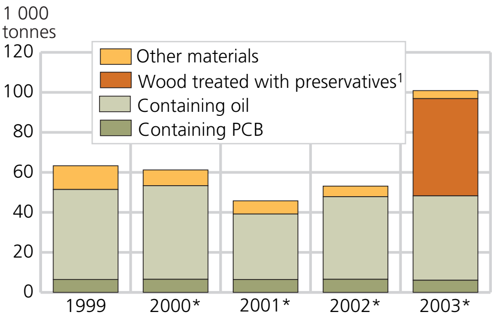



Source: Waste statistics, Statistics Norway.

### Origin and materials

- Of the total quantity of 794 000 tonnes of hazardous waste, 693 000 tonnes was dealt with through the proper registered channels in 2003.
- About 2/3 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.
- From 1 January 2003, the Norwegian list of hazardous wastes was expanded. For example, wood treated with preservatives (annual quantity of waste about 50 000 tonnes) is now classified as hazardous.

**Figure 7.6. Hazardous waste dealt with outside the proper channels, by material. 1999-2003***




[1] New category 1 January 2003.
Source: Waste statistics, Statistics Norway.

## Unknown treatment/disposal method

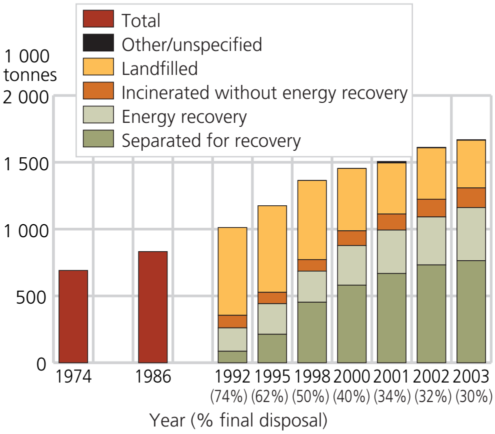
- About 100 000 tonnes of hazardous waste - 13 per cent of the total - was dealt with outside the proper channels in 2003.
- About half of this is wooden materials treated with preservatives, which are classified as hazardous waste from 1 January 2003. However, new studies indicate that wood treated with preservatives can be incinerated at ordinary incineration plants without an increase in emissions of hazardous substances.
- Waste containing PCBs that is not dealt with through the proper channels is a serious environmental problem. About 6 000 tonnes of such waste, corresponding to 10 tonnes of pure PCBs, was dealt with outside the proper channels each year in the period 1999-2003. Most of this consisted of insulating windows from the 1960s and 1970s. Only 15 per cent of these windows were collected and dealt with appropriately in 2003.

**Box 7.5. 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 by hazardous waste transport firms, 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, and the arrangements apply to almost 20 per cent of all hazardous waste that is generated.Some companies hold permits to export hazardous waste. In 2003, about 2 per cent of all hazardous waste was exported, most of this by companies in the petroleum extraction and manufacturing sectors. Hazardous waste that is dealt with without being reported to the authorities is considered to be dealt with outside the proper channels. In 2003, this applied to about 100 000 tonnes of hazardous waste. Some of this was probably in fact handled at approved facilities, but not reported to the authorities as required, while the rest was treated and/or disposed of illegally, and may in the worst case have been dumped in the environment.

## 7.4. Household waste

**Figure 7.7. Household waste by method of recovery or disposal. 1974-2003**




Source: Waste statistics, Statistics Norway.

### Quantities and methods of disposal

- In 2003, per capita generation of household waste was 365 kg, 130 kg more than in 1992 and 11 kg more than in 2002.
- In 2003, 764 000 tonnes of household waste, or 46 per cent of the total, was separated for recovery.
- After a rise in the quantity of waste landfilled the previous year, there was a small drop (27 000 tonnes) in 2003, and the quantity landfilled was 357 000 tonnes.

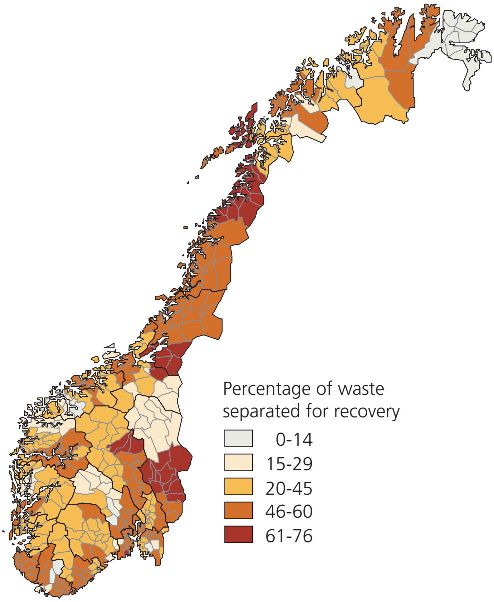
**Box 7.6. Legislation relating to waste management in Norway**

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 7.8. Percentage of household waste separated for recovery, by municipality. 2003**



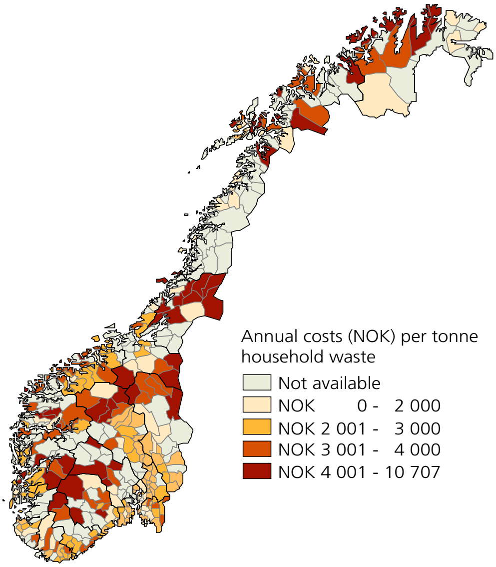

Source: Waste statistics, Statistics Norway.

## Waste recovery

- In 2003, each person in Norway separated 167 kg of household waste for recovery, 6 kg more than in 2002. The proportion of household waste delivered for final disposal (incineration without energy recovery and landfilling) in 2003 was 30 per cent.
- The highest proportions of household waste were separated in Hedmark and Nord-Trøndelag counties, 67 and 60 per cent respectively. The percentage increase in household waste separation was highest in Finnmark, where it rose from 15 per cent in 2002 to 32 per cent in 2003.
- In 2003, the largest fractions of separated waste were paper and board and wet organic waste (food waste). These materials accounted for 34 and 19 per cent respectively of the total separated. Plastic accounted for only 1 per cent of the total. However, new technology has made it possible to separate different types of plastic automatically.
- More and more municipalities are introducing collection schemes for separated waste. In 2003, 382 municipalities had collection schemes for paper and 335 for wet organic waste. Only 2 per cent of the population lived in areas with no collection scheme for separated waste in 2003. In these areas, only the residual waste is collected, and people must deliver separated waste to collection points themselves.

## 7.5. Financial situation in the municipal waste management system

**Figure 7.9. Annual costs per tonne of household waste, by municipality. 2003**




Source: Environmental protection expenditure statistics, Statistics Norway

### Waste management costs not fully covered by fees

- In 2003, the average annual costs per tonne of household waste collected were NOK 1 958.
- The overall costs incurred by the municipalities in managing consumer waste in 2003 were NOK 3.2 billion.
- In the same year, the municipalities charged a total of NOK 2.9 billion in waste management fees.
- This means that 91 per cent of the costs were covered by fees (see Appendix, table G9).
- The average annual fee per subscriber for household waste was NOK 1 774 in 2004.
- 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. Since the municipalities to a large extent purchase waste management services externally, there is little investment in the municipal waste management sector.
- In 2003, the municipalities invested NOK 92 million in the municipal waste management sector. This means that investments dropped by nearly half (46 per cent) from the year before.

**More information:** Eva Vinju, Håkon Skullerud, and Robert Straumann (financial data).

## 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 95/8, 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 organic waste amounts 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 (2002): Tema: Miljøforurensninger. Bromerte flammerhemmere. (Brominated flame retardants) http://www.folkehelsa.no/tema/miljoforu/bromflam.html. 31/8-2002.

Norwegian Labour Inspection Authority (2002): Arbeidsmiljø – HMS: Faktaside om løsemidler (*Fact sheet on organic solvents*). http://www.arbeidstilsynet.no/info/tema/losemidler.html

Norwegian Pollution Control Authority (1992): *Miljøbelastninger forårsaket av fyllinger* (The environmental impact of landfills), Report No. 92:23.

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 (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.

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 (2004a): Ikke egen returordning for impregnert tre (Waste collection and recovery scheme for wood impregnated with preservatives not to be introduced now) http://www.sft.no/nyheter/dabafile11673.html ,18.062004.

Norwegian Pollution Control Authority (2004b): Miljøgifter fra gamle avfallsdeponi (Hazardous substances from old waste deposit sites). http://www.sft.no/nyheter/dbafile12060.html ,17.09.2004.

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. 24 (2000-2001) to the Storting: *The Government's environmental policy and the state of the environment in Norway.* Ministry of the Environment.

Statistics Norway (2001): (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.

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.

# 8. Water resources and water pollution

**As water resources are used in almost all forms of economic activity and are vulnerable to over-exploitation and degradation, it is important to monitor developments. In many parts of the world, there is a growing shortage of clean water supplies, due to the increasing withdrawal of water for industrial, household, agricultural and mining and quarrying purposes, and discharges of waste water and environmentally hazardous substances. Although the overall situation in Norway is good as regards both quantity and quality, there can be substantial problems at the local level.**

Drinking 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 Water Works Register show that water quality was satisfactory in 454 (58 per cent) of a total of 779 water works in 2003 (Norwegian Institute of Public Health 2004a). The quality of drinking water supplied by some private and small municipal water works, particularly in the north, is still unsatisfactory. There are many reasons for this. Even though the regulations require that all water from surface water sources shall be disinfected, many 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 Control Authority 2003).

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.

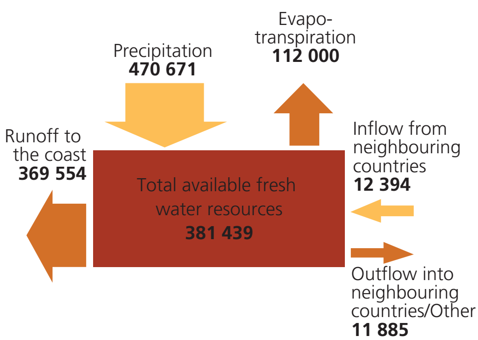
Discharges of phosphorus and nitrogen from the waste water treatment sector have been a matter of concern for many years, because these plant nutrients play an important role in the eutrophication of rivers, lakes and coastal areas. Eutrophication causes excessive growth of algae and oxygen depletion. Agriculture and aquaculture 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.

## 8.1. Availability and consumption of water

**Figure 8.1. Annual available water resources in Norway. Average 1961-1990. Million m$^3$**

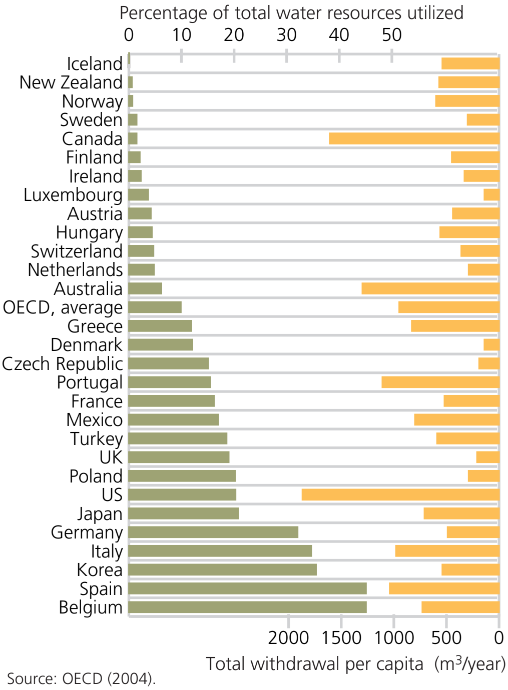



Source: Based on data from the Norwegian Water Resources and Energy Directorate and the Norwegian Meteorological Institute.

### Available water resources

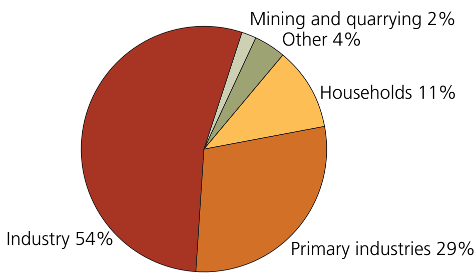
- Renewable water resources in Norway in a normal year total about 381 billion m$^3$.
- 97 per cent of the annual input of water resources is in the form of precipitation, while the remainder is in the form of incoming water flows via rivers from our three neighbouring countries.
- About 79 per cent of the annual input of water drains to the sea and to neighbouring countries through watercourses and run-off. The rest evaporates.

**Figure 8.2. Percentage of total water resources utilized and withdrawal per inhabitant in OECD countries at the turn of the century**




Source: OECD (2004).

**Figure 8.3. Total water consumption by sector. 1999 or latest year for which figures are available**




Source: Provisional figures from Statistics Norway.

## Water withdrawal and consumption

- Only 0.7 per cent of the water resources available each year in Norway is utilized (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 utilize 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 withdrawn annually per inhabitant in Norway. This is well below the average for the OECD countries (910 m$^3$). The average American uses 1 790 m$^3$, while an inhabitant of Denmark uses 130 m$^3$.
- A total of about 3 130 million m$^3$ of water is used annually in Norway. The largest share, just under 1 700 million m$^3$, is used in manufacturing. The sectors that utilize most are the wood processing industry, the food processing industry and the petrochemical industry.
- Over 340 million m$^3$ is used by households. Approximately 90 per cent of this amount is supplied by public water works. Manufacturing industry and the primary industries (agriculture, forestry and fish framing) largely meet their water needs from their own sources.

**Box 8.1. 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 secondary EU directives of importance to water resource management, including the Urban Waste Water Treatment Directive (see Box 8.3). 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 evironmental 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. Each river basin district shall also have a management plan, which shall include the following:

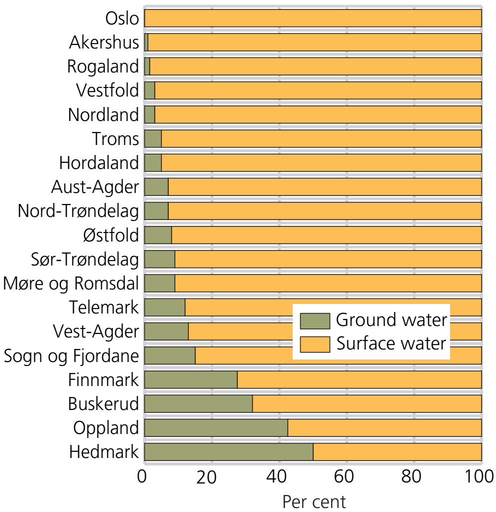
- environmental objectives
- action plans (programmes of measures) for the bodies of water
- description of the river basin
- impact of human activity
- protected areas (e.g. designated protected areas, recreation areas, areas defined as a result of other directives)
- the results of the monitoring of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

These management plans shall be produced for all river basin districts by 2009. With regard to Norway, the progress of the various processes and developments in relation to water bodies shall be reported to the EFTA Surveillance Authority (ESA). The requirements and objectives of the directive shall be achieved by 2015.

Sources: The Norwegian Pollution Control Authority (*www.sft.no/arbeidsomr/vann/vanndirektiv/*), the Norwegian Institute for Water Research *(www.vanndirektivet.no*) and the Water Framework Directive (*europa.eu.int/comm/environment/water/water-framework/index_en.html*).

## 8.2. Public water supplies

**Figure 8.4. Percentage of population connected to municipal water works using various sources of drinking water. By county. 2002**

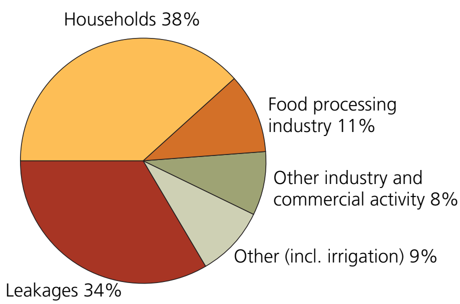



Source: National Institute of Public Health (2004b).

### Water sources

- In 2002, about 90 per cent of Norway's population was served by public water supplies from about 1 700 water works. These water works, which include municipal, intermunicipal and privately-owned water works, are subject to reporting requirements and registered in the Water Works Register of the National Institute of Public Health. The remaining 10 per cent of the population was supplied by smaller water works or from their own water sources.
- In 2002, 65 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 2002 had the highest percentage of the population connected to water works using groundwater as their source were Hedmark and Oppland.

**Figure 8.5. Percentage of public water supplies used by various sectors[1]. 2002**

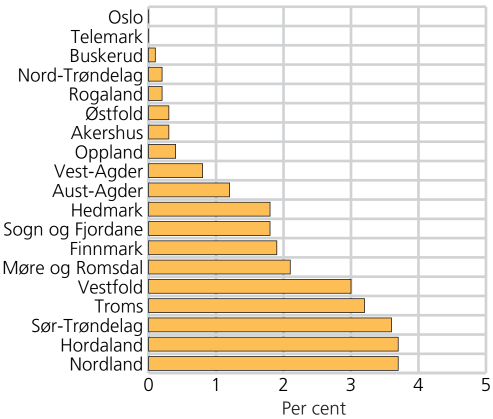



[1] The figure is based on 2002-data for 1182 water works. These water works supplied 3.0 million persons.
Source: National Institute of Public Health (2004b).

### Production and consumption of water

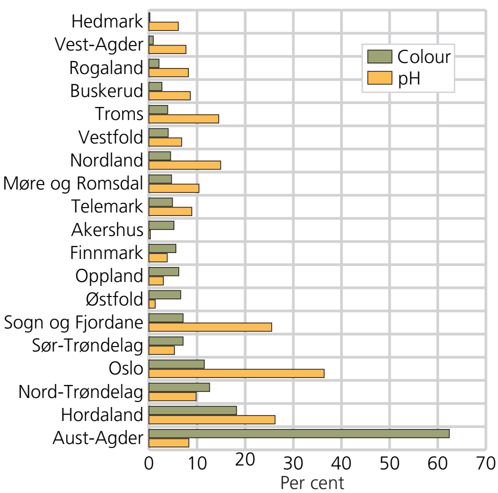
- In 2002, water production at Norwegian water works was calculated to be 808 million m³, with households using 38 per cent of this total.
- About a third of the water produced was lost due to leakages from pipelines and joints.
- Average household consumption is estimated at 197 litres per person per day.
- There is substantial uncertainty associated with these figures as they are largely based on estimates from the water works.

**Figure 8.6. Percentage of samples from public water works that do not satisfy the requirements with respect to content of thermo-tolerant pathogenic bacteria. By county. 2002**




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

**Figure 8.7. Percentage of samples from public water works that do not satisfy the requirements with respect to pH and colour. By county. 2002**




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 and 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 2002, the highest percentages of unsatisfactory samples were recorded in the counties of Nordland, Hordaland and Sør-Trøndelag.
- Acidic water corrodes pipelines and can result in high metal content levels 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 number of water works in densely populated areas in Eastern Norway are finding it difficult to meet the acidity and colour requirements.
- 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.

### Box 8.2. Concepts related to nutrient inputs to coastal areas and inland waters

**North Sea Agreements**
The North Sea Agreements refer to 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.

**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 that is rich in nutrients and very productive biologically is called eutrophic, while water that is poor in nutrients and unproductive is termed oligotrophic. 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.

**Box 8.3. The Urban Waste Water Treatment Directive**

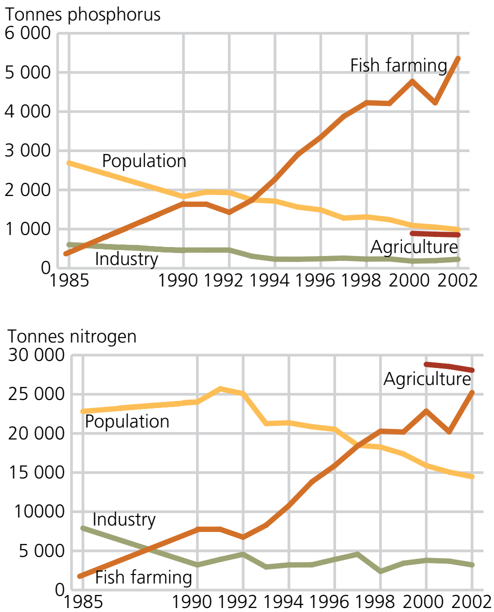
The objective of the Urban Waste Water Treatment Directive (EU Council Directive of 21 May 1991 concerning urban waste water treatment, 91/271/EEC, amended by Directive 98/15/EEC) is to protect people and the environment from the adverse effects of waste water discharges. Waste water from human activities generally contains nitrogen, phosphorus, organic substances, microorganisms 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 2000 for discharges to inland water bodies and river estuaries and more than 10 000 p.e. for discharges to coastal waters. The requirements shall be met at the latest by 31 December 2005. The Urban Waste Water Treatment Directive sets out a general requirement for secondary treatment (see box 8.4), 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 8.4) 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 (Norwegian Pollution Control Authority 2004).

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.

## 8.3. Inputs of nutrients to coastal areas

**Figure 8.8. Inputs[1] of phosphorus and nitrogen to the Norwegian coast, by sector. 1985-2002**

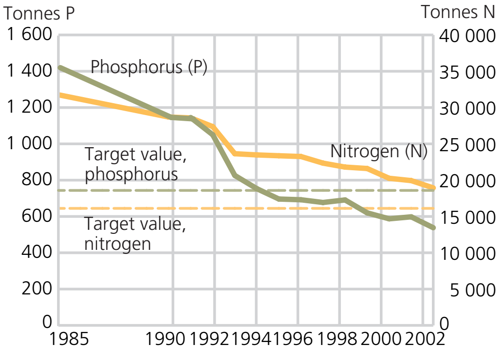



[1] Inputs from agriculture have not been modelled for data sets prior to 2000.
Source: Norwegian Institute for Water Research (2003).

### The Norwegian coast

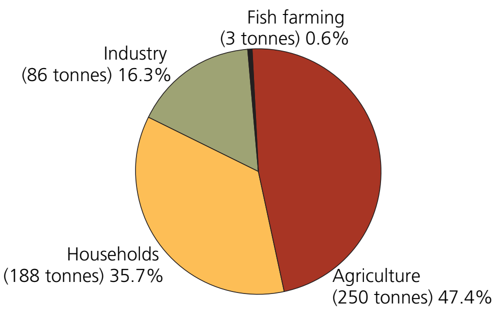
- In the period from 1985 to 2002, the total anthropogenic inputs of phosphorus and nitrogen to the coast increased by an estimated 60 and 25 per cent respectively
- Due to the development of the fish farming industry along the coast from the county of Rogaland and northwards, the discharges from this industry have increased substantially since 1985. In 2002, phosphorus discharges were 5 000 tonnes higher and nitrogen discharges 23 500 tonnes higher than in 1985. Today, this industry accounts for 72 per cent of phosphorus inputs and 36 per cent of nitrogen inputs to coastal areas.
- In 2002, agriculture was the largest source of nitrogen run-off to the Norwegian coast, and accounted for about 40 per cent of the anthropogenic inputs.

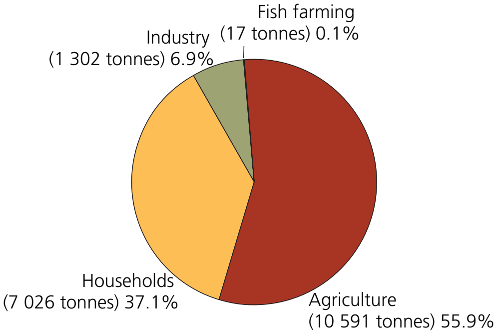
**Figure 8.9. Inputs of phosphorus and nitrogen to the North Sea region. 1985-2002**




Source: Norwegian Institute for Water Research (2003).

**Figure 8.10. Inputs of phosphorus and nitrogen to the North Sea region by sector. 2002**




Source: Norwegian Institute for Water Research (2003).

## 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) have been reduced by 64 and 41 per cent respectively from 1985 to 2002.
- 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 8.2).
- Phosphorus inputs from municipal waste water treatment plants (mainly from households) have been reduced by 740 tonnes (80 per cent) since 1985 and nitrogen inputs by 4 903 tonnes (41 per cent).
- Phosphorus inputs from agriculture have been reduced by around 38 per cent and nitrogen inputs by 28 per cent since 1985.
- Phosphorus and nitrogen inputs from manufacturing industry have been reduced by 35 and 77 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 8.4. Terms, municipal waste water treatment**

**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 micro-organisms. 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 treatement 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.

The number of **population equivalents (p.e.)** 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.

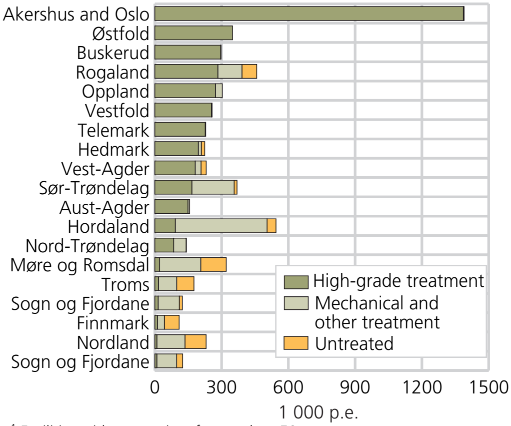
The **hydraulic capacity** (treatment capacity) of a treatment plant is the amount of waste water it is designed to treat.

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).

## 8.4. Municipal waste water treatment

**Figure 8.11. Hydraulic capacity of waste water treatment plants[1], by treatment method. By county. 2002.**

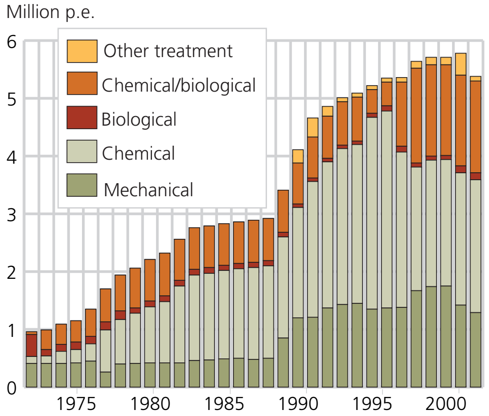



[1] Facilities with a capacity of more than 50 p.e.
Source: Waste water treatment statistics, Statistics Norway.

### Treatment capacity at waste water treatment facilities

- In 2002, total waste water treatment capacity in Norway was 5.38 million population equivalents (p.e.), 74 per cent of which was high-grade treatment. In addition, systems with direct discharges of untreated sewage had a total capacity of 0.53 million p.e.
- High-grade treatment methods account for over 96 per cent of treatment capacity in the North Sea counties, but only 28 per cent of the total in the rest of the country.
- High-grade treatment capacity in the North Sea region totals 1.32 p.e. per inhabitant, while the equivalent figure for the rest of the country is 0.35 p.e. This is a small decrease from 2001 for both areas, which may be caused by a decrease in number of plants or improved reporting.
- The developments 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.

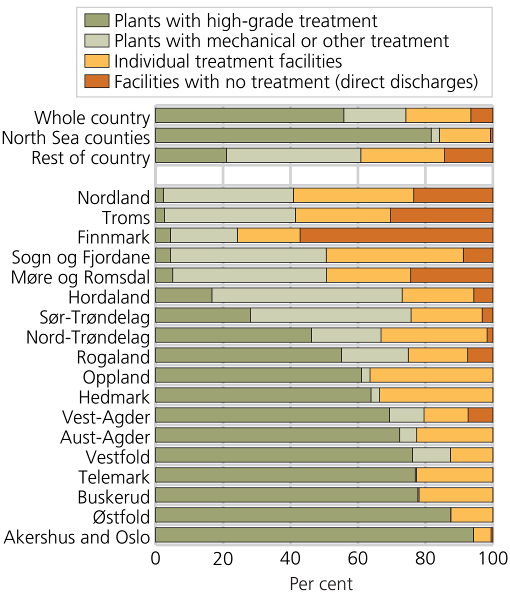
**Figure 8.12. Trend in treatment capacity[1]. Whole country. 1972-2002**




[1] Facilities with a capacity of more than 50 p.e.
Source: Waste water treatment statistics, Statistics Norway.

- While 2001 showed a marked increased in the category "Other treatment", reporting in 2002 indicates a decrease to about the 1997 level. This category includes natural purification processes. The changes in this category must to a large degree be attributed to modified reporting routines, rather than real changes in the number of plants.
- Upgrading of older mechanical plants and closures may explain the continued decrease in capacity in this category.

**Figure 8.13. Percentage of population connected to various types of treatment plants. By county. 2002**




Source: Waste water treatment statistics, Statistics Norway.

## Connection to waste water treatment plants

- In 2002, 80 per cent of the population of Norway were connected to waste water treatment plants with a capacity greater than 50 p.e. and to municipal sewerage systems. The remaining 20 per cent were connected to smaller, individual treatment facilities.
- Over 50 per cent of the population were connected to high-grade treatment plants in 2002. In the North Sea counties, this proportion was over 80 per cent, while the figure for the rest of the country was 20 per cent.

## Discharges of plant nutrients from waste water treatment plants

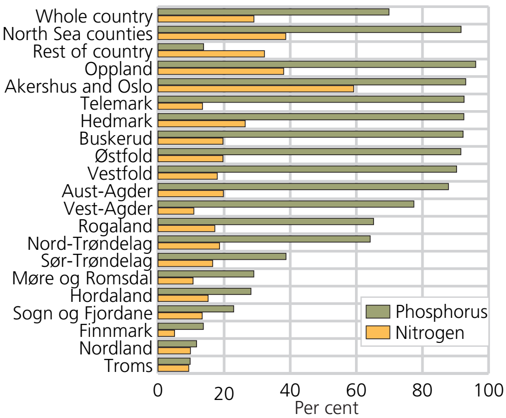
- Discharges of phosphorus and nitrogen from the waste water treatment sector in 2002 totalled 1 186 and 15 800 tonnes respectively. This includes leakages from sewers and discharges from individual treatment facilities.
- Plants in the North Sea counties accounted for 27 per cent of the phosphorus discharges and 51 per cent of the nitrogen discharges. This corresponds to a discharge of 0.13 kg phosphorus and 3.24 kg nitrogen per capita per year. The equivalent figures for the rest of the country were 0.43 kg phosphorus and 3.8 kg nitrogen. In both regions there has been a decrease in per capita discharges.

**Table 8.1. Total discharges of phosphorus and nitrogen from sewerage systems 2000-2002. By county. 2002**

| | 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** |
| North Sea counties (01-10) | 321 | 123 | 74 | 126 | 0.13 | 8 095 | 6 246 | 509 | 1 362 | 3.24 |
| Other counties (11-20) | 864 | 602 | 46 | 221 | 0.43 | 7 707 | 5 539 | 321 | 1 884 | 3.80 |
| Østfold 01 | 31 | 11 | 7 | 13 | 0.12 | 917 | 760 | 47 | 109 | 3.63 |
| Akershus and Oslo 02-03 | 99 | 46 | 33 | 21 | 0.10 | 2 343 | 1 918 | 235 | 196 | 2.37 |
| Hedmark 04 | 28 | 7 | 5 | 18 | 0.15 | 760 | 510 | 35 | 225 | 4.04 |
| Oppland 05 | 25 | 4 | 5 | 17 | 0.14 | 707 | 431 | 35 | 244 | 3.86 |
| Buskerud 06 | 32 | 9 | 6 | 16 | 0.13 | 805 | 596 | 37 | 174 | 3.36 |
| Vestfold 07 | 36 | 14 | 7 | 14 | 0.16 | 931 | 774 | 47 | 112 | 4.30 |
| Telemark 08 | 24 | 7 | 5 | 13 | 0.15 | 619 | 461 | 27 | 132 | 3.74 |
| Aust-Agder 09 | 16 | 6 | 3 | 7 | 0.16 | 400 | 291 | 18 | 88 | 3.89 |
| Vest-Agder 10 | 30 | 19 | 4 | 7 | 0.19 | 614 | 504 | 28 | 82 | 3.89 |
| Rogaland 11 | 85 | 57 | 8 | 24 | 0.22 | 1 257 | 1 000 | 60 | 228 | 3.29 |
| Hordaland 12 | 180 | 132 | 9 | 38 | 0.41 | 1 598 | 1 198 | 71 | 329 | 3.65 |
| Sogn og Fjordane 14 | 52 | 32 | 2 | 18 | 0.49 | 417 | 239 | 14 | 164 | 3.89 |
| Møre og Romsdal 15 | 140 | 99 | 7 | 34 | 0.58 | 1 119 | 801 | 45 | 273 | 4.59 |
| Sør-Trøndelag 16 | 128 | 97 | 8 | 23 | 0.48 | 938 | 698 | 42 | 198 | 3.52 |
| Nord-Trøndelag 17 | 40 | 19 | 3 | 18 | 0.31 | 434 | 276 | 17 | 141 | 3.40 |
| Nordland 18 | 112 | 69 | 4 | 38 | 0.47 | 889 | 547 | 30 | 313 | 3.74 |
| Troms 19 | 88 | 63 | 3 | 22 | 0.58 | 722 | 514 | 28 | 183 | 4.76 |
| Finnmark 20 | 40 | 34 | 2 | 5 | 0.55 | 333 | 264 | 14 | 55 | 4.52 |

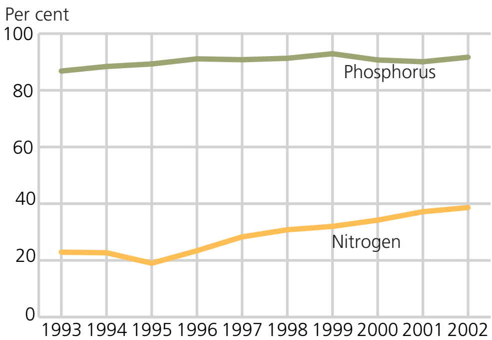
[1] Estimated at 5 per cent of the content of phosphorus and nitrogen in waste water before treatment.
Source: Waste water statistics. Statistics Norway.

**Figure 8.14. Estimated treatment effect for phosphorus and nitrogen. By county. 2002**



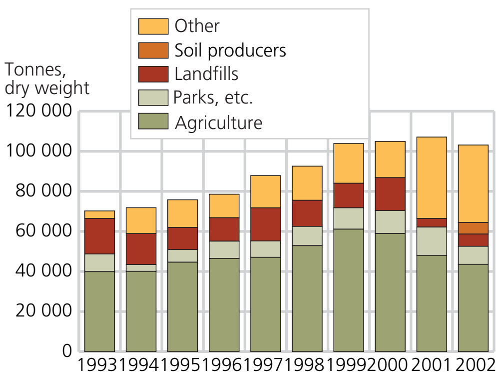

Source: Waste water treatment statistics, Statistics Norway.

**Figure 8.15. Trend in treatment effect for phosphorus and nitrogen in the North Sea region. 1993-2002**




Source: Waste water treatment statistics, Statistics Norway.

**Figure 8.16. Quantities of sewage sludge used for different purposes. Whole country. 1993-2002**




Source: Waste water treatment statistics, Statistics Norway.

## Treatment efficiency

- In 2002, waste water treatment plants in the North Sea counties removed on average 92 per cent of the phosphorus and 39 per cent of the nitrogen load processed by the plants. In the rest of the country, treatment efficiency for these nutrients was 35 and 14 per cent respectively.
- In the North Sea region, a 2 per cent increase in treatment efficiency for both phosphorus and nitrogen was registered from 2001 to 2002. Treatment efficiency for phosphorus has stood at over 90 per cent since 1996. 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 by almost 20 percentage points due to the construction of nitrogen removal plants in the Oslofjord area.

## 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 stabilized and hygienized to remove odours and harmful bacteria before utilization or disposal in landfills.

- In 2002, 103 135 tonnes of sludge, expressed as dry weight, was used for various purposes, a decrease of 3.7 per cent compared with 2001. The amount of sludge that has been reported used for various purposes since 1993 seems to be stabilising. This year, the municipalities have begun to report the amount of sludge used by soil producers. It is assumed that this was previously included in existing categories.
- If the content of heavy metals exceeds the limit values, the sludge cannot be used in integrated plant nutrient management.
- The trend over the past few years has been lower mean values for the content of most heavy metals in sludge. From 2001 to 2002 this trend continued for cadmium and copper, while there has been an increase for other heavy metals. This is primarily caused by random variations, and not a change in trend for these heavy metals.
- The content of heavy metals varies, sometimes substantially, from one plant to another. This is because the composition of waste water varies (depending on, for example, the amount of waste water from households, and the proportion of industrial waste water and of rain/melt water).

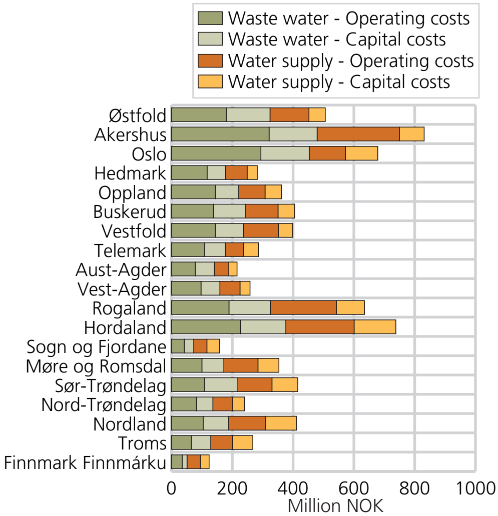
**Table 8.2. Content of heavy metals in sludge. 2002**

| Heavy metals | Mean value | Maximum value | Limit value agriculture | Limit value parks etc. | Change in mean value 2001-2002 |
|---|---|---|---|---|---|
| | Milligrams per kg expressed as dry weight | | | | Per cent |
| Cadmium (Cd) | 0.8 | 117 | 2 | 5 | -19.4 |
| Chromium (Cr) | 26.9 | 358 | 100 | 150 | 9.6 |
| Copper (Cu) | 219.5 | 1 500 | 650 | 1 000 | -3.3 |
| Mercury (Hg) | 0.9 | 27 | 3 | 5 | 12.5 |
| Nickel (Ni) | 14.5 | 509 | 50 | 80 | 14.1 |
| Lead (Pb) | 19.1 | 2 060 | 80 | 200 | 16.7 |
| Zinc (Zn) | 320.7 | 4 175 | 800 | 1 500 | 5.9 |

Source: Waste water treatment statistics, Statistics Norway.

## 8.5. Financial situation in the municipal water and waste water sectors

**Figure 8.17. Annual costs in the water supply and waste water sectors, by type. By county. 2003**

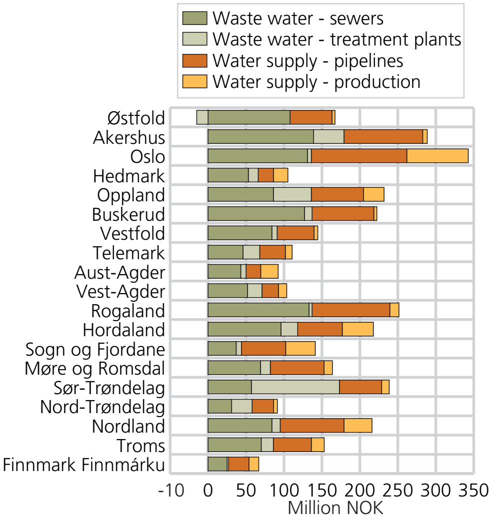



Source: Environmental protection expenditure statistics, Statistics Norway.

### Costs

- In 2003, annual costs in the municipal water and waste water sectors totalled NOK 7.6 billion. Of this, the water supply accounted for NOK 3.3 billion and waste water for NOK 4.3 billion.
- In most counties, operating costs are higher than capital costs. At the national level, operating costs account for 60 per cent of the total annual costs for the waste water sector. The corresponding figure for the water supply sector was 63 per cent. Operating costs constitute a larger share of total costs than the year before. The potential for improvements in efficiency lies primarily in the operating costs.
- Municipalities in Norway are not allowed to charge more through fees than they need to cover the costs of the service. In 2003, revenues from fees totalled 100 per cent of annual costs for the waste water sector. The corresponding figure for the water sector was 102 per cent. In both cases the ratio between annual costs and revenues from fees has increased since 2002. The reason is that an increasing number of municipalities have decided on a 100 per cent cost coverage for water, waste water and renovation services.

**Figure 8.18. Investments in the water supply and waste water sectors, by type. By county. 2003**

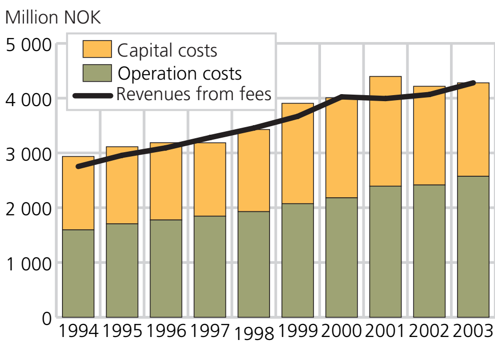



Source: Environmental protection expenditure statistics, Statistics Norway.

## Investments

- Investments in the municipal water supply sector in 2003 totalled NOK 1 480 million. The corresponding figure for the waste water sector was NOK 1 857 million.
- The share of total investments in distribution systems (sewage and water pipelines) in 2003 decreased somewhat for both the water and the waste water supply sector, and constituted 75 and 78 per cent respectively of total investments.
- Investments vary widely across municipalities and counties. This is partly related to the number of inhabitants and settlement structure. For the waste water sector it also depends on whether counties are included in the North Sea Agreements or not.
- Due to stricter requirements in the forthcoming waste water regulations, upgrading will be required in a number of treatment plants in Western Norway and northwards. The Pollution Control Authority estimates the need for investments at NOK 1-1.5 billon up to the end of 2006 (Norwegian Pollution Control Authority 2003).

**Figure 8.19. Costs and revenues from fees in the waste water sector, by type. Whole country. 1994-2003**

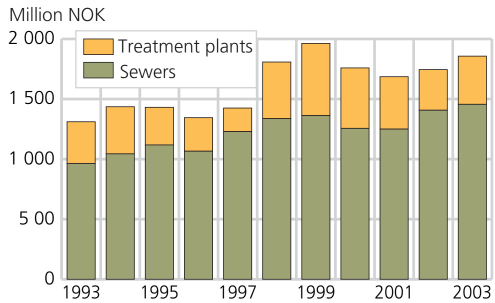



Source: Environmental protection expenditure statistics, Statistics Norway.

## Increase in costs in waste water sector

- In 2003, the annual costs in the waste water sector totalled NOK 4 280 million, an increase compared to the year before, but still lower than the peak year 2001.
- For the country as a whole, the ratio between annual costs and revenues from fees has been relatively constant over the period from 1994. The ratio has varied far more at municipal level, however. An increasing number of municipalities have decided on a 100 per cent cost coverage for this sector.

**Figure 8.20. Investments in the waste water sector, by type. Whole country. 1993-2003**




Source: Environmental protection expenditure statistics, Statistics Norway.

### Varying investments in the waste water sector

- In 2003, investments in the municipal waste water sector totalled NOK 1 857 million, an increase of 6.4 per cent compared with 2002.
- From 2002 to 2003, investments in waste water treatment plants increased somewhat, but are still lower than in previous years. Annual variations may be caused by large single investments and are not necessarily signs of a change in trend.

**More information:** Julie Hass and Robert Straumann (financial data) and Jørn Kristian Undelstvedt.

## 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

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

Norwegian Food Control Authority (2003): Article on the Authority's web-site: http://www.snt.no/dokumentasjon/maten/2002/drikkevann.htm (In Norwegian only).

National Institute of Public Health (2004a): Liliane Myrstad, pers. comm., September 2004.

National Institute of Public Health (2004b): Report from the Register of Water Works – drinking water 2003, Water report 109, Report 2004:2.

Norwegian Institute for Water Research (2003): Government programme for pollution monitoring – input of nutrients to Norwegian coastal areas in 2002, calculated using the input model TEOTIL. NIVA report nr. 4771-2003. Norwegian Institute for Water Research (NIVA).

Norwegian Pollution Control Authority (2003): Public consultation on proposal for two general pollution regulations concerning products and pollution. Letter of consultation of 22 July 2003.

Norwegian Pollution Control Authority (2004): Torstein Finnesand, pers. comm., August 2004.

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

# 9. 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. 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 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.**

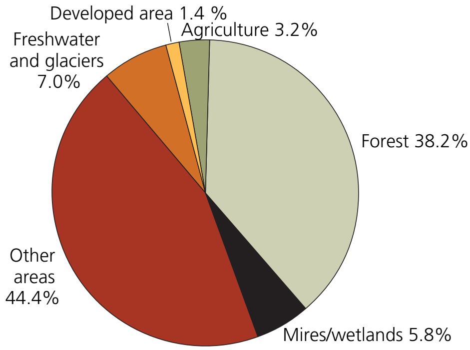
How the land is used is of great importance in terms of economics and the environment, and it affects people's lives. Changes in land use result in changes in the cultural landscape and the local environment. This has considerable impact on human health and quality of life, and on the productivity and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

Resource and environmental conflicts often result as settlement patterns become increasingly concentrated along the coast 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.

Sustainable urban settlement development is one of the main issues in Report No. 29 (1996-1997) to the Storting on regional planning and land use policy. The objective of planning is to focus on strengthening economic activity and promoting settlement in urban settlement centres, reducing the need for transport, generally making more efficient use of the land and ensuring green spaces are protected for recreational purposes and to maintain biological diversity. Efforts to develop a national environmental and land use policy have been followed up in the Reports to the Storting on the Government's environmental policy and the state of the environment in Norway (Reports No. 8 (1999-2000), No. 24 (2000-2001) and No. 25 (2002-2003)), which set national targets for biological diversity, outdoor recreation and the cultural heritage.

## 9.1. Land use in Norway

**Figure 9.1. Proportion of different types of land cover. Mainland Norway. 2004**




Source: Norwegian Mapping Authority and Statistics Norway.

### The most common types of land use

- In 2000, developed land contained a total of 3.4 million buildings, 4 000 km of rail track and 91 000 km of public roads, in addition to about 73 000 km of forest roads and other roads. (Norwegian Mapping Authority 2002 and Norwegian State Railways 1992).
- Agricultural area in use covers about 10 400 $km^2$ and productive forest about 75 000 $km^2$ (Norwegian Institute for Land Inventory 1999).
- The remaining land area comprises other cultivated land, non-developed coastal areas, scrub and heaths, marginal forest, and mountains. About 2 600 $km^2$ of the mainland is under permanent ice and snow (Wold 1992).

### Box 9.1. 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 $km^2$ in total (304 280 $km^2$ land and 19 522 $km^2$ 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 2004, pp. 19-23 and 47- http://www.ssb.no/english/yearbook/).

### Box 9.2. Protected areas. Overview of legislation

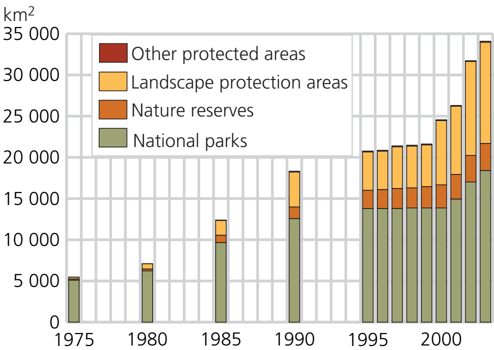
Most of the protected areas in Norway are protected under the Nature Conservation Act. Other legislation and treaties of importance in this connection include:

- 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.

## 9.2. Protection and development

**Figure 9.2. Areas protected under the Nature Conservation Act. Whole country. 1975-2003. km²**




Source: Directorate for Nature Management.

### Areas protected under the Nature Conservation Act

- The total area protected under the Nature Conservation Act has expanded considerably since 1975. At 1 January 2004, protected areas included 21 national parks, 1 659 nature reserves, 135 protected landscapes and 98 other types of protected area. See also Appendix, table I5.
- Protected areas account for about 34 100 km² or 10.5 per cent of Norway's total area.
- At the end of 2003, a total of 2 323 km² of forest had been protected, of which 764 km² of productive forest. This included 570 km² of productive coniferous forest, or just below 1 per cent of the total productive coniferous forest area (Directorate for Nature Management 2004).

**Box 9.3. Building activity in the 100-metre belt along the coast**

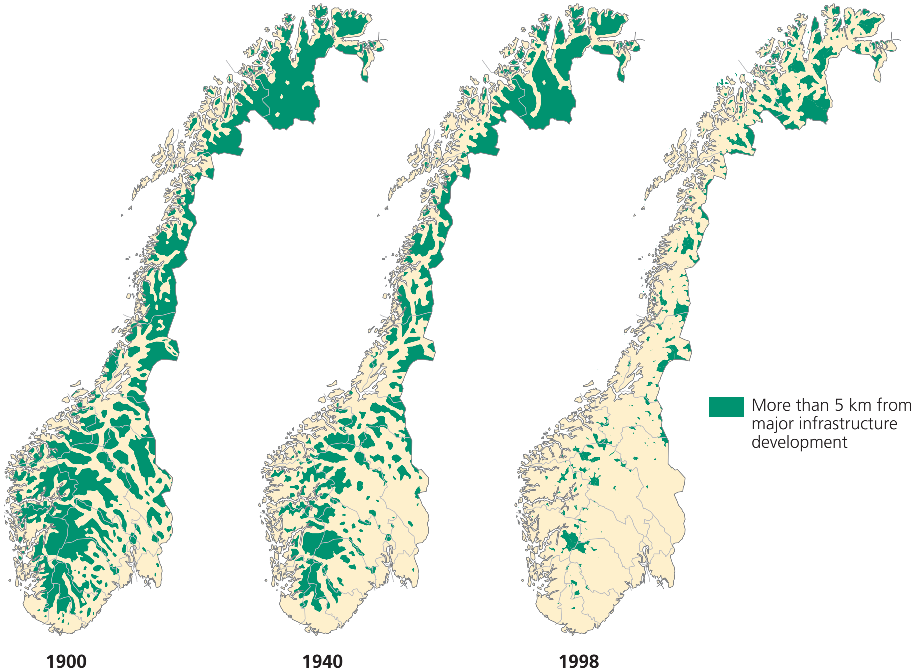
Protecting areas of recreational value is an expressed national target. Several specific key figures have been drawn up as operational tools to monitor developments in relation to the national targets for the priority area *Outdoor recreation* in environmental policy.

Access to the 100-metre belt along the coast is one such key figure. 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 23.5 per cent of the total length of the coastline is less than 100 metres from the nearest building (registered in the GAB as of 1 January 2004). From Halden in the south-east to Hordaland in the west, a stretch of the coast specifically mentioned in the context of key figures, as much as 39.1 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 (see Chapter 1, figure 1.2 and Appendix, table I4).

## Wilderness-like area

- Wilderness-like areas, defined as areas more than 5 km from major infrastructure development, have been dramatically reduced from about 48 per cent of Norway's land area in 1900 to between 11 and 12 per cent today. See also figure 1.1 in Chapter 1.

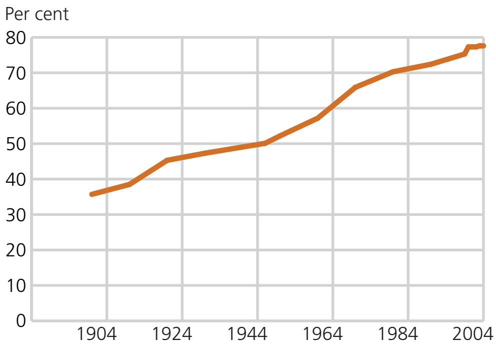
**Figure 9.3. Wilderness-like areas. 1900, 1940 and 1998**




Source: Directorate for Nature Management and Norwegian Mapping Authority.

# 9.3. Area and population in urban settlements

**Figure 9.4. Percentage of population resident in urban settlements/densely populated areas. 1900-2004**




Source: Population statistics, Statistics Norway.

## Population trends and area of urban settlements

- The percentage of the population living in urban settlements/built-up areas has increased considerably from 1900 to 2004. A total of 77.6 per cent of the Norwegian population lived in a total of 911 urban settlements at 1 January 2004.
- Close to half of the population growth in urban settlements in 2003 occurred in the four largest towns: Oslo, Bergen, Stavanger/Sandnes and Trondheim (See also Statistics Norway 2002a).

**Table 9.1. Urban settlements, residents and area, by size of population. 2004. Change from 2003 to 2004**

| Size groups of urban settlements, by number of residents | 2004 | | | Change from 2003 to 2004 | | |
|---|---|---|---|---|---|---|
| | Population | Total area in km² | Number of areas | Population | Total area in km² | Number of areas |
| **Total** | **3 536 454** | **2 217.3** | **911** | **22 037** | **-7.1** | **-21** |
| 200 - 499 | 115 421 | 159.7 | 335 | -7 656 | -13.4 | -26 |
| 500 - 999 | 51 093 | 182.8 | 219 | - 2 373 | -1.4 | -2 |
| 1 000 - 1 999 | 205 907 | 205.3 | 148 | 6 780 | 4.4 | 6 |
| 2 000 - 99 999 | 1 733 346 | 1 172.9 | 205 | 14 170 | 2.9 | 1 |
| 100 000 - | 1 330 687 | 496.6 | 4 | 11 116 | 0.4 | 0 |

Source: Population statistics and land use statistics, Statistics Norway.

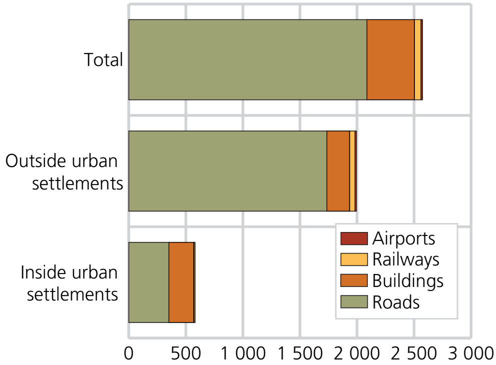
## Box 9.4. Delimitation of urban settlements and background data

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 9.5. Developed area in Norway, by type. km². 2004**




Source: Land use statistics, Statistics Norway.

## Physically developed area in urban settlements

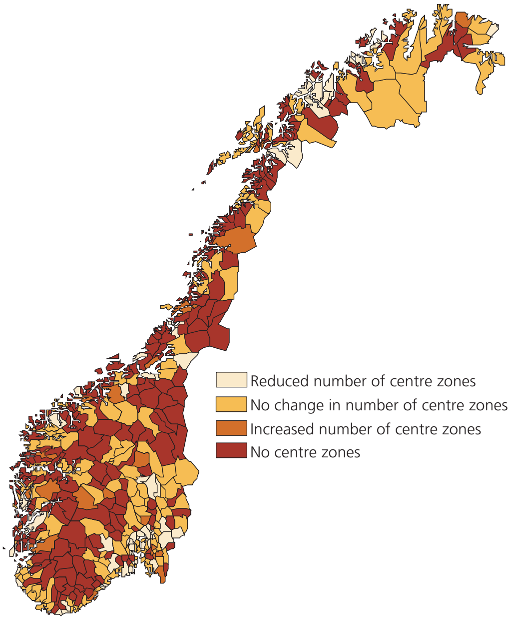
- The urban settlements make up less than 1 per cent of Norway's total area, but about one fourth of the physically developed area.
- Roads account for about 2/3 of the physically developed area in urban settlements.
- Infrastructure, buildings and roads make up about 30 per cent of the total area of urban settlements.
- In urban areas, buildings covered about 220 $km^2$. Buildings outside urban areas covered about 200 $km^2$.

### Box 9.5. Land use calculation, data sources and uncertainty

Land use statistics for urban settlements is 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 2002c-g).

**Figure 9.6. Change in number of centre zones by municipality. 2003-2004**




Source: Statistics Norway (2004a).
Map data: Norwegian Mapping Authority.

## Centre zones

- Centre zones (see box 9.6) only figured in 259 of Norway's 435 municipalities as of 1 January 2004, and tend not to be formed in the smallest municipalities (Statistics Norway 2004a).
- In 2003, 15 municipalities lost their centre zones. A net loss of 90 centre zones occurred this year.
- As of 1 January 2004 there were a total of 610 centre zones with a population of about 407 000 in Norway. This is equivalent to a 12 per cent decline in the number of centre zones following an increase from 622 in 2000 to 692 in 2003.
- The number of employees in centre zones were 693 000, a decrease of 6 000 from the year before, mainly as a result of the decline in the number of centre zones.

**Box 9.6. 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 9.7. 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 have been described in more detail in *Natural Resources and the Environment 2002. Norway* (Statistics Norway 2002b)

### Box 9.8. Targets and key figures 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." On the basis of this target, two key figures to measure performance over time have been calculated:
- 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 *Natural Resources and the Environment 2003. Norway* (Statistics Norway 2003), and a county overview is presented in the Appendix, table I3.

## 9.4. 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 (see table 9.2).
- 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 incorporate these aspects in their municipal master plan to the greatest extent.
- See also Chapter 4.7 Management of uncultivated areas.

**Table 9.2. 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 |
| By population in municipalities, 2003 | | | | | | |
| Over 300 000 | 100 | 0 | 100 | 0 | 100 | 2.0 |
| 50 000-300 000 | 82 | 2.8 | 82 | 1.4 | 64 | 4.3 |
| 30 000-50 000 | 69 | 2.1 | 77 | 2.7 | 54 | 2.6 |
| 20 000-30 000 | 61 | 3.4 | 88 | 2.3 | 53 | 6.8 |
| 10 000-20 000 | 31 | 2.6 | 62 | 2.2 | 35 | 5.3 |
| 5 000-10 000 | 24 | 3.4 | 62 | 3.0 | 25 | 5.3 |
| 2 000-5 000 | 22 | 1.5 | 51 | 2.0 | 28 | 5.0 |
| Under 2 000 | 21 | 1.1 | 55 | 2.3 | 21 | 6.7 |

Source: Statistics Norway (2004b).

## 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 9.3).
- 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 in areas where building is prohibited has increased from 70 per cent in 2002 to 74 per cent in 2003. The percentage increase is highest along the coast.
- The case load in municipalities does not seem influence the percentage of exemptions granted.

**Table 9.3. Building project applications in areas of particular environmental value. 2001-2003**

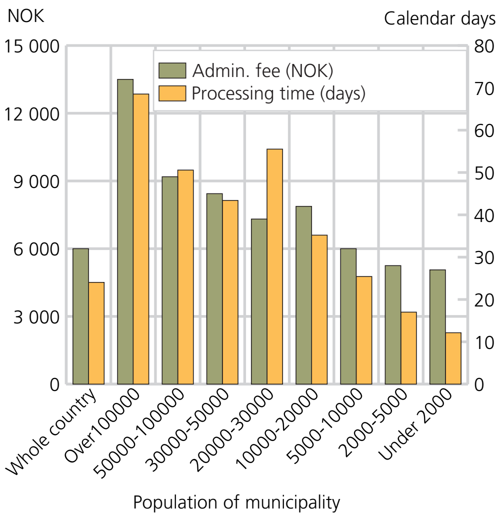
| Type of area | Year | No. of cases processed[2] | Applications consistent with plan, percentage approved | Applications that include exemptions, percentage approved | Rejected applications, percentage |
|---|---|---|---|---|---|
| Projects in agricultural areas, areas of natural environment and outdoor recreation areas[1] | 2001 | 15 853 | 70 | 23 | 8 |
| | 2002 | 17 167 | 74 | 20 | 6 |
| | 2003 | 7 801 | 62 | 29 | 9 |
| 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 |
| Projects along rivers and lakes where building is prohibited[1] | 2001 | 336 | . | 80 | 20 |
| | 2002 | 410 | . | 80 | 20 |
| | 2003 | 325 | . | 74 | 26 |
| 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 |

[1] As from 2003, exceptions apply exclusively to new buildings

[2] The number applies to municipalities that have reported. About 80 per cent of the municipalities have reported.

Source: Statistics Norway (2004b).

**Figure 9.7. Administrative municipal fee for building of single-family dwelling and average case processing time for undertakings for which application is required, by population. 2003**




Source: Statistics Norway (2004b).

## Fees and case processing time in municipal land use management

- In 2003, the municipalities used fees and other revenues to cover about half of their land use planning expenses. Net expenses for this purpose accounted for 1 per cent of total net municipal operating expenses.
- 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.

**More information:** Vilni Bloch, Erik Engelien, Margrete Steinnes and Henning Høie (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 Institute of Land Inventory: http://www.nijos.no/
Norwegian Institute for Air Research: http://www.nilu.no/
Norwegian Institute for Water Research: http://www.niva.no/engelsk/welcome.htm
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/
Norwegian Pollution Control Authority: http://www.sft.no/english/
Norwegian Mapping Authority: http://www.statkart.no/

## References

Directorate for Nature Management (2004): The Directorate's website (english.dirnat.no) and Asbjørn Tingstad, pers. comm., August 2004 (protection of forest areas).

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 Institute of Land Inventory (1999): *SKOG 2000. Statistikk over skogforhold og -ressurser i Norge* (Forests 2000. Statistics on forests and forest resources in Norway). Report 7/1999.

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 State Railways (1992): *NSB Almanakk 1992*.

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 (2002a): Hedmark – det minst urbane fylket (Hedmark - the least urbanised county), *Statistics Norway* 03 September 2002, http://www.ssb.no/english/subjects/02/01/10/beftett_en/arkiv/

Statistics Norway (2002b): *Natural Resources and the Environment 2002*. Norway. Statistical Analyses 58.

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

Statistics Norway (2002f): *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 (2002g): *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 (2004a): Arealbruk i sentrumssoner, 1. januar 2004. Mange små sentra forsvann siste året. (Delimitation of centre zones. 1 January 2004. Fewer small centre zones last year.) Statistics Norway http://www.ssb.no/english/subjects/01/01/20/arealsentrum_en/

Statistics Norway (2004b): Utbygging i grønne områder: De fleste får dispensasjon. *Dagens statistikk, 08.07.04*, (Land use planning in municipalities and counties, 2003. Exemptions in green areas normally approved (http://www.ssb.no/english/subjects/01/01/20/fysplan_en/).

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

## Other literature

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

# Status and important trends

## Appendix A

**Table A.1 Investment in pollution treatment equipment (end-of-pipe). Manufacturing, Mining and quarrying (NACE 10, 12-37). 2000 and 2001. 1 000 NOK**

| Industry division (SIC 94) | Air/climate | Wastewater | Solid waste | Soil and ground-water | Biodiversity and land-scape | Other | Total | End of pipe investment as per cent of gross in-vestment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Per cent |
| **2000, total** | **278 174** | **117 436** | **87 495** | **.** | **.** | **310 677** | **793 788** | **5.2** |
| **2001, total** | **298 282** | **151 147** | **59 670** | **1 442** | **5 336** | **70 108** | **585 985** | **3.5** |
| NACE C, 10, 12-14 MINING AND QUARRYING | 1 425 | 1 216 | 374 | 51 | 2 | 2 683 | 5 751 | 1.1 |
| 10 Coal and peat | - | - | 373 | - | - | 2 363 | 2 736 | 1.8 |
| 13 Metal ores | - | 566 | - | - | - | - | 566 | 2.2 |
| 14 Other mining and quarrying | 1 425 | 650 | 1 | 51 | 2 | 320 | 2 449 | 0.7 |
| NACE D, 15-37 INDUSTRY | 296 837 | 149 911 | 59 276 | 1 391 | 5 334 | 67 425 | 580 174 | 3.6 |
| 15-16 FOOD PRODUCTS; BEVERAGES AND TOBACCO | 12 621 | 46 512 | 3 910 | 64 | 37 | 1 450 | 64 594 | 1.5 |
| 15.1 Meat and meat products | 1 352 | 3 758 | 1 668 | 10 | 28 | - | 6 816 | 1.1 |
| 15.2 Fish and fish products | 3 342 | 12 907 | 1 604 | - | - | 1 050 | 18 903 | 1.4 |
| 15.5 Dairy products | 5 591 | 2 442 | 262 | - | - | - | 8 295 | 2.3 |
| 15.3-4/6-8 Other food products | 2 336 | 27 395 | 326 | 54 | 9 | 400 | 30 520 | 2.2 |
| 15.9/16 Beverages and tobacco | - | 10 | 50 | - | - | - | 60 | 0.0 |
| 17-19 TEXTILES AND TEXTILE PRODUCTS, LEATHER AND LEATHER PRODUCTS | 447 | 543 | 348 | - | - | - | 1 338 | 0.9 |
| 17 Textiles | 397 | 523 | 308 | - | - | - | 1 228 | 0.8 |
| 18 Wearing apparel, dressing and dyeing of fur | - | 20 | - | - | - | - | 20 | 0.2 |
| 19 Leather and leather products | 50 | - | 40 | - | - | - | 90 | 3.6 |
| 20 WOOD AND WOOD PRODUCTS | 2 058 | 1 032 | 918 | 150 | 112 | 120 | 4 390 | 0.9 |
| 21 PULP, PAPER AND PAPER PRODUCTS | 14 025 | 21 300 | 6 729 | - | 4 590 | 25 | 46 669 | 6.7 |
| 22 PUBLISHING AND PRINTING, ETC. | 1 063 | 268 | 644 | - | 19 | - | 1 994 | 0.3 |

**Table A.1 (cont.). Investment in pollution treatment equipment (end-of-pipe). Manufacturing, Mining and quarrying (NACE 10, 12-37). 2000 and 2001. 1 000 NOK**

| Industry division (SIC 94) | Air/climate | Wastewater | Solid waste | Soil and ground-water | Biodiversity and land-scape | Other | Total | End of pipe investment as per cent of gross in-vestment |
|---|---|---|---|---|---|---|---|---|
| 23-24 PETROLEUM PROD-UCTS AND CHEMICAL PRODUCTS . . . . . . . . . . . . | 44 712 | 8 677 | 1 241 | 247 | 450 | 6 753 | 62 080 | 2.6 |
| 23-24.1 Refined petrole-um products and basic chemicals . . . . . . . . . . . | 42 918 | 7 432 | 423 | 247 | 450 | 4 320 | 55 790 | 3.2 |
| 24.2-24.7 Other chemi-cal products . . . . . . . . . | 1 794 | 1 245 | 818 | - | - | 2 433 | 6 290 | 0.9 |
| 25 RUBBER AND PLASTIC PRODUCTS . . . . . . . . . . . . | 196 | 1 128 | 930 | - | 9 | 1 186 | 3 449 | 2.1 |
| 26 OTHER NON-METALLIC MINERAL PRODUCTS . . . . | 1 142 | 1 928 | 11 301 | 7 | 2 | 54 000 | 68 380 | 13.1 |
| 27 BASIC METALS . . . . . . | 194 964 | 59 647 | 29 567 | - | 100 | 50 | 284 328 | 10.3 |
| 28 METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT . . . . . . . . . . . | 6 801 | 358 | 574 | 2 | 11 | - | 7 746 | 1.4 |
| 29 MACHINERY AND EQUIPMENT N.E.C . . . . . . | 2 263 | 256 | 318 | 200 | 1 | - | 3 038 | 0.4 |
| 30-33 ELECTRICAL AND OPTICAL EQUIPMENT . . . . | 3 595 | 924 | 229 | - | - | - | 4 748 | 0.5 |
| 30 Office machinery and computers . . . . . . . . . . | - | - | - | - | - | - | - | 0.0 |
| 31 Electrical machinery and apparatus n.e.c.. . . | 2 704 | 646 | 27 | - | - | - | 3 377 | 0.9 |
| 32 Radio, television, communication equip-ment . . . . . . . . . . . . . . | 290 | 278 | 200 | - | - | - | 768 | 0.2 |
| 33 Medical, precision and optical instruments | 601 | - | 2 | - | - | - | 603 | 0.4 |
| 34-35 (-35.114/5) TRANS-PORT EQUIPMENT. . . . . . . | 8 409 | 5 642 | 1 133 | 1 | 2 | - | 15 187 | 2.3 |
| 34 Motor vehicles, trail-ers and semitrailers. . . . | 3 195 | 2 900 | 650 | 1 | - | - | 6 746 | 2.2 |
| 35 (-35.114/5) Other transport equipment. . . | 5 214 | 2 742 | 483 | - | 2 | - | 8 441 | 2.3 |
| 35.114/5 OIL PLATFORMS | 68 | - | 50 | - | - | - | 118 | 0.0 |
| 36-37 MANUFACTURING N.E.C. . . . . . . . . . . . . . . . . | 4 473 | 1 696 | 1 384 | 720 | 1 | 3 841 | 12 115 | 1.9 |
| 36 Furniture and manu-facturing n.e.c. . . . . . . . | 3 173 | 1 696 | 584 | 120 | 1 | 450 | 6 024 | 1.6 |
| 37 Recycling . . . . . . . . . | 1 300 | - | 800 | 600 | - | 3 391 | 6 091 | 2.4 |

**Source:** Environmental protection expenditure statistics, Statistics Norway.

# Energy

## Appendix B

**Table B.1 Reserve accounts for crude oil. Fields already developed or where development has been approved. Million $Sm^3$ o.e.**

| | 1990 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001[1] | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|
| Reserves as of 01.01 | 1 189 | 1 654 | 1 795 | 1 858 | 1 810 | 1 692 | 1 770 | 1 776 | 1 589 |
| New fields | 126 | 315 | 84 | - | 36 | 190 | 106 | 2 | 26 |
| Re-evaluations | 125 | 13 | 168 | 133 | 26 | 81 | 97 | 3 | 113 |
| Extraction | -99 | -188 | -189 | -181 | -181 | -193 | -197 | -191 | -189 |
| Reserves as of 31.12 | 1 340 | 1 795 | 1 858 | 1 810 | 1 692 | 1 770 | 1 776 | 1 589 | 1 540 |
| R/P-ratio | 13 | 10 | 10 | 10 | 9 | 9 | 9 | 8 | 8 |

[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 B.2 Reserve accounts for natural gas. Fields already developed or where development has been approved. Million $Sm^3$ o.e.**

| | 1990 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001[1] | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|
| Reserves as of 01.01 | 1 261 | 1 352 | 1 479 | 1 173 | 1 172 | 1 247 | 1 259 | 2 189 | 2 117 |
| New fields | 17 | 195 | 12 | - | 45 | 61 | 229 | 7 | 376 |
| Re-evaluations | -20 | -27 | -271 | 47 | 82 | 5 | 759 | -9 | 45 |
| Extraction | -28 | -41 | -47 | -48 | -52 | -54 | -58 | -70 | -78 |
| Reserves as of 31.12 | 1 230 | 1 479 | 1 173 | 1 172 | 1 247 | 1 259 | 2 189 | 2 117 | 2 461 |
| R/P-ratio | 45 | 36 | 25 | 24 | 24 | 23 | 38 | 30 | 32 |

[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 B.3 Norway´s hydropower potential and developed and undeveloped hydropower[1]. GWh**

| Year | Hydro-power potential[2] | Developed as of 31 Dec. | Undeveloped | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Under construc-tion[3] | Licence granted | Applied for licence | Licence denied[4] | Notifica-tion sub-mitted | Perma-nently 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 | 1 351 | 3 456 | 36 543 | 24 623 |
| 2001 | 186 947 | 118 154 | 349 | 1 036 | 3 765 | 1 344 | 1 576 | 36 543 | 24 179 |
| 2002 | 186 486 | 118 277 | 993 | 498 | 3 583 | 1 362 | 1 294 | 36 543 | 23 936 |
| 2003 | 186 544 | 118 415 | 1 174 | 1 416 | 2 002 | 1 435 | 893 | 36 543 | 24 667 |

[1]Mean annual production capability. [2]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]Included in 'Licence granted' and 'Applied for licence' before 2000.

**Source:** Norwegian Water Resources and Energy Directorate.

**Table B.4 Extraction, conversion and use[1] of energy commodities. 2002***

| | Coal and coke | Wood, wood waste, black liquor, waste | Crude oil | Natural gas | Petroleum products[2] | Electricity | District heating | Total | Average annual change 1976-2002 | Average annual change 2001-2002 |
|---|---|---|---|---|---|---|---|---|---|---|
| | PJ | | | | | | | | Per cent | |
| Extraction of energy commodities | 60 | - | 6 213 | 2 792 | [3] 485 | 467 | - | 10 017 | | |
| Energy use in extraction sectors | - | - | - | [4]-176 | -11 | -8 | 0 | -194 | | |
| Imports and Norwegian purchases abroad | 45 | 1 | 27 | - | 288 | 19 | - | 380 | | |
| Exports and foreign purchases in Norway | -59 | 0 | -5 733 | -2 576 | -721 | -54 | - | -9 144 | | |
| Stocks (+decrease, -increase) | 2 | .. | -5 | - | 0 | . | . | -2 | | |
| Primary supplies | 48 | 1 | 502 | 40 | 42 | 424 | 0 | 1 058 | | |
| Oil refineries | 7 | - | -502 | - | 469 | -2 | - | -27 | | |
| Other energy sectors or supplies | -1 | 51 | - | 0 | 18 | 1 | 9 | 78 | | |
| Registered losses, statistical errors | -8 | .. | -1 | -17 | -33 | -34 | -2 | -95 | | |
| Registered use outside energy sectors | 46 | 51 | - | 24 | 496 | 390 | 7 | 1 013 | 0.8 | -5.1 |
| Domestic use | 46 | 51 | - | 24 | 334 | 390 | 7 | 852 | 1.3 | -3.5 |
| Agriculture and fisheries | - | 0 | - | - | 28 | 8 | 0 | 36 | 0.7 | 0.5 |
| Energy-intensive manufacturing | 32 | 0 | - | 22 | 69 | 112 | 0 | 237 | 1.5 | -8.9 |
| Other manufacturing and mining | 13 | 26 | - | 1 | 28 | 53 | 1 | 122 | -0.2 | -5.4 |
| Other industries | 0 | 0 | - | 0 | 136 | 90 | 5 | 232 | 2.1 | 0.4 |
| Private households | 0 | 25 | - | 0 | 73 | 127 | 1 | 226 | 1.5 | -0.8 |
| International maritime transport | - | - | - | - | 162 | - | - | 162 | -1.1 | -12.8 |

[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:** Statistics Norway.

**Table B.5 Use of energy commodities outside the energy sectors and international maritime transport[1]**

| Energy commodity | 1976 | 1980 | 1985 | 1990 | 1995 | 1998 | 1999 | 2000 | 2001 | 2002* | 2003* | Average annual change 1976-2002 | Average annual change 2002-2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | PJ | | | | | | Per cent | |
| **Total** | **608** | **677** | **735** | **751** | **784** | **852** | **857** | **837** | **882** | **852** | **849** | **1.3** | **-0.3** |
| Electricity | 241 | 269 | 329 | 349 | 374 | 394 | 393 | 394 | 404 | 390 | 372 | 1.9 | -4.5 |
| Firm power | 232 | 265 | 312 | 324 | 348 | 367 | 370 | 358 | 378 | 367.0 | ... | 1.8 | ... |
| Spot power | 9 | 4 | 17 | 24 | 26 | 27 | 24 | 36 | 26 | 22.7 | ... | 3.6 | ... |
| Oil, total | 299 | 294 | 259 | 246 | 253 | 271 | 276 | 250 | 264 | 264 | 271 | -0.5 | 2.8 |
| Oil other than transport | 159 | 137 | 77 | 57 | 51 | 56 | 54 | 43 | 47 | 45 | 48 | -4.7 | 6.5 |
| Petrol | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -21.8 | 0.0 |
| Kerosene | 17 | 16 | 9 | 7 | 7 | 7 | 7 | 5 | 6 | 6 | 6 | -3.9 | 7.5 |
| Middle distillates | 66 | 62 | 43 | 35 | 30 | 32 | 33 | 27 | 27 | 28 | 31 | -3.3 | 10.9 |
| Heavy fuel oil | 66 | 56 | 25 | 15 | 14 | 17 | 15 | 11 | 13 | 11 | 12 | -6.6 | 7.5 |
| Oil for transport | 141 | 157 | 183 | 189 | 202 | 215 | 222 | 207 | 217 | 219 | 223 | 1.7 | 2.0 |
| Petrol, aviation fuel, jet fuel | 74 | 82 | 92 | 99 | 102 | 100 | 103 | 97 | 100 | 98 | 94 | 1.1 | -4.6 |
| Middle distillates | 64 | 71 | 83 | 86 | 99 | 115 | 119 | 110 | 118 | 120 | 125 | 2.5 | 4.2 |
| Heavy fuel oil | 3 | 5 | 7 | 3 | 1 | 1 | 1 | 1 | 0 | 0 | 4 | -11.1 | : |
| Gas[2] | 1 | 41 | 52 | 64 | 54 | 77 | 76 | 81 | 102 | 94 | 101 | 17.3 | 7.8 |
| District heating | - | - | 2 | 3 | 4 | 5 | 6 | 5 | 7 | 7 | 7 | . | 0.0 |
| Solid fuel | 65 | 73 | 93 | 90 | 100 | 105 | 106 | 106 | 105 | 97 | 97 | 1.6 | -0.3 |
| Coal and coke | 47 | 48 | 57 | 49 | 56 | 58 | 56 | 56 | 50 | 46 | 45 | -0.1 | -1.9 |
| Wood, wood waste, black liquor, waste | 19 | 25 | 35 | 41 | 44 | 48 | 50 | 50 | 55 | 51 | 52 | 3.9 | 1.1 |

[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:** Statistics Norway.

**Table B.6 Net use[1] of energy in the energy sectors. PJ**

| | 1976 | 1980 | 1985 | 1990 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002* | 2003* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **52** | **87** | **91** | **156** | **185** | **197** | **206** | **196** | **197** | **218** | **215** | **210** | **222** |
| **Of this:** | | | | | | | | | | | | | |
| Electricity | 4 | 6 | 8 | 7 | 10 | 7 | 11 | 8 | 9 | 8 | 9 | 9 | 10 |
| Natural gas | 30 | 52 | 61 | 116 | 141 | 151 | 153 | 147 | 145 | 167 | 175 | 176 | 185 |

[1]Does not include energy use for conversion purposes.
**Source:** Statistics Norway.

**Table B.7 Use of energy commodities ouside the energy sectors and international maritime transport, by sector[1]. 2001. PJ**

| | Coal and coke | Wood, wood waste, black liquor, waste | Crude oil | Natural gas | Petroleum products[2] | Electricity | District heating | Total |
|---|---|---|---|---|---|---|---|---|
| **Total** | **50.0** | **55.2** | **-** | **31.5** | **335.1** | **403.9** | **6.7** | **882.4** |
| **Manufacturing and mining** | **49.9** | **30.1** | **-** | **31.1** | **102.1** | **174.6** | **0.8** | **388.6** |
| Oil drilling | - | - | - | - | 3.9 | - | - | 3.9 |
| Manufacture of pulp and paper | - | 20.5 | - | 0.5 | 6.2 | 22.9 | - | 50.1 |
| Manufacture of basic chemicals | 11.2 | - | - | 29.0 | 67.3 | 24.4 | 0.3 | 132.2 |
| Manufacture of minerals[3] | 8.1 | 0.7 | - | - | 6.8 | 4.7 | - | 20.3 |
| Manufacture of iron, steel and ferro-alloys | 22.3 | 1.1 | - | - | 1.0 | 24.8 | - | 49.2 |
| Manufacture of other metals | 5.0 | - | - | 1.2 | 3.2 | 68.8 | - | 78.1 |
| Manufacture of metal goods, boats, ships and oil platforms | 3.3 | 0.4 | - | 0.2 | 3.6 | 9.4 | 0.0 | 17.1 |
| Manufacture of wood, plastic, rubber and chemical goods, printing | - | 7.4 | - | 0.0 | 2.8 | 6.9 | 0.1 | 17.2 |
| Manufacture of consumer goods | - | 0.0 | - | 0.3 | 6.6 | 11.9 | 0.3 | 19.1 |
| **Other industries, total** | **0.1** | **25.1** | **-** | **0.4** | **233.0** | **229.3** | **6.0** | **493.8** |
| Construction | - | 0.1 | - | - | 8.9 | 3.0 | - | 12.0 |
| Agriculture and forestry | 0.0 | 0.1 | - | - | 6.6 | 7.5 | 0.0 | 14.3 |
| Fishing, whaling and sealing | - | - | - | - | 20.9 | 0.5 | - | 21.4 |
| Land transport[4] | - | - | - | 0.1 | 47.7 | 2.3 | - | 50.0 |
| Sea transport, domestic | - | - | - | - | 20.6 | 0.0 | - | 20.7 |
| Air transport[4] | - | - | - | - | 24.9 | 0.3 | - | 25.3 |
| Other private services | - | - | - | 0.0 | 24.2 | 57.6 | 2.5 | 84.4 |
| Public sector, municipal | - | - | - | 0.2 | 2.6 | 20.1 | 1.6 | 24.6 |
| Public sector, state | - | - | - | - | 4.5 | 8.7 | 0.6 | 13.8 |
| Private households | 0.1 | 24.9 | - | 0.1 | 72.0 | 129.2 | 1.2 | 227.4 |

[1]Includes energy commodities used as raw materials. See also tables F3 and F4, which give emission figures for the same sectors. [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:** Statistics Norway.

**Table B.8 Electricity balance**

| | 1975 | 1980 | 1985 | 1990 | 1995 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003* | Average annual change 1990-2003* | Average annual change 2002-2003* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TWh | | | | | | | | | | | Per cent | |
| Production | 77.5 | 84.1 | 103.3 | 121.8 | 123.0 | 116.8 | 122.4 | 142.8 | 121.6 | 130.5 | 107.1 | -1.0 | -17.9 |
| + Imports | 0.1 | 2.0 | 4.1 | 0.3 | 2.3 | 8.0 | 6.9 | 1.5 | 10.8 | 5.3 | 13.4 | 33.9 | 151.3 |
| - Exports | 5.7 | 2.5 | 4.6 | 16.2 | 9.0 | 4.4 | 8.8 | 20.5 | 7.2 | 15.0 | 5.6 | -7.9 | -62.8 |
| = Gross domestic consumption | 71.9 | 83.6 | 102.7 | 105.9 | 116.3 | 120.4 | 120.5 | 123.8 | 125.2 | 120.8 | 114.9 | 0.6 | -4.9 |
| - Consumption in pumped storage power plants | 0.1 | 0.5 | 0.8 | 0.3 | 1.4 | 0.8 | 0.6 | 0.7 | 0.8 | 0.7 | 0.8 | 8.0 | 22.7 |
| - Consumption in power plants, losses and statistical differences | 7.1 | 8.0 | 10.0 | 7.9 | 10.0 | 9.1 | 9.4 | 12.2 | 11.1 | 10.0 | 8.8 | 0.8 | -12.3 |
| = Net domestic consumption | 64.7 | 75.1 | 91.9 | 97.7 | 105.0 | 110.4 | 110.5 | 110.9 | 113.3 | 110.1 | 105.3 | 0.6 | -4.3 |
| - Spot power | 3.2 | 1.2 | 4.8 | 6.7 | 7.5 | 7.5 | 7.0 | 10.5 | 7.8 | 6.8 | 2.4 | -7.5 | -64.6 |
| = Net firm power consumption | 61.4 | 73.9 | 87.1 | 91.0 | 97.5 | 103.0 | 103.5 | 100.4 | 105.5 | 103.2 | 102.9 | 0.9 | -0.3 |
| - Energy-intensive manufacturing | 26.2 | 27.9 | 30.0 | 29.6 | 28.4 | 30.2 | 31.1 | 30.5 | 32.1 | 29.6 | 30.3 | 0.2 | 2.3 |
| = General consumption | 35.2 | 46.0 | 57.1 | 61.5 | 69.1 | 72.8 | 72.4 | 69.9 | 73.4 | 73.6 | 72.6 | 1.3 | -1.4 |
| General consumption corrected for temperature | 36.3 | 45.1 | 54.6 | 65.4 | 69.6 | 73.5 | 74.9 | 74.4 | 74.0 | 76.3 | 75.3 | 1.1 | -1.4 |

**Source:** Statistics Norway and Norwegian Water Resources and Energy Directorate.

**Table B.9 Average prices[1] for electricity[2] and some selected oil products. Energy supplied**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Price in øre/kWh[4] | | | | | | | | | | | | | |
| **Electricity** | 45.7 | 46.5 | 46.6 | 47.8 | 46.8 | 49.7 | 52.4 | 55.0 | 51.0 | 50.3 | 52.3 | 61.0 | 68.0 | 90.0 |
| | Price in øre/kWh[4] | | | | | | | | | | | | | |
| **Heating products** | | | | | | | | | | | | | | |
| Heating kerosene | 33.9 | 40.1 | 37.4 | 37.8 | 37.1 | 37.7 | 41.6 | 43.8 | 42.6 | 47.6 | 59.5 | 61.1 | 57.2 | 60.4 |
| Fuel oil no.1/light fuel oils[3] | 26.6 | 31.9 | 28.3 | 28.0 | 28.2 | 29.6 | 34.0 | 37.0 | 34.3 | 39.9 | 51.5 | 53.4 | 48.8 | 54.1 |
| Fuel oil no.2 | 25.7 | 30.8 | 27.2 | 26.9 | 27.1 | [3].. | .. | .. | .. | .. | .. | .. | .. | .. |
| | Price in øre/litre[4] | | | | | | | | | | | | | |
| **Transport products** | | | | | | | | | | | | | | |
| Petrol, leaded, high oct. | 643 | 741 | 795 | 836 | 851 | 889 | . | . | . | . | . | . | . | . |
| Petrol, unl. 98 octane | 622 | 705 | 747 | 787 | 791 | 838 | 880 | 909 | 904 | 948 | 1 087 | 976 | 931 | 963 |
| Petrol, unl. 95 octane | 594 | 677 | 717 | 757 | 761 | 807 | 849 | 888 | 873 | 919 | 1 052 | 944 | 901 | 929 |
| Auto diesel | 286 | 341 | 326 | 403 | 649 | 701 | 757 | 779 | 781 | 827 | 991 | 862 | 808 | 834 |

[1] Including all taxes. [2] Price for households and agriculture. The price includes energy price, grid rent and taxes. Until 1992, prices are for firm power only. From 1993, both firm power and spot 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 B.10 Total primary energy supply. World, total and selected countries**

| | 1973 | 1980 | 1990 | 1995 | 2000 | 2001 | Per unit GDP (2001) | Per unit GDP (2001) | Per capita (2001) |
|---|---|---|---|---|---|---|---|---|---|
| | Mtoe | | | | | | toe/1 000 1995 USD | toe/1 000 1995 USD PPP[1] | toe/capita |
| **World, total** | **6 033.7** | **7 154.0** | **8 598.6** | **9 123.1** | **9 953.5** | **10 029.1** | **0.29** | **0.24** | **1.64** |
| **OECD** | **3 757.7** | **4 077.6** | **4 516.7** | **4 884.0** | **5 316.3** | **5 332.8** | **0.19** | **0.22** | **4.68** |
| Norway | 14.6 | 18.7 | 21.5 | 23.9 | 25.8 | 26.6 | 0.15 | 0.22 | 5.90 |
| Denmark | 19.8 | 19.8 | 17.6 | 20.1 | 19.4 | 19.8 | 0.10 | 0.14 | 3.69 |
| Finland | 21.4 | 25.4 | 29.2 | 29.6 | 33.0 | 33.8 | 0.20 | 0.27 | 6.52 |
| Iceland | 1.2 | 1.5 | 2.2 | 2.3 | 3.2 | 3.4 | 0.37 | 0.44 | 11.80 |
| Sweden | 39.3 | 39.9 | 46.7 | 50.0 | 47.5 | 51.1 | 0.17 | 0.24 | 5.74 |
| Belgium | 46.3 | 46.1 | 48.7 | 52.6 | 59.3 | 59.0 | 0.18 | 0.23 | 5.74 |
| France | 176.6 | 187.7 | 227.1 | 240.8 | 257.4 | 265.6 | 0.15 | 0.19 | 4.36 |
| Greece | 12.4 | 15.7 | 22.2 | 23.5 | 27.8 | 28.7 | 0.20 | 0.17 | 2.62 |
| Italy | 128.9 | 139.0 | 152.6 | 160.9 | 171.7 | 172.0 | 0.14 | 0.13 | 2.97 |
| Netherlands | 62.4 | 65.0 | 66.5 | 72.2 | 75.5 | 77.2 | 0.15 | 0.19 | 4.81 |
| Poland | 93.1 | 123.0 | 99.9 | 99.9 | 90.1 | 90.6 | 0.55 | 0.26 | 2.34 |
| Portugal | 7.2 | 10.3 | 17.2 | 20.0 | 24.6 | 24.7 | 0.19 | 0.15 | 2.46 |
| Spain | 52.4 | 68.6 | 91.2 | 103.3 | 124.3 | 127.4 | 0.18 | 0.17 | 3.16 |
| United Kingdom | 220.7 | 201.3 | 212.2 | 223.2 | 231.2 | 235.2 | 0.18 | 0.18 | 4.00 |
| Switzerland | 19.7 | 20.9 | 25.1 | 25.3 | 26.5 | 28.0 | 0.08 | 0.14 | 3.87 |
| Czech Republic | 45.4 | 47.3 | 47.4 | 41.0 | 40.4 | 41.4 | 0.73 | 0.30 | 4.03 |
| Turkey | 24.4 | 31.5 | 53.0 | 61.9 | 77.5 | 72.5 | 0.38 | 0.19 | 1.06 |
| Germany | 337.9 | 360.4 | 356.2 | 342.3 | 343.4 | 351.1 | 0.13 | 0.18 | 4.26 |
| Hungary | 21.3 | 28.5 | 28.5 | 25.6 | 24.9 | 25.3 | 0.45 | 0.22 | 2.49 |
| Austria | 21.7 | 23.3 | 25.0 | 27.2 | 28.8 | 30.7 | 0.11 | 0.15 | 3.78 |
| Canada | 161.0 | 193.0 | 209.1 | 231.8 | 250.9 | 248.2 | 0.35 | 0.30 | 7.98 |
| Mexico | 55.2 | 98.9 | 124.0 | 132.7 | 150.6 | 152.3 | 0.41 | 0.19 | 1.54 |
| United States | 1 736.5 | 1 811.7 | 1 927.6 | 2 088.5 | 2 303.8 | 2 281.4 | 0.25 | 0.25 | 7.98 |
| Japan | 323.6 | 346.5 | 436.5 | 495.4 | 524.2 | 520.7 | 0.09 | 0.17 | 4.09 |
| Republic of Korea | 21.6 | 41.4 | 92.6 | 147.9 | 191.2 | 194.8 | 0.30 | 0.29 | 4.11 |
| Australia | 57.6 | 70.4 | 87.5 | 94.4 | 109.8 | 115.6 | 0.25 | 0.24 | 5.94 |
| **Non-OECD** | **2 275.9** | **3 076.4** | **4 081.9** | **4 239.1** | **4 637.1** | **4 696.3** | **0.72** | **0.27** | **0.95** |
| Romania | 47.8 | 65.1 | 62.4 | 46.4 | 36.3 | 36.8 | 1.18 | 0.31 | 1.64 |
| Russia | .. | .. | .. | 628.4 | 614.0 | 621.4 | 1.65 | 0.67 | 4.29 |
| Egypt | 8.1 | 16.0 | 32.0 | 35.2 | 46.4 | 48.0 | 0.60 | 0.23 | 0.74 |
| Ethiopia | 9.4 | 11.1 | 15.2 | 16.5 | 18.7 | 19.2 | 2.42 | 0.39 | 0.29 |
| Nigeria | 39.0 | 52.9 | 70.9 | 79.7 | 91.1 | 95.4 | 2.85 | 0.93 | 0.73 |
| South Africa | 49.1 | 65.4 | 91.2 | 104.1 | 108.9 | 107.7 | 0.61 | 0.24 | 2.49 |
| Argentina | 35.6 | 41.9 | 45.0 | 53.1 | 61.5 | 57.6 | 0.21 | 0.15 | 1.54 |
| Brazil | 81.9 | 111.7 | 133.0 | 154.2 | 183.9 | 185.1 | 0.23 | 0.16 | 1.07 |
| Guatemala | 3.0 | 3.9 | 4.5 | 5.4 | 7.2 | 7.3 | 0.40 | 0.15 | 0.63 |
| Venezuela | 21.3 | 35.6 | 43.9 | 51.9 | 56.7 | 54.9 | 0.67 | 0.42 | 2.23 |
| Bangladesh | 6.4 | 8.4 | 12.9 | 16.2 | 18.6 | 20.4 | 0.40 | 0.10 | 0.15 |
| India | 193.6 | 243.4 | 363.2 | 440.6 | 523.6 | 531.5 | 1.08 | 0.20 | 0.51 |
| Indonesia | 40.2 | 59.9 | 92.8 | 123.1 | 146.1 | 152.3 | 0.70 | 0.27 | 0.73 |
| China[2] | 427.3 | 598.5 | 870.4 | 1 066.6 | 1 142.4 | 1 139.4 | 1.02 | 0.24 | 0.90 |
| Thailand | 16.4 | 22.8 | 43.2 | 63.2 | 72.2 | 75.5 | 0.43 | 0.21 | 1.23 |

[1] PPP (Purchasing power parity): GDP adjusted to local purchasing power. [2] Excluding Hong Kong.

**Source:** OECD/IEA: Energy Balances of OECD Countries 2000-2001 and OECD/IEA: Energy Balances of non-OECD Countries 2000-2001.

**Table B.11 Norway´s net exports of energy commodities. Selected countries and regions. 2003*. Million NOK**

| | Coal, coke and briquettes | Mineral oil and products | Gas, natural and manufactured | Electricity |
|---|---|---|---|---|
| Nordic countries . | 134 | 16 929 | 1 050 | -2 332 |
| EFTA. . . . . . . . . . . . . . | - | 184 | 124 | - |
| EU. . . . . . . . . . . . . . . . | 535 | 170 062 | 63 206 | -2 332 |
| Developing countries . | -98 | 3 193 | 678 | - |
| | | | | |
| Denmark. . . . . . . . . . . | 155 | 5 202 | 64 | -1 213 |
| Finland . . . . . . . . . . . . | 17 | 2 831 | 100 | -33 |
| Sweden . . . . . . . . . . . | -38 | 8 506 | 885 | -1 086 |
| Belgium . . . . . . . . . . . | -17 | 2 162 | 6 594 | - |
| France. . . . . . . . . . . . . | 43 | 18 070 | 12 263 | - |
| Ireland . . . . . . . . . . . . | - | 1 283 | - | - |
| Italy. . . . . . . . . . . . . . . | 0 | 6 283 | 4 937 | - |
| Netherlands . . . . . . . . | 0 | 30 082 | 6 101 | - |
| Portugal . . . . . . . . . . . | 91 | 669 | 25 | - |
| Spain . . . . . . . . . . . . . | 0 | 3 412 | 2 312 | - |
| UK . . . . . . . . . . . . . . . | -111 | 73 682 | 7 830 | - |
| Czech Republic. . . . . . | - | -1 | 2 191 | - |
| Turkey . . . . . . . . . . . . | - | -1 | 1 500 | - |
| Germany. . . . . . . . . . . | 317 | 17 879 | 22 096 | - |
| China . . . . . . . . . . . . . | -34 | 2 131 | 216 | - |
| Canada. . . . . . . . . . . . | - | 15 995 | 0 | - |
| USA . . . . . . . . . . . . . . | -8 | 25 572 | 1 614 | - |

**Source:** Statistics Norway.

# Agriculture

## Appendix C

**Table C.1 Agricultural area in use. km²**

| Year | 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* | 10 357 | 3 345 | 515 | 4 868 | 1 629 |

**Source:** Agricultural statistics from Statistics Norway.

**Table C.2 Sales of commercial fertilizer expressed as content of nitrogen and phosphorus**

| Year | 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 | 10.1 | 1.2 |

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

**Table C.3 Sales of pesticides. Environmental taxes on pesticides**

| Year | Sales of pesticides. Tonnes active substances | | | | | Taxes as per cent of purchase price[1] | | Taxes | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Fungi-cides | Insecti-cides | Herbi-cides | Other sub-stances including additives | Environ-mental tax | Control fee | Total | Environ-mental tax | Control fee and registra-tion fee |
| | Tonnes | | | | | Per cent | | Million NOK | | |
| 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 | 28.6 | 20.2 | 8.4 |
| 1991 | 771.0 | 144.2 | 18.4 | 563.6 | 44.8 | 13.0 | 6.0 | 26.9 | 18.8 | 8.1 |
| 1992 | 781.0 | 148.6 | 26.9 | 561.2 | 44.3 | 13.0 | 6.0 | 31.7 | 22.5 | 9.2 |
| 1993 | 764.5 | 179.7 | 16.9 | 510.0 | 57.9 | 13.0 | 6.0 | 32.3 | 21.9 | 10.4 |
| 1994 | 861.6 | 156.7 | 22.0 | 625.9 | 57.0 | 13.0 | 6.0 | 30.9 | 21.0 | 9.9 |
| 1995 | 931.3 | 167.3 | 20.4 | 688.9 | 54.7 | 13.0 | 6.0 | 27.9 | 18.9 | 9.0 |
| 1996 | 706.2 | 139.7 | 15.8 | 503.2 | 47.4 | 15.5 | 7.0 | 32.5 | 21.8 | 10.7 |
| 1997 | 754.2 | 175.4 | 19.5 | 503.8 | 55.5 | 15.5 | 7.0 | 30.7 | 21.0 | 9.7 |
| 1998 | 954.6 | 263.3 | 22.8 | 544.3 | 124.3 | 15.5 | 9.0 | 38.2 | 24.1 | 14.1 |
| 1999 | 796.3 | 219.9 | 23.8 | 448.7 | 103.9 | . | . | 52.8 | 35.4 | 17.4 |
| 2000 | 380.2 | 53.8 | 10.0 | 283.4 | 33.0 | . | . | 69.2 | 52.9 | 16.3 |
| 2001 | 518.7 | 119.9 | 8.5 | 377.2 | 13.1 | . | . | 44.8 | 34.9 | 9.9 |
| 2002 | 818.5 | 149.6 | 10.1 | 632.2 | 26.6 | . | . | 72.8 | 56.1 | 16.7 |
| 2003 | 688.5 | 167.1 | 13.6 | 462.6 | 45.2 | . | . | 83.6 | 65.4 | 18.2 |

[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 and Norwegian Agricultural Economics Research Institute.

**Table C.4 Organic farming**

| Year | No. of holdings inspected for organic farmingy | Area approved as organically operated | Area under conversion | No. of dairy cows on holdings approved for organic farming | No. of sheep on holdings approved for organic farming[1] | Total grants to organic farming | Of which conversion and acreage support |
|---|---|---|---|---|---|---|---|
| | | Decares | | | | Million NOK | |
| 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 |

[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 the registration date was 31 December.
**Source:** Debio and Norwegian Agricultural Authority.

**Table C.5 Organic farming. County. 2003**

| | No. of holdings inspected for organic farming | Area approved as organically operated | Area under conversion | Percentage of total agricultural area in use | No. of dairy cows on holdings approved for organic farming | Percentage of total no. of dairy cows |
|---|---|---|---|---|---|---|
| | | Decares | | Per cent | | Per cent |
| **Whole country** | **2 466** | **308 835** | **72 954** | **3.7** | **5 226** | **1.9** |
| Østfold | 157 | 18 147 | 5 532 | 3.1 | 304 | 5.5 |
| Akershus and Oslo | 145 | 22 916 | 4 161 | 3.4 | 574 | 11.1 |
| Hedmark | 251 | 34 319 | 9 960 | 4.1 | 795 | 5.0 |
| Oppland | 261 | 33 567 | 5 416 | 3.7 | 374 | 1.1 |
| Buskerud | 231 | 20 483 | 11 776 | 6.1 | 202 | 3.2 |
| Vestfold | 85 | 12 738 | 1 696 | 3.3 | 267 | 9.7 |
| Telemark | 128 | 13 298 | 3 565 | 6.5 | 193 | 7.2 |
| Aust-Agder | 30 | 2 994 | 93 | 2.7 | 62 | 2.6 |
| Vest-Agder | 46 | 7 038 | 1 283 | 4.2 | 225 | 3.6 |
| Rogaland | 51 | 6 160 | 758 | 0.7 | 241 | 0.5 |
| Hordaland | 107 | 8 676 | 1 002 | 2.2 | 150 | 1.0 |
| Sogn og Fjordane | 173 | 17 967 | 1 767 | 4.2 | 54 | 0.3 |
| Møre og Romsdal | 122 | 12 906 | 3 473 | 2.7 | 214 | 0.8 |
| Sør-Trøndelag | 292 | 45 572 | 5 214 | 6.6 | 773 | 2.8 |
| Nord-Trøndelag | 219 | 26 721 | 11 128 | 4.2 | 525 | 1.7 |
| Nordland | 114 | 16 650 | 5 450 | 3.7 | 173 | 0.9 |
| Troms | 45 | 7 175 | 660 | 2.9 | 100 | 1.7 |
| Finnmark | 9 | 1 507 | 20 | 1.5 | 0 | 0.0 |

**Source:** Debio and agricultural statistics from Statistics Norway.

**Table C.6 Number of holdings by size of agricultural area in use[1]**

| Year | Total | 5-49 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* | 58 041 | 8 371 | 12 055 | 18 494 | 16 835 | 2 286 |

[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.

# Forest and uncultivated land

## Appendix D

**Table D.1 Forest balance 2002. 1000 m$^3$ without bark**

| | Total | Spruce | Pine | Broad-leaved trees |
|---|---|---|---|---|
| Growing stock as of 01.01 | 710 447 | 313 176 | 237 997 | 159 273 |
| Total losses | 11 124 | 7 092 | 2 325 | 1 707 |
| Of which total roundwood cut | 8 864 | 5 998 | 1 826 | 1 041 |
| Sales, excl. fuelwood | 7 263 | 5 515 | 1 693 | 55 |
| Fuelwood, sales and private | 1 399 | 323 | 93 | 983 |
| Own use | 202 | 160 | 39 | 3 |
| Other losses | 2 259 | 1 094 | 499 | 667 |
| Logging waste | 573 | 360 | 110 | 104 |
| Natural losses | 1 686 | 734 | 390 | 562 |
| Total increments | 24 348 | 12 230 | 6 493 | 5 625 |
| Volume as of 31.12 | 723 672 | 318 315 | 242 166 | 163 191 |

**Source:** Statistics Norway and Norwegian Institute for Land Inventory.

**Table D.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 |
| 1999/2003[1] | 704 487 | 313 979 | 235 030 | 155 478 | 23 997 | 12 627 | 6 064 | 5 306 |
| **Region, 1999/2003** | | | | | | | | |
| Østfold, Akershus/Oslo, Hedmark | 195 913 | 99 682 | 73 698 | 22 533 | 7 397 | 4 150 | 2 246 | 1 001 |
| Oppland, Buskerud, Vestfold | 152 849 | 86 879 | 41 641 | 24 329 | 5 090 | 3 149 | 991 | 950 |
| Telemark, Aust-Agder, Vest-Agder | 125 940 | 40 723 | 56 639 | 28 578 | 3 802 | 1 516 | 1 319 | 967 |
| Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal | 90 385 | 23 551 | 35 360 | 31 474 | 3 454 | 1 602 | 873 | 979 |
| Sør-Trøndelag, Nord-Trøndelag | 85 727 | 50 610 | 19 033 | 16 084 | 2 580 | 1 639 | 398 | 543 |
| Nordland, Troms | 50 326 | 12 533 | 6 057 | 31 736 | 1 586 | 571 | 165 | 850 |
| Finnmark | 3 347 | 1 | 2 602 | 744 | 88 | 0 | 72 | 16 |

[1]Volume and average annual increment for all types of land use classes for 1999-2003 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 D.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 |

**Source:** Statistics Norway.

**Table D.4 Registered mortality of large carnivores and eagles**

| Hunting year | Bear | Wolf | Wolverine | Lynx | Eagle |
|---|---|---|---|---|---|
| 1993/1994 | 3 | - | 13 | 48 | 56 |
| 1994/1995 | 1 | - | 17 | 64 | 51 |
| 1995/1996 | 1 | - | 16 | 103 | 47 |
| 1996/1997 | 3 | - | 17 | 113 | 58 |
| 1997/1998 | 3 | - | 19 | 127 | 51 |
| 1998/1999 | 5 | 1 | 22 | 105 | 59 |
| 1999/2000 | 5 | 2 | 31 | 101 | 54 |
| 2000/2001 | 6 | 17 | 41 | 98 | 32 |
| 2001/2002 | 3 | 2 | 48 | 102 | 42 |
| 2002/2003 | 1 | 7 | 38 | 71 | 59 |
| **Cause of death 2002/2003** | | | | | |
| Killed by vechicle or train | - | 2 | - | 6 | 13 |
| Felled by permit[1] | - | 1 | 5 | - | 1 |
| Licenced hunting of wolverine | - | - | 28 | - | . |
| Quota hunting of lynx | - | - | - | 62 | . |
| Other causes[1] | 1 | 4 | 5 | 3 | 45 |

[1] Including animals felled in self-defence or illegally, unknown reasons, etc.
**Source:** Statistics Norway.

# Fisheries, sealing, whaling and fish farming

## Appendix E

**Table E.1 Stock trends for some important fish stocks. 1 000 tonnes**

| Year | North-East Arctic cod[1] | North-East Arctic haddock[1] | North-East Arctic saithe[2] | Greenland halibut[7] | Barents Sea capelin[3, 5] | Norwegian spring-spawning herring[3] | North Sea herring[4] | North Sea cod[4] |
|---|---|---|---|---|---|---|---|---|
| 1979 | 1 110 | 320 | 430 | 110 | 6 580 | 660 | 110 | 150 |
| 1980 | 860 | 260 | 550 | 90 | 8 220 | 700 | 130 | 170 |
| 1981 | 980 | 190 | 530 | 90 | 4 490 | 710 | 200 | 180 |
| 1982 | 750 | 120 | 480 | 90 | 4 210 | 680 | 280 | 180 |
| 1983 | 740 | 60 | 480 | 100 | 4 770 | 720 | 430 | 150 |
| 1984 | 810 | 40 | 410 | 90 | 3 300 | 710 | 680 | 130 |
| 1985 | 960 | 140 | 370 | 90 | 1 090 | 590 | 700 | 120 |
| 1986 | 1 290 | 280 | 350 | 90 | 160 | 470 | 680 | 110 |
| 1987 | 1 120 | 240 | 360 | 90 | 110 | 970 | 900 | 100 |
| 1988 | 910 | 160 | 360 | 80 | 360 | 2 900 | 1 190 | 100 |
| 1989 | 890 | 120 | 330 | 90 | 770 | 3 520 | 1 250 | 90 |
| 1990 | 960 | 120 | 400 | 80 | 4 900 | 3 670 | 1 180 | 80 |
| 1991 | 1 560 | 150 | 530 | 70 | 6 650 | 3 800 | 980 | 70 |
| 1992 | 1 910 | 230 | 700 | 50 | 5 370 | 3 670 | 700 | 70 |
| 1993 | 2 360 | 460 | 770 | 50 | 990 | 3 510 | 470 | 60 |
| 1994 | 2 150 | 540 | 760 | 50 | 260 | 3 960 | 510 | 70 |
| 1995 | 1 820 | 490 | 820 | 60 | 190 | 4 860 | 460 | 70 |
| 1996 | 1 700 | 420 | 840 | 60 | 470 | 6 500 | 450 | 80 |
| 1997 | 1 530 | 310 | 800 | 70 | 870 | 7 840 | 540 | 80 |
| 1998 | 1 220 | 190 | 910 | 70 | 1 860 | 7 120 | 720 | 70 |
| 1999 | 1 110 | 190 | 910 | 70 | 2 580 | 6 580 | 830 | 60 |
| 2000 | 1 140 | 170 | 890 | 70 | 3 840 | 5 290 | 820 | 40 |
| 2001 | 1 460 | 250 | 1 040 | 80 | 3 480 | 4 580 | 1 280 | 30 |
| 2002 | 1 680 | 290 | 1 150 | 70 | 2 120 | 4 590 | 1 570 | 40 |
| 2003 | 1 760 | 360 | 1 020 | 80 | 660 | 5 790 | 1 740 | 50 |
| 2004 | 1 750 | 360 | 1 000 | .. | .. | 6 300 | 2 010 | .. |

| Year | North Sea haddock[4] | North Sea saithe[4,6] | North Sea whiting[4] | North Sea plaice[4] | North Sea sole[4] | Blue whiting (northern and southern stock[4] | Mackerel (North Sea, western and southern)[4] |
|---|---|---|---|---|---|---|---|
| 1979 | 110 | 240 | .. | 280 | 40 | .. | 2 880 |
| 1980 | 150 | 230 | 550 | 270 | 30 | .. | 2 430 |
| 1981 | 240 | 240 | 520 | 280 | 20 | 2 810 | 2 490 |
| 1982 | 300 | 210 | 400 | 270 | 30 | 2 290 | 2 390 |
| 1983 | 250 | 210 | 360 | 300 | 40 | 1 850 | 2 660 |
| 1984 | 200 | 170 | 290 | 300 | 40 | 1 510 | 2 650 |
| 1985 | 240 | 150 | 290 | 330 | 40 | 1 650 | 2 640 |
| 1986 | 220 | 150 | 300 | 330 | 40 | 1 890 | 2 630 |
| 1987 | 150 | 150 | 320 | 360 | 30 | 1 700 | 2 600 |
| 1988 | 150 | 140 | 310 | 350 | 40 | 1 510 | 2 620 |
| 1989 | 120 | 110 | 300 | 390 | 30 | 1 450 | 2 680 |
| 1990 | 80 | 100 | 330 | 360 | 90 | 1 350 | 2 530 |
| 1991 | 60 | 90 | 280 | 300 | 80 | 1 790 | 2 840 |
| 1992 | 100 | 100 | 270 | 270 | 80 | 2 400 | 2 870 |
| 1993 | 130 | 100 | 240 | 240 | 60 | 2 360 | 2 710 |
| 1994 | 150 | 110 | 230 | 200 | 70 | 2 340 | 2 520 |
| 1995 | 150 | 160 | 250 | 180 | 60 | 2 180 | 2 730 |
| 1996 | 180 | 200 | 220 | 160 | 40 | 2 010 | 2 730 |
| 1997 | 190 | 200 | 190 | 130 | 30 | 2 070 | 2 850 |
| 1998 | 160 | 210 | 160 | 180 | 20 | 2 850 | 2 880 |
| 1999 | 110 | 200 | 160 | 170 | 40 | 3 450 | 3 150 |
| 2000 | 90 | 230 | 200 | 200 | 40 | 3 490 | 3 120 |
| 2001 | 240 | 240 | 220 | 180 | 40 | 3 680 | 3 430 |
| 2002 | 390 | 360 | 210 | 140 | 30 | 4 070 | 3 150 |
| 2003 | 460 | .. | 240 | 150 | 30 | 4 300 | 3 090 |
| 2004 | .. | .. | .. | .. | .. | 3 790 | .. |

[1] Fish aged 3 years and older. [2] Fish aged 2 years and older. [3] Fish aged 1 year and older. [4] Spawning stock. [5] As of 1 August. [6] Including saithe west of Scotland. [7] Fish aged 5 years and older.
**Source:** ICES and the Institute of Marine Research.

**Table E.2 Norwegian catches by species and groups of species. 1 000 tonnes**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000* | 2001* | 2002* | 2003* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 2 198 | 2 619 | 2 584 | 2 526 | 2 702 | 2 820 | 3 055 | 3 040 | 2 809 | 2 891 | 2 862 | 2 924 | 2 699 |
| Cod | 164 | 219 | 275 | 374 | 365 | 358 | 401 | 321 | 257 | 219 | 209 | 228 | 217 |
| Haddock | 25 | 40 | 44 | 74 | 80 | 97 | 106 | 79 | 53 | 46 | 52 | 55 | 60 |
| Saithe | 140 | 168 | 188 | 189 | 219 | 222 | 184 | 194 | 198 | 170 | 170 | 203 | 212 |
| Tusk | 27 | 26 | 27 | 20 | 19 | 19 | 14 | 21 | 23 | 22 | 19 | 18 | 13 |
| Ling/Blue ling | 23 | 22 | 20 | 19 | 19 | 19 | 16 | 23 | 20 | 18 | 15 | 16 | 15 |
| Greenland halibut | 33 | 11 | 15 | 13 | 14 | 17 | 12 | 12 | 20 | 13 | 15 | 12 | 13 |
| Redfish | 56 | 38 | 33 | 29 | 22 | 30 | 23 | 29 | 31 | 26 | 29 | 16 | 17 |
| Others and unspecified[2] | 44 | 43 | 57 | 31 | 27 | 32 | 40 | 43 | 29 | 29 | 40 | 29 | 28 |
| Capelin | 576 | 811 | 530 | 113 | 28 | 208 | 158 | 88 | 92 | 371 | 483 | 522 | 249 |
| Mackerel | 179 | 207 | 224 | 260 | 202 | 137 | 137 | 158 | 161 | 174 | 181 | 184 | 163 |
| Herring | 201 | 227 | 352 | 539 | 687 | 763 | 923 | 832 | 829 | 800 | 581 | 574 | 560 |
| Sprat | 34 | 33 | 47 | 44 | 41 | 59 | 7 | 35 | 22 | 6 | 12 | 3 | 3 |
| Other industrial fisheries[1] | 447 | 527 | 541 | 587 | 745 | 642 | 798 | 964 | 828 | 734 | 811 | 804 | 922 |
| Crustaceans and molluscs | 58 | 57 | 61 | 48 | 49 | 44 | 45 | 61 | 68 | 71 | 70 | 76 | 74 |
| Seaweed | 191 | 189 | 170 | 185 | 185 | 173 | 192 | 180 | 179 | 192 | 175 | 183 | 153 |

[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 E.3 Consumption of antibacterial agents in fish farming. kg of active ingredients**

| Year | Total | Oxytetra-cyclin-chloride | Nifura-zolidone | Oxolinic acid | Trimeto-prim + sul-phadiazine (Tribrissen) | Sulpha-merazine | Flumequin | Florfenicol |
|---|---|---|---|---|---|---|---|---|
| 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 |

**Source:** Norwegian Institute of Public Health.

**Table E.4 Exports of some main groups of fish products. 1 000 tonnes**

| Year | Fresh | Frozen whole | Fillets | Salted or smoked | Dried | Canned, etc. | Meal | Oil |
|---|---|---|---|---|---|---|---|---|
| 1981 | 24.6 | 58.7 | 74.0 | 13.6 | 86.2 | 15.0 | 266.5 | 107.3 |
| 1982 | 46.2 | 100.2 | 76.3 | 14.9 | 68.8 | 11.2 | 228.6 | 101.1 |
| 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* | 513.5 | 823.3 | 204.4 | 43.2 | 71.3 | 9.9 | 74.0 | 31.5 |

**Source:** External Trade Statistics from Statistics Norway.

**Table E.5 Exports of fish and fish products by important recipient countries. Million NOK**

| Year | Total | EU-countries, total | Of this | | | | Other countries, total | Of this | |
|---|---|---|---|---|---|---|---|---|---|
| | | | France | Denmark | United Kingdom | Germany | | Japan | USA |
| 1982 | 5 931.4 | 2 494.0 | 419.9 | 211.4 | 880.9 | 338.3 | 3 437.5 | 229.5 | 421.2 |
| 1983 | 7 367.7 | 3 186.2 | 568.8 | 337.2 | 1 022.1 | 515.0 | 4 181.3 | 334.5 | 747.6 |
| 1984 | 7 675.2 | 3 233.3 | 530.3 | 350.3 | 1 026.7 | 545.8 | 4 442.1 | 408.2 | 920.1 |
| 1985 | 8 172.3 | 3 605.0 | 605.1 | 377.1 | 1 202.0 | 632.8 | 4 567.8 | 463.8 | 1 129.2 |
| 1986 | 8 749.4 | 4 293.9 | 781.0 | 626.9 | 1 014.2 | 705.5 | 4 455.5 | 408.8 | 1 194.7 |
| 1987 | 9 992.3 | 5 597.0 | 1 114.1 | 926.7 | 1 059.1 | 754.2 | 4 395.3 | 501.0 | 1 397.9 |
| 1988 | 10 693.1 | 6 107.2 | 1 318.6 | 1 115.1 | 987.2 | 932.3 | 4 585.9 | 808.0 | 1 059.6 |
| 1989 | 10 999.2 | 6 416.1 | 1 305.5 | 1 196.0 | 1 019.5 | 892.9 | 4 583.1 | 755.7 | 996.1 |
| 1990 | 13 002.4 | 8 119.2 | 1 617.1 | 2 046.3 | 868.8 | 1 046.5 | 4 883.3 | 1 067.5 | 754.7 |
| 1991 | 14 940.4 | 9 114.8 | 1 534.8 | 2 021.9 | 991.0 | 1 196.1 | 5 825.6 | 1 797.7 | 436.4 |
| 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 | 400.0 |
| 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 | 565.7 |
| 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 | 723.1 |
| 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 | 800.1 |
| 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 | 762.7 |
| 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 | 962.9 |
| 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 | 999.8 |
| 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 | 1 351.4 |
| 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 | 1 390.3 |
| 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 | 1 121.2 |
| 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 | 1 296.0 |
| 2003* | 26 395.5 | 14 851.7 | 2 311.1 | 3 071.8 | 1 501.0 | 1 416.9 | 11 543.6 | 2 516.0 | 1 045.3 |

**Source:** External Trade Statistics from Statistics Norway.

**Table E.6 Exports of salmon**

| Year | Total | | Farmed salmon. Fresh, chilled and frozen | | Fresh and frozen fillets, smoked, gravlax, other salmon, etc.[1] | |
|---|---|---|---|---|---|---|
| | Amount 1000 tonnes | Value Million NOK | Amount 1000 tonnes | Value Million NOK | Amount 1000 tonnes | Value Million NOK |
| 1981 | 7.9 | 317.7 | 7.5 | 292.9 | 0.4 | 24.9 |
| 1982 | 9.6 | 422.7 | 9.2 | 395.3 | 0.4 | 27.4 |
| 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* | 415.0 | 10 059.4 | 364.6 | 7 769.4 | 50.4 | 2 290.0 |

[1] Mainly farmed salmon, but other categories are also included.
**Source:** External Trade Statistics from Statistics Norway.

**Table E.7 Catch quantities[1] and export value[2] of fish and fish products. Selected countries**

| Country[3] | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | 87 672 | 51 163 | 93 774 | 52 682 | 95 502 | 55 295 | 92 862 | 55 194 | 93 191 | 58 211 |
| China[5] | 17 229 | 2 656 | 17 240 | 2 960 | 16 987 | 3 603 | 16 529 | 3 999 | 16 553 | 4 485 |
| Peru | 4 338 | 639 | 8 429 | 788 | 10 659 | 1 129 | 7 986 | 1 213 | 8 767 | 1 066 |
| USA | 4 709 | 2 400 | 4 750 | 2 945 | 4 717 | 3 055 | 4 944 | 3 316 | 4 937 | 3 260 |
| Indonesia | 3 961 | 1 628 | 4 045 | 1 527 | 4 120 | 1 584 | 4 273 | 1 535 | 4 505 | 1 491 |
| Japan | 5 304 | 718 | 5 189 | 720 | 4 984 | 802 | 4 713 | 768 | 4 443 | 789 |
| Chile | 3 265 | 1 597 | 5 050 | 1 700 | 4 300 | 1 794 | 3 797 | 1 939 | 4 271 | 1 869 |
| India | 3 373 | 1 049 | 3 472 | 1 180 | 3 666 | 1 405 | 3 777 | 1 238 | 3 770 | 1 411 |
| Russia | 4 455 | 1 168 | 4 141 | 1 218 | 3 974 | 1 386 | 3 628 | 1 528 | 3 232 | 1 399 |
| Thailand | 2 930 | 4 031 | 2 952 | 4 110 | 2 997 | 4 367 | 2 932 | 4 039 | 2 921 | 3 676 |
| Norway | 2 861 | 3 661 | 2 628 | 3 765 | 2 699 | 3 533 | 2 687 | 3 364 | 2 743 | 3 569 |
| Iceland | 1 682 | 1 434 | 1 736 | 1 379 | 1 983 | 1 229 | 1 981 | 1 270 | 2 129 | 1 429 |
| Philippines | 1 833 | 445 | 1 873 | 372 | 1 897 | 400 | 1 949 | 374 | 2 031 | 415 |
| Korea Rep. | 2 028 | 1 246 | 2 119 | 1 393 | 1 825 | 1 386 | 1 991 | 1 156 | 1 669 | 1 046 |
| Viet Nam | 1 294 | 821 | 1 386 | 940 | [4]1 451 | 1 481 | [4]1 491 | 1 781 | [4]1 508 | 2 030 |
| Mexico | 1 180 | 718 | 1 206 | 650 | 1 316 | 707 | 1 399 | 668 | 1 451 | 602 |

[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 2002. [4] FAO estimate from available sources of information or calculation based on specific assumptions. [5] Catch data, considered to be overstated since the early 1990s, under review and subject to possible downward revisions.
**Source:** FAO.

**Table E.8 Total catches[1] in world fisheries. 2002**

| | 1000 tonnes | Per cent |
|---|---|---|
| **Total catches** | **93 191** | **100.0** |
| **By area:** | | |
| Inland waters | 8 738 | 9.4 |
| Marine areas | 84 452 | 90.6 |
| **By animal group:** | | |
| Fishes | 78 522 | 84.3 |
| Crustaceans | 6 706 | 7.2 |
| Molluscs | 7 427 | 8.0 |
| Others | 535 | 0.6 |
| **Catches in marine areas by various distributions** | | |
| **Marine catches, total** | **84 452** | **100.0** |
| **By marine fishing areas:** | | |
| North Atlantic | 13 294 | 15.7 |
| Central Atlantic | 5 138 | 6.1 |
| Mediterranean and Black Sea | 1 550 | 1.8 |
| South Atlantic | 3 926 | 4.6 |
| Indian Ocean | 9 352 | 11.1 |
| North Pacific | 24 139 | 28.6 |
| Central Pacific | 12 547 | 14.9 |
| South Pacific | 14 505 | 17.2 |
| **By continents:** | | |
| Africa | 4 706 | 5.6 |
| North America | 8 072 | 9.6 |
| South America | 15 644 | 18.5 |
| Asia | 39 773 | 47.1 |
| Europe | 14 809 | 17.5 |
| Oceania | 1 110 | 1.3 |
| Other, not elsewhere specified | 338 | 0.4 |
| **By species:** | | |
| Anchoveta - *Engraulis ringens* | 9 703 | 11.5 |
| Alaska pollock - *Theragra chalcogramma* | 2 655 | 3.1 |
| Skipjack tuna - *Katsuwonus pelamis* | 2 031 | 2.4 |
| Capelin - *Mallotus villosus* | 1 961 | 2.3 |
| Atlantic herring - *Clupea harengus* | 1 872 | 2.2 |
| Japanese anchovy - *Engraulis japonicus* | 1 854 | 2.2 |
| Chilean jack mackerel - *Trachurus murphyi* | 1 750 | 2.1 |
| Blue whiting - *Micromesistius poutassou* | 1 603 | 1.9 |
| Chub mackerel - *Scomber japonicus* | 1 471 | 1.7 |
| Largehead hairtail - *Trichiurus lepturus* | 1 452 | 1.7 |
| Yellowfin tuna - *Thunnus albacares* | 1 341 | 1.6 |
| European pilchard - *Sardina pilchardus* | 1 090 | 1.3 |
| Atlantic cod - *Gadus morhua* | 890 | 1.1 |
| Atlantic mackerel - *Scomber scombrus* | 769 | 0.9 |
| Californian pilchard - *Sardinops caeruleus* | 722 | 0.9 |
| European anchovy - *Engraulis encrasicolus* | 661 | 0.8 |
| European sprat - *Sprattus sprattus* | 620 | 0.7 |
| Akiami paste shrimp - *Acetes japonicus* | 585 | 0.7 |
| Gulf menhaden - *Brevoortia patronus* | 582 | 0.7 |
| Japanese Spanish mackerel - *Scomberomorus niphonius* | 554 | 0.7 |
| Argentine shortfin squid - *Illex argentinus* | 511 | 0.6 |
| Japanese flying squid - *Todarodes pacificus* | 504 | 0.6 |
| Round sardinella - *Sardinella aurita* | 444 | 0.5 |
| Bigeye tuna - *Thunnus obesus* | 430 | 0.5 |
| Indian oil sardine - *Sardinella longiceps* | 410 | 0.5 |
| Argentine hake - *Merluccius hubbsi* | 409 | 0.5 |

[1] Not including farmed fish. Not including whales, seals and other sea mammals and aquatic plants.
**Source:** FAO.

# Air pollution and climate

## Appendix F

**Table F.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 | $C_3F_8$ | $CF_4$ | C2F6 | $SF_6$ | $CO_2$-equiv-alents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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. . . . | 30.4 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1974. . . . | 27.6 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1975. . . . | 30.5 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1976. . . . | 33.3 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1977. . . . | 33.2 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1978. . . . | 32.5 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1979. . . . | 34.5 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1980. . . . | 31.7 | 259 | 14 | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1981. . . . | 31.7 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 0 | .. |
| 1982. . . . | 30.8 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 91 | .. |
| 1983. . . . | 31.8 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 100 | .. |
| 1984. . . . | 33.7 | .. | .. | - | - | - | - | - | - | - | .. | .. | .. | 185 | .. |
| 1985. . . . | 32.1 | .. | .. | - | - | - | - | - | - | - | .. | 489 | 20 | 199 | .. |
| 1986. . . . | 34.6 | .. | .. | - | - | - | - | - | - | - | .. | 479 | 20 | 240 | .. |
| 1987. . . . | 33.0 | 292 | 16 | - | - | - | - | - | - | - | .. | 464 | 19 | 240 | 53 |
| 1988. . . . | 35.4 | 292 | 16 | - | - | - | - | - | - | - | .. | 443 | 18 | 223 | 55 |
| 1989. . . . | 33.9 | 307 | 17 | - | - | - | - | - | - | - | .. | 430 | 18 | 107 | 51 |
| 1990. . . . | 34.7 | 307 | 18 | - | - | - | - | - | 0 | - | .. | 479 | 20 | 91 | 52 |
| 1991. . . . | 33.6 | 311 | 17 | - | - | - | 0 | - | 0 | - | .. | 369 | 14 | 86 | 50 |
| 1992. . . . | 33.9 | 316 | 15 | - | - | - | 0 | - | 1 | - | .. | 294 | 11 | 29 | 48 |
| 1993. . . . | 35.6 | 322 | 16 | - | - | - | 2 | - | 1 | - | .. | 290 | 10 | 30 | 50 |
| 1994. . . . | 37.3 | 326 | 17 | 0 | 0 | 0 | 5 | 0 | 1 | - | .. | 251 | 9 | 36 | 52 |
| 1995. . . . | 37.4 | 329 | 17 | 0 | 0 | 2 | 10 | 2 | 1 | - | 0 | 229 | 8 | 24 | 52 |
| 1996. . . . | 40.6 | 332 | 17 | 0 | 0 | 5 | 17 | 4 | 1 | 0 | 0 | 214 | 5 | 23 | 55 |
| 1997. . . . | 40.6 | 335 | 17 | 0 | 0 | 10 | 26 | 7 | 2 | 0 | 0 | 201 | 8 | 23 | 55 |
| 1998. . . . | 40.8 | 331 | 18 | 0 | 0 | 15 | 38 | 10 | 5 | 0 | 0 | 185 | 7 | 29 | 55 |
| 1999. . . . | 41.3 | 329 | 18 | 0 | 1 | 20 | 50 | 15 | 6 | 0 | 0 | 164 | 6 | 35 | 56 |
| 2000. . . . | 40.9 | 334 | 18 | 0 | 1 | 26 | 61 | 20 | 8 | 0 | 0 | 131 | 5 | 37 | 55 |
| 2001. . . . | 42.1 | 333 | 18 | 0 | 2 | 33 | 72 | 27 | 10 | 0 | 0 | 152 | 6 | 32 | 57 |
| 2002*. . . | 40.9 | 327 | 19 | 0 | 2 | 41 | 86 | 35 | 12 | 1 | 0 | 163 | 7 | 10 | 55 |
| 2003*. . . | 42.7 | 327 | 18 | 0 | 5 | 27 | 65 | 20 | 11 | 0 | - | 102 | 4 | 11 | 56 |

[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 F.2 Emissions to air**

| | $SO_2$ | $NO_X$ | $NH_3$ | Acid equivalents[1] | NMVOC | CO | Particulates[2] |
|---|---|---|---|---|---|---|---|
| | | | | 1000 tonnes | | | |
| 1973 | 156 | 183 | .. | .. | 187 | 718 | .. |
| 1974 | 149 | 180 | .. | .. | 179 | 678 | .. |
| 1975 | 138 | 185 | .. | .. | 200 | 732 | .. |
| 1976 | 146 | 181 | .. | .. | 202 | 775 | .. |
| 1977 | 146 | 195 | .. | .. | 207 | 821 | .. |
| 1978 | 142 | 187 | .. | .. | 166 | 847 | .. |
| 1979 | 144 | 197 | .. | .. | 182 | 885 | .. |
| 1980 | 136 | 191 | 20 | 9.6 | 173 | 878 | 47 |
| 1981 | 128 | 181 | .. | .. | 181 | 871 | .. |
| 1982 | 110 | 185 | .. | .. | 189 | 879 | .. |
| 1983 | 103 | 190 | .. | .. | 201 | 871 | .. |
| 1984 | 95 | 204 | .. | .. | 212 | 898 | .. |
| 1985 | 98 | 216 | .. | .. | 231 | 901 | .. |
| 1986 | 91 | 231 | .. | .. | 249 | 926 | .. |
| 1987 | 73 | 230 | 21 | 8.5 | 253 | 886 | 51 |
| 1988 | 67 | 226 | 19 | 8.1 | 252 | 917 | .. |
| 1989 | 58 | 225 | 21 | 7.9 | 275 | 869 | 48 |
| 1990 | 52 | 224 | 20 | 7.7 | 294 | 867 | 70 |
| 1991 | 44 | 214 | 21 | 7.2 | 294 | 800 | 64 |
| 1992 | 36 | 212 | 22 | 7.0 | 322 | 778 | 61 |
| 1993 | 35 | 221 | 22 | 7.2 | 338 | 781 | 68 |
| 1994 | 35 | 219 | 22 | 7.2 | 352 | 766 | 69 |
| 1995 | 33 | 221 | 23 | 7.2 | 367 | 734 | 68 |
| 1996 | 33 | 230 | 24 | 7.4 | 371 | 707 | 70 |
| 1997 | 30 | 233 | 23 | 7.4 | 369 | 670 | 74 |
| 1998 | 30 | 234 | 23 | 7.4 | 361 | 634 | 67 |
| 1999 | 28 | 237 | 23 | 7.4 | 368 | 600 | 65 |
| 2000 | 27 | 224 | 23 | 7.1 | 380 | 571 | 66 |
| 2001 | 25 | 220 | 23 | 6.9 | 391 | 560 | 65 |
| 2002* | 22 | 213 | 22 | 6.6 | 345 | 530 | 62 |
| 2003* | 23 | 220 | 23 | 6.8 | 301 | 494 | 60 |

[1] Total acidifying effect of $SO_2$, $NO_x$ and $NH_3$. [2] $PM_{10}$.

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

**Table F.3 Emissions of greenhouse gases to air by sector. 2001**

| | $CO_2$ | $CH_4$ | $N_2O$ | HFC[1] | PFC[2] | $SF_6$ | $CO_2$ equivalents |
|---|---|---|---|---|---|---|---|
| | Mill. tonnes | 1000 tonnes | | Tonnes | | | Mill. tonnes |
| **Total** | **42.1** | **333.4** | **17.9** | **143.6** | **157.9** | **32.4** | **56.7** |
| **Energy sectors** | **14.1** | **38.6** | **0.1** | **1.7** | **0.0** | **2.7** | **15.0** |
| Extraction of oil and gas[3] | 11.8 | 37.4 | 0.1 | 1.5 | 0.0 | - | 12.7 |
| Extraction of coal | 0.0 | 1.0 | - | 0.0 | - | - | 0.0 |
| Oil refining | 1.9 | 0.1 | 0.0 | 0.0 | - | - | 1.9 |
| Electricity supplies[4] | 0.3 | 0.2 | 0.0 | 0.0 | - | 2.7 | 0.4 |
| **Manufacturing and mining** | **11.7** | **27.5** | **5.7** | **27.2** | **157.9** | **27.4** | **15.8** |
| Oil drilling | 0.4 | 0.2 | 0.0 | 0.0 | - | - | 0.5 |
| Manufacture of pulp and paper | 0.5 | 10.9 | 0.1 | 0.0 | - | - | 0.8 |
| Manufacture of basic chemicals | 3.0 | 1.2 | 5.5 | 0.1 | - | - | 4.7 |
| Manufacture of minerals[5] | 1.9 | 0.0 | 0.1 | 0.0 | - | - | 1.9 |
| Manufacture of iron, steel and ferro-alloys | 2.6 | 0.5 | 0.0 | 0.6 | - | - | 2.6 |
| Manufacture of other metals | 2.3 | 0.0 | 0.0 | 0.6 | 157.9 | 27.4 | 4.0 |
| Manufacture of metal goods, boats, ships and oil platforms | 0.3 | 0.0 | 0.0 | 15.0 | - | 0.1 | 0.3 |
| Manufacture of wood, plastic, rubber, and chemical goods, printing | 0.2 | 14.7 | 0.0 | 0.7 | - | - | 0.5 |
| Manufacture of consumer goods | 0.6 | 0.0 | 0.0 | 10.1 | 0.0 | - | 0.6 |
| **Other** | **11.0** | **258.9** | **10.7** | **100.2** | **0.0** | **1.9** | **20.1** |
| Construction | 0.7 | 0.1 | 0.1 | 1.8 | - | - | 0.7 |
| Agriculture and forestry | 0.5 | 96.6 | 9.4 | 1.3 | - | - | 5.4 |
| Fishing, whaling and sealing | 1.4 | 0.1 | 0.0 | 6.0 | 0.0 | - | 1.5 |
| Land transport, domestic | 3.5 | 0.2 | 0.2 | 8.0 | 0.0 | - | 3.6 |
| Sea transport, domestic | 1.5 | 0.2 | 0.0 | 3.1 | 0.0 | - | 1.5 |
| Air transport[6] | 1.1 | 0.0 | 0.0 | 0.5 | - | - | 1.1 |
| Other private services | 1.8 | 0.4 | 0.3 | 73.8 | 0.0 | 1.9 | 2.1 |
| Public sector, municipal[7] | 0.2 | 161.3 | 0.5 | 3.6 | 0.0 | - | 3.8 |
| Public sector, state | 0.3 | 0.0 | 0.0 | 2.0 | 0.0 | - | 0.3 |
| **Private households** | **5.2** | **8.4** | **1.4** | **14.6** | **-** | **0.3** | **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 F.4 Emissions to air by sector. 2001**

| | $SO_2$ | $NO_X$ | $NH_3$ | Acid equivalents[1] | NMVOC | CO | Particulates[2] |
|---|---|---|---|---|---|---|---|
| | | | | 1000 tonnes | | | |
| **Total** | **24.6** | **220.4** | **22.7** | **6.9** | **391.4** | **559.6** | **65.3** |
| **Energy sectors** | **3.0** | **58.7** | **0.0** | **1.4** | **270.6** | **10.2** | **1.0** |
| Extraction of oil and gas[3] | 0.5 | 55.0 | - | 1.2 | 260.6 | 8.1 | 0.6 |
| Extraction of coal | 0.0 | 0.0 | - | 0.0 | 0.0 | 0.0 | 0.0 |
| Oil refining | 1.9 | 2.3 | - | 0.1 | 9.4 | 0.0 | 0.2 |
| Electricity supplies[4] | 0.6 | 1.4 | 0.0 | 0.0 | 0.6 | 2.1 | 0.1 |
| **Manufacturing and mining** | **17.0** | **28.8** | **0.7** | **1.2** | **23.0** | **49.6** | **11.8** |
| Oil drilling | 0.2 | 6.7 | - | 0.2 | 0.6 | 0.7 | 0.7 |
| Manufacture of pulp and paper | 1.7 | 2.1 | - | 0.1 | 0.5 | 4.6 | 0.6 |
| Manufacture of basic chemicals | 5.3 | 4.8 | 0.4 | 0.3 | 1.6 | 32.1 | 2.4 |
| Manufacture of minerals[5] | 1.6 | 5.9 | 0.2 | 0.2 | 2.0 | 0.9 | 2.3 |
| Manufacture of iron, steel and ferro-alloys | 5.2 | 5.3 | - | 0.3 | 1.8 | 1.1 | 2.4 |
| Manufacture of other metals | 1.9 | 1.4 | 0.1 | 0.1 | 0.0 | 1.1 | 3.0 |
| Manufacture of metal goods, boats, ships and oil platforms | 0.1 | 0.7 | 0.0 | 0.0 | 2.6 | 1.2 | 0.0 |
| Manufacture of wood, plastic, rubber, and chemical goods, printing | 0.3 | 0.9 | 0.0 | 0.0 | 12.7 | 7.1 | 0.2 |
| Manufacture of consumer goods | 0.6 | 1.0 | 0.0 | 0.0 | 1.2 | 0.8 | 0.1 |
| **Other** | **3.7** | **114.5** | **20.6** | **3.8** | **42.4** | **98.3** | **7.8** |
| Construction | 0.1 | 5.8 | 0.0 | 0.1 | 10.4 | 4.6 | 1.7 |
| Agriculture and forestry | 0.2 | 6.7 | 20.1 | 1.3 | 3.2 | 14.5 | 2.9 |
| Fishing, whaling and sealing | 0.9 | 32.4 | 0.0 | 0.7 | 0.8 | 6.7 | 0.2 |
| Land transport, domestic | 0.2 | 23.4 | 0.1 | 0.5 | 4.9 | 20.5 | 2.2 |
| Sea transport, domestic | 1.4 | 32.6 | - | 0.8 | 1.6 | 1.4 | 0.3 |
| Air transport[6] | 0.2 | 3.6 | - | 0.1 | 2.4 | 5.6 | 0.0 |
| Other private services | 0.4 | 6.5 | 0.3 | 0.2 | 15.8 | 43.8 | 0.4 |
| Public sector, municipal[7] | 0.1 | 0.2 | - | 0.0 | 1.6 | 0.2 | 0.0 |
| Public sector, state | 0.1 | 3.5 | 0.0 | 0.1 | 1.7 | 0.9 | 0.0 |
| **Private households** | **0.9** | **18.4** | **1.4** | **0.5** | **55.3** | **401.5** | **44.7** |

[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 F.5 Emissions to air by source[1]. 2001**

| | $CO_2$ | $CH_4$ | $N_2O$ | $SO_2$ | $NO_X$ | $NH_3$ | NMVOC | CO | Particu-lates[2] |
|---|---|---|---|---|---|---|---|---|---|
| | Mill. tonnes | 1 000 tonnes | | | | | | | |
| **Total** | **42.1** | **333.4** | **17.9** | **24.6** | **220.4** | **22.7** | **391.4** | **559.6** | **65.3** |
| Stationary combustion | 17.9 | 11.6 | 0.4 | 6.3 | 59.6 | 0.1 | 12.7 | 201.3 | 46.2 |
| Process emissions | 8.7 | 318.8 | 15.2 | 14.5 | 10.7 | 20.8 | 321.3 | 33.1 | 13.9 |
| Mobile combustion | 15.4 | 3.0 | 2.4 | 3.8 | 150.2 | 1.8 | 57.3 | 325.2 | 5.2 |
| **Stationary combustion** | | | | | | | | | |
| **Total** | **17.9** | **11.6** | **0.4** | **6.3** | **59.6** | **0.1** | **12.7** | **201.3** | **46.2** |
| Oil and gas extraction | 10.6 | 3.6 | 0.1 | 0.3 | 45.0 | - | 1.5 | 7.9 | 0.5 |
| Natural gas | 8.1 | 3.1 | 0.1 | - | 29.3 | - | 0.8 | 5.9 | 0.4 |
| Flaring | 1.3 | 0.1 | 0.0 | - | 6.7 | - | 0.0 | 0.8 | 0.0 |
| Diesel combustion | 0.5 | 0.0 | 0.0 | 0.3 | 8.2 | - | 0.5 | 0.6 | 0.0 |
| Gas terminals | 0.7 | 0.3 | 0.0 | 0.0 | 0.8 | - | 0.1 | 0.6 | 0.0 |
| Manufacturing and mining | 5.4 | 0.7 | 0.2 | 4.6 | 10.6 | - | 2.1 | 14.9 | 0.8 |
| Refining | 1.2 | 0.1 | 0.0 | 0.7 | 1.3 | - | 0.6 | 0.0 | 0.1 |
| Manufacture of pulp and paper | 0.5 | 0.4 | 0.1 | 1.3 | 2.0 | - | 0.4 | 4.6 | 0.2 |
| Manufacture of mineral products | 0.8 | 0.0 | 0.0 | 0.3 | 3.8 | - | 0.1 | 0.3 | 0.0 |
| Manufacture of chemicals | 1.5 | 0.1 | 0.0 | 0.5 | 1.4 | - | 0.0 | 0.1 | 0.1 |
| Manufacture of metals | 0.5 | 0.0 | 0.0 | 0.2 | 0.6 | - | 0.1 | 1.0 | 0.0 |
| Other manufacturing | 0.9 | 0.2 | 0.0 | 1.6 | 1.4 | - | 0.9 | 9.0 | 0.3 |
| Other industries | 1.0 | 0.6 | 0.0 | 0.6 | 1.1 | - | 0.1 | 10.0 | 2.1 |
| Dwellings | 0.8 | 6.6 | 0.0 | 0.7 | 1.9 | 0.1 | 8.6 | 168.3 | 42.7 |
| Incineration of waste and landfill gas | 0.2 | 0.1 | 0.0 | 0.1 | 1.0 | - | 0.4 | 0.1 | 0.0 |
| **Process emissions** | | | | | | | | | |
| **Total** | **8.7** | **318.8** | **15.2** | **14.5** | **10.7** | **20.8** | **321.3** | **33.1** | **13.9** |
| Oil and gas extraction | 1.0 | 33.8 | 0.0 | - | 0.4 | - | 258.9 | 0.1 | 0.7 |
| Venting, leaks, etc. | 0.2 | 12.5 | 0.0 | - | 0.4 | - | 5.7 | 0.1 | 0.7 |
| Oil loading at sea | 0.8 | 19.7 | - | - | - | - | 235.7 | - | - |
| Oil loading, on shore | 0.0 | 0.1 | - | - | - | - | 15.3 | - | - |
| Gas terminals | 0.0 | 1.6 | - | - | - | - | 2.2 | - | - |
| Manufacturing and mining | 7.5 | 2.5 | 5.5 | 14.5 | 10.2 | 0.7 | 11.8 | 33.0 | 11.3 |
| Refining | 0.7 | - | - | 1.2 | 0.9 | - | 8.8 | - | 0.2 |
| Manufacture of pulp and paper | - | - | - | 0.4 | - | - | - | - | 0.4 |
| Manufacture of chemicals | 0.7 | 0.8 | 5.5 | 1.9 | 1.4 | 0.4 | 0.7 | 32.0 | 1.2 |
| Manufacture of mineral products | 0.9 | - | - | 0.7 | - | 0.2 | - | - | 3.1 |
| Manufacture of metals | 5.1 | 0.7 | - | 10.3 | 8.0 | 0.1 | 1.6 | 1.0 | 6.5 |
| Iron, steel and ferro-alloys | 3.1 | 0.7 | - | 8.0 | 7.0 | - | 1.6 | - | 3.5 |
| Aluminium | 1.8 | - | - | 1.4 | 0.9 | 0.1 | - | - | 2.7 |
| Other metals | 0.3 | - | - | 0.9 | 0.0 | 0.0 | - | 1.0 | 0.2 |
| Other manufacturing | 0.1 | 1.0 | - | - | - | - | 0.7 | - | 0.0 |
| Petrol distribution | 0.0 | - | - | - | - | - | 8.3 | - | - |
| Agriculture | - | 96.1 | 9.2 | - | - | 20.1 | - | - | 0.0 |
| Landfill gas | 0.0 | 185.4 | - | - | - | - | - | - | - |
| Solvents | 0.1 | - | - | - | - | - | 42.3 | - | 0.0 |
| Road dust | - | - | - | - | - | - | - | - | 1.9 |
| Other process emissions | 0.0 | 1.0 | 0.5 | - | - | - | - | - | 0.0 |

**Table F.5 (cont.). Emissions to air by source[1]. 2001**

| | $CO_2$ | $CH_4$ | $N_2O$ | $SO_2$ | $NO_X$ | $NH_3$ | NMVOC | CO | Particulates[2] |
|---|---|---|---|---|---|---|---|---|---|
| | Mill. tonnes | 1 000 tonnes | | | | | | | |
| **Mobile combustion** | | | | | | | | | |
| **Total** | **15.4** | **3.0** | **2.4** | **3.8** | **150.2** | **1.8** | **57.3** | **325.2** | **5.2** |
| Road traffic | 9.3 | 2.2 | 1.9 | 0.6 | 46.7 | 1.8 | 38.5 | 261.2 | 2.5 |
| Petrol engines | 5.0 | 1.9 | 1.7 | 0.3 | 19.2 | 1.8 | 29.6 | 227.9 | 0.3 |
| Passenger cars | 4.4 | 1.7 | 1.6 | 0.3 | 16.8 | 1.7 | 26.6 | 204.0 | 0.3 |
| Other light vehicles | 0.6 | 0.1 | 0.1 | 0.0 | 1.9 | 0.1 | 2.5 | 21.7 | 0.0 |
| Heavy vehicles | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.4 | 2.2 | 0.0 |
| Diesel engines | 4.3 | 0.1 | 0.2 | 0.3 | 27.3 | 0.0 | 3.7 | 13.3 | 2.2 |
| Passenger cars | 0.5 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.4 | 1.7 | 0.4 |
| Other light vehicles | 1.2 | 0.0 | 0.1 | 0.1 | 2.6 | 0.0 | 0.9 | 4.5 | 0.7 |
| Heavy vehicles | 2.5 | 0.1 | 0.1 | 0.2 | 23.5 | 0.0 | 2.4 | 7.1 | 1.1 |
| Motorcycles, mopeds | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 | 0.0 | 5.3 | 19.9 | 0.0 |
| Motorcycles | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 2.6 | 14.9 | 0.0 |
| Mopeds | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 5.0 | 0.0 |
| Snow scooters | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 3.3 | 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 | 12.5 | 0.0 | 3.9 | 25.8 | 1.5 |
| 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 | 0.2 | 3.8 | - | 1.6 | 6.1 | 0.0 |
| Domestic < 1000 m | 0.4 | 0.0 | 0.0 | 0.1 | 1.1 | - | 0.3 | 2.0 | 0.0 |
| Domestic > 1000 m | 0.8 | - | 0.0 | 0.1 | 2.8 | - | 1.3 | 4.1 | 0.0 |
| Shipping | 3.8 | 0.4 | 0.1 | 2.8 | 85.3 | - | 2.7 | 5.9 | 0.8 |
| Coastal traffic, etc. | 2.1 | 0.2 | 0.1 | 1.8 | 46.8 | - | 1.6 | 1.8 | 0.5 |
| Fishing vessels | 1.4 | 0.1 | 0.0 | 0.9 | 32.2 | - | 0.6 | 3.6 | 0.2 |
| Mobile oil rigs, etc. | 0.3 | 0.1 | 0.0 | 0.2 | 6.3 | - | 0.4 | 0.6 | 0.0 |

[1] Does not include international sea traffic. [2] $PM_{10}$.

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

**Table F.6 Emissions to air by source[1]. 2002***

| | $CO_2$ | $CH_4$ | $N_2O$ | $SO_2$ | $NO_x$ | $NH_3$ | NMVOC | CO | Particulates[2] |
|---|---|---|---|---|---|---|---|---|---|
| | Mill. tonnes | 1000 tonnes | | | | | | | |
| **Total** | **40.9** | **327.4** | **18.8** | **22.1** | **213.0** | **22.2** | **344.9** | **529.6** | **61.6** |
| Stationary combustion | 17.6 | 11.7 | 0.3 | 5.5 | 56.7 | 0.1 | 12.4 | 193.2 | 43.8 |
| Process emissions | 7.8 | 312.8 | 15.8 | 13.3 | 9.6 | 20.2 | 278.0 | 30.1 | 12.9 |
| Mobile combustion | 15.6 | 2.9 | 2.6 | 3.3 | 146.7 | 1.9 | 54.5 | 306.3 | 4.9 |
| **Stationary combustion** | | | | | | | | | |
| **Total** | **17.6** | **11.7** | **0.3** | **5.5** | **56.7** | **0.1** | **12.4** | **193.2** | **43.8** |
| Oil and gas extraction | 10.5 | 3.7 | 0.1 | 0.2 | 42.9 | - | 1.4 | 7.8 | 0.5 |
| Natural gas | 8.4 | 3.3 | 0.1 | - | 30.6 | - | 0.9 | 6.1 | 0.4 |
| Flaring | 1.0 | 0.1 | 0.0 | - | 5.0 | - | 0.0 | 0.6 | 0.0 |
| Diesel combustion | 0.4 | 0.0 | 0.0 | 0.2 | 6.5 | - | 0.4 | 0.5 | 0.0 |
| Gas terminals | 0.8 | 0.3 | 0.0 | 0.0 | 0.8 | - | 0.1 | 0.6 | 0.0 |
| Manufacturing and mining | 5.0 | 0.7 | 0.2 | 4.0 | 9.6 | - | 1.8 | 13.5 | 0.7 |
| Refining | 1.1 | 0.0 | 0.0 | 0.4 | 1.2 | - | 0.5 | 0.0 | 0.1 |
| Manufacture of pulp and paper | 0.5 | 0.3 | 0.1 | 1.2 | 1.8 | - | 0.4 | 4.6 | 0.1 |
| Manufacture of mineral products | 0.8 | 0.0 | 0.0 | 0.4 | 3.5 | - | 0.1 | 0.3 | 0.0 |
| Manufacture of chemicals | 1.4 | 0.1 | 0.0 | 0.5 | 1.3 | - | 0.0 | 0.1 | 0.1 |
| Manufacture of metals | 0.3 | 0.0 | 0.0 | 0.2 | 0.5 | - | 0.0 | 0.3 | 0.0 |
| Other manufacturing | 0.9 | 0.2 | 0.0 | 1.4 | 1.4 | - | 0.8 | 8.4 | 0.3 |
| Other industries | 1.1 | 0.6 | 0.0 | 0.5 | 1.2 | - | 0.1 | 9.7 | 2.0 |
| Dwellings | 0.8 | 6.6 | 0.0 | 0.6 | 1.9 | 0.1 | 8.6 | 162.0 | 40.6 |
| Incineration of waste and landfill gas | 0.2 | 0.1 | 0.0 | 0.2 | 1.1 | - | 0.4 | 0.1 | 0.0 |
| **Process emissions** | | | | | | | | | |
| **Total** | **7.8** | **312.8** | **15.8** | **13.3** | **9.6** | **20.2** | **278.0** | **30.1** | **12.9** |
| Oil and gas extraction | 0.9 | 30.1 | 0.0 | - | 0.4 | - | 215.9 | 0.1 | 0.3 |
| Venting, leaks, etc. | 0.2 | 11.9 | 0.0 | - | 0.4 | - | 5.1 | 0.1 | 0.3 |
| Oil loading at sea | 0.6 | 16.4 | - | - | - | - | 193.1 | - | - |
| Oil loading, on shore | 0.0 | 0.1 | - | - | - | - | 14.3 | - | - |
| Gas terminals | 0.0 | 1.7 | - | - | - | - | 3.4 | - | - |
| Manufacturing and mining | 6.7 | 2.5 | 6.2 | 13.3 | 9.2 | 0.5 | 11.7 | 30.0 | 10.7 |
| Refining | 0.7 | - | - | 1.3 | 0.9 | - | 8.8 | - | 0.1 |
| Manufacture of pulp and paper | - | - | - | 0.5 | - | - | - | - | 0.2 |
| Manufacture of chemicals | 0.7 | 0.9 | 6.2 | 2.2 | 1.2 | 0.4 | 0.7 | 29.9 | 1.2 |
| Manufacture of mineral products | 0.9 | - | - | 0.6 | - | 0.2 | - | - | 3.1 |
| Manufacture of metals | 4.4 | 0.6 | - | 8.6 | 7.1 | 0.0 | 1.3 | 0.2 | 6.1 |
| Iron, steel and ferro-alloys | 2.6 | 0.6 | - | 6.5 | 6.1 | - | 1.3 | - | 3.1 |
| Aluminium | 1.7 | - | - | 1.5 | 0.9 | - | - | - | 2.9 |
| Other metals | 0.1 | - | - | 0.6 | 0.0 | 0.0 | - | 0.2 | 0.0 |
| Other manufacturing | 0.1 | 1.0 | - | - | - | - | 0.9 | - | 0.0 |
| Petrol distribution | 0.0 | - | - | - | - | - | 8.2 | - | - |
| Agriculture | - | 95.0 | 9.2 | - | - | 19.7 | - | - | 0.0 |
| Landfill gas | 0.0 | 184.2 | - | - | - | - | - | - | - |
| 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 F.6 (cont.). Emissions to air by source[1]. 2002***

| | $CO_2$ | $CH_4$ | $N_2O$ | $SO_2$ | $NO_x$ | $NH_3$ | NMVOC | CO | Parti-culates[2] |
|---|---|---|---|---|---|---|---|---|---|
| | Mill. tonnes | 1000 tonnes | | | | | | | |
| **Mobile combustion** | | | | | | | | | |
| **Total** | **15.6** | **2.9** | **2.6** | **3.3** | **146.7** | **1.9** | **54.5** | **306.3** | **4.9** |
| Road traffic | 9.5 | 2.1 | 2.1 | 0.5 | 44.1 | 1.9 | 35.5 | 239.8 | 2.4 |
| Petrol engines | 4.9 | 1.8 | 1.9 | 0.3 | 17.3 | 1.9 | 26.3 | 205.8 | 0.3 |
| Passenger cars | 4.3 | 1.6 | 1.8 | 0.3 | 15.1 | 1.8 | 23.8 | 185.1 | 0.3 |
| Other light vehicles | 0.5 | 0.1 | 0.1 | 0.0 | 1.7 | 0.1 | 2.2 | 18.8 | 0.0 |
| Heavy vehicles | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.3 | 1.8 | 0.0 |
| Diesel engines | 4.5 | 0.1 | 0.2 | 0.2 | 26.6 | 0.0 | 3.6 | 13.0 | 2.1 |
| Passenger cars | 0.6 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.4 | 1.9 | 0.4 |
| Other light vehicles | 1.3 | 0.0 | 0.1 | 0.1 | 2.6 | 0.0 | 0.9 | 4.7 | 0.7 |
| Heavy vehicles | 2.5 | 0.1 | 0.1 | 0.1 | 22.5 | 0.0 | 2.3 | 6.4 | 1.0 |
| Motorcycles, mopeds | 0.1 | 0.2 | 0.0 | 0.0 | 0.2 | 0.0 | 5.6 | 21.0 | 0.0 |
| Motorcycles | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 | 0.0 | 2.8 | 15.7 | 0.0 |
| Mopeds | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 5.3 | 0.0 |
| Snow scooters | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 3.4 | 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 | 0.1 | 12.0 | 0.0 | 3.8 | 25.6 | 1.4 |
| Railways | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | - | 0.1 | 0.2 | 0.1 |
| Air traffic | 1.2 | 0.0 | 0.0 | 0.1 | 4.2 | - | 1.9 | 8.7 | 0.0 |
| Domestic < 1000 m | 0.3 | 0.0 | 0.0 | 0.0 | 1.0 | - | 0.4 | 2.2 | 0.0 |
| Domestic > 1000 m | 0.9 | - | 0.0 | 0.1 | 3.2 | - | 1.5 | 6.5 | 0.0 |
| Shipping | 3.8 | 0.4 | 0.1 | 2.5 | 84.7 | - | 2.6 | 6.0 | 0.7 |
| Coastal traffic, etc. | 2.1 | 0.2 | 0.1 | 1.5 | 45.8 | - | 1.6 | 1.7 | 0.5 |
| Fishing vessels | 1.5 | 0.1 | 0.0 | 0.9 | 33.7 | - | 0.7 | 3.7 | 0.2 |
| Mobile oil rigs, etc. | 0.2 | 0.1 | 0.0 | 0.1 | 5.2 | - | 0.4 | 0.5 | 0.0 |

[1] Does not include international sea traffic. [2] $PM_{10}$.
**Source:** Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

**Table F.7 Emissions to air by county. 2001**

| | $CO_2$ | $CH_4$ | $N_2O$ | $SO_2$ | $NO_x$ | $NH_3$ | NMVOC | CO | Particulates[4] |
|---|---|---|---|---|---|---|---|---|---|
| | Mill. tonnes | 1000 tonnes | | | | | | | |
| **Total** | **42.4** | **333.5** | **17.9** | **25.3** | **223.2** | **22.7** | **391.6** | **553.6** | **63.1** |
| Of this, national emission figures | 42.2 | 333.4 | 17.9 | 24.6 | 220.4 | 22.7 | 391.4 | 553.0 | 63.1 |
| Of this, international sea and air traffic[1] | 0.2 | 0.0 | 0.0 | 0.6 | 2.8 | - | 0.2 | 0.6 | 0.0 |
| Østfold | 1.4 | 15.5 | 0.8 | 1.8 | 5.3 | 1.2 | 7.8 | 32.0 | 3.4 |
| Akershus | 1.7 | 17.9 | 1.0 | 0.4 | 7.9 | 1.0 | 13.2 | 54.4 | 4.1 |
| Oslo | 1.2 | 8.4 | 0.3 | 0.5 | 5.1 | 0.1 | 9.9 | 26.0 | 1.0 |
| Hedmark | 0.8 | 17.7 | 1.1 | 0.2 | 4.5 | 1.8 | 5.5 | 30.4 | 3.6 |
| Oppland | 0.7 | 20.8 | 1.0 | 0.1 | 3.9 | 2.1 | 5.3 | 30.0 | 4.1 |
| Buskerud | 1.0 | 17.7 | 0.6 | 0.7 | 5.4 | 0.8 | 6.6 | 34.1 | 4.3 |
| Vestfold | 1.2 | 10.9 | 0.5 | 1.2 | 4.6 | 0.7 | 7.9 | 26.5 | 2.6 |
| Telemark | 3.2 | 11.4 | 3.9 | 1.1 | 6.7 | 0.7 | 5.6 | 24.7 | 3.5 |
| Aust-Agder | 0.5 | 7.0 | 0.2 | 1.5 | 1.9 | 0.3 | 3.2 | 40.1 | 2.1 |
| Vest-Agder | 1.2 | 12.0 | 0.3 | 1.7 | 3.3 | 0.5 | 4.5 | 18.8 | 2.2 |
| Rogaland | 2.6 | 36.2 | 1.4 | 0.9 | 7.7 | 3.4 | 11.6 | 35.4 | 4.1 |
| Hordaland | 3.6 | 26.0 | 0.7 | 2.1 | 9.1 | 1.2 | 33.9 | 36.6 | 3.9 |
| Sogn og Fjordane | 1.2 | 11.5 | 0.5 | 1.4 | 3.8 | 1.2 | 2.7 | 12.3 | 2.4 |
| Møre og Romsdal | 1.4 | 17.2 | 0.7 | 0.5 | 5.3 | 1.5 | 6.3 | 26.1 | 4.3 |
| Sør-Trøndelag | 1.4 | 16.6 | 0.8 | 2.6 | 5.5 | 1.7 | 6.4 | 33.4 | 4.7 |
| Nord-Trøndelag | 0.7 | 15.5 | 0.9 | 0.9 | 3.4 | 2.1 | 3.9 | 25.2 | 4.1 |
| Nordland | 2.1 | 19.5 | 2.5 | 3.0 | 7.9 | 1.5 | 5.3 | 23.5 | 3.8 |
| Troms | 0.8 | 8.6 | 0.3 | 1.1 | 4.0 | 0.6 | 3.4 | 15.3 | 2.5 |
| Finnmark | 0.3 | 6.3 | 0.2 | 0.1 | 1.8 | 0.2 | 1.9 | 8.0 | 0.7 |
| Svalbard and Jan Mayen | 0.1 | 1.0 | 0.0 | 0.4 | 0.2 | 0.0 | 0.1 | 0.2 | 0.1 |
| Continental shelf | 14.0 | 35.8 | 0.2 | 2.6 | 114.2 | - | 245.2 | 15.0 | 1.8 |
| Airspace[2] | 0.9 | 0.0 | 0.0 | 0.1 | 3.4 | - | 1.4 | 4.7 | 0.0 |
| Open sea[3] | 0.4 | 0.0 | 0.0 | 0.2 | 8.2 | - | 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 F.8 Emissions factors**

| | Tonnes $CO_2$/ tonnes 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 (2003) | 2.75 | 58.35 |
| Coal | 2.42 | 86.12 |
| Coal coke | 3.19 | 111.93 |
| Petrol coke | 3.59 | 102.57 |
| Fuelwood and black liquor | 0.00 | 0.00 |
| Garbage | 0.25 | 23.90 |
| LNG/NGL/CNG | 2.75 | - |
| Refinery gas | 2.80 | 57.61 |
| Fuel gas | 2.50 | 50.00 |
| Methane | 0.28 | 5.48 |

**Source:** Statistics Norway.

**Table F.9 Selected factors for mobile emissions to air, by source[1]. 2002**

| | $CO_2$ | $CH_4$ | $N_2O$ | $SO_2$ | $NO_X$ | $NH_3$ | NMVOC | CO | Particulates[2] |
|---|---|---|---|---|---|---|---|---|---|
| | kg/kg | g/kg | | | | | | | |
| Petrol engines | | | | | | | | | |
| Passenger cars | 3.13 | 1.19 | 1.31 | 0.20 | 10.91 | 1.289 | 17.18 | 133.67 | 0.181 |
| Other light vehicles | 3.13 | 0.67 | 0.66 | 0.20 | 9.62 | 0.681 | 12.44 | 108.74 | 0.136 |
| Heavy vehicles | 3.13 | 1.31 | 0.04 | 0.20 | 34.48 | 0.063 | 23.52 | 124.03 | 0.100 |
| Diesel engines | | | | | | | | | |
| Passenger cars | 3.17 | 0.06 | 0.20 | 0.15 | 7.29 | 0.022 | 1.91 | 9.55 | 2.033 |
| Other light vehicles | 3.17 | 0.07 | 0.16 | 0.15 | 6.39 | 0.013 | 2.15 | 11.56 | 1.676 |
| Heavy vehicles | 3.17 | 0.12 | 0.13 | 0.15 | 28.08 | 0.003 | 2.90 | 7.97 | 1.229 |
| Motorcycles | 3.13 | 4.94 | 0.05 | 0.20 | 7.03 | 0.051 | 126.20 | 710.13 | 0.145 |
| Mopeds | 3.13 | 5.85 | 0.06 | 0.20 | 2.74 | 0.053 | 367.53 | 699.88 | 0.140 |
| Snow scooters | 3.13 | 5.85 | 0.06 | 0.20 | 2.74 | 0.053 | 367.53 | 699.88 | 0.140 |
| Small boats petrol[3] | 3.13 | 5.10 | 0.02 | 0.20 | 6.00 | - | 240.00 | 415.00 | 8.000 |
| Small boats diesel | 3.17 | 0.18 | 0.03 | 0.60 | 54.00 | - | 27.00 | 25.00 | 4.000 |
| Motorized equipment petrol[4] | 3.13 | 5.50 | 0.07 | 0.20 | 10.00 | - | 110.00 | 1 200.00 | 1.000 |
| Motorized equipment diesel | 3.17 | 0.17 | 1.30 | 0.60 | 50.00 | - | 6.00 | 15.00 | 4.000 |
| Railways | 3.17 | 0.18 | 1.20 | 0.60 | 47.00 | - | 4.00 | 11.00 | 3.800 |
| Air traffic | | | | | | | | | |
| Domestic < 100 m | 3.15 | 0.19 | 0.10 | 0.32 | 6.85 | - | 1.67 | 18.76 | 0.025 |
| Domestic 100-1000 m | 3.15 | 0.03 | 0.10 | 0.32 | 13.21 | - | 0.27 | 2.04 | 0.025 |
| Domestic > 1000 m | 3.15 | - | 0.10 | 0.32 | 12.11 | - | 0.57 | 3.08 | 0.007 |
| Shipping[5] | | | | | | | | | |
| Coastal traffic, etc. | 3.17 | 0.23 | 0.08 | 1.60 | 67.90 | - | 2.40 | 2.90 | 0.700 |
| Fishing vessels | 3.17 | 0.23 | 0.08 | 1.60 | 71.81 | - | 1.40 | 7.90 | 0.500 |
| Mobile oil rigs, etc. | 3.17 | 0.80 | 0.02 | 1.60 | 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 F.10 International emissions of $CO_2$ from energy use[1]. Million tonnes $CO_2$. Emissions per unit GDP and per capita**

| | 1980 | 1985 | 1990 | 1995 | 1999 | Per unit GDP[2] | Per capita |
|---|---|---|---|---|---|---|---|
| | Mill. tonnes | | | | | kg/1000 USD | tonnes per capita |
| Whole world | 18 102 | 18 834 | 20 652 | 21 512 | 22 414 | .. | 3.7 |
| OECD | 10 923 | 10 582 | 11 095 | 11 555 | 12 239 | 516 | 11.0 |
| Norway | 29 | 27 | 28 | 30 | 37 | 311 | 8.3 |
| Denmark | 61 | 60 | 50 | 58 | 53 | 399 | 10.0 |
| Finland | 59 | 52 | 53 | 55 | 58 | 497 | 11.2 |
| Iceland | 2 | 2 | 2 | 2 | 2 | 282 | 7.2 |
| Sweden | 69 | 59 | 49 | 51 | 48 | 234 | 5.4 |
| Belgium | 126 | 103 | 106 | 114 | 119 | 486 | 11.6 |
| France | 472 | 374 | 364 | 344 | 361 | 274 | 6.2 |
| Greece | 45 | 56 | 69 | 72 | 82 | 538 | 7.8 |
| Ireland | 26 | 27 | 32 | 34 | 40 | 422 | 10.7 |
| Italy | 370 | 357 | 397 | 412 | 421 | 342 | 7.3 |
| Luxembourg | 12 | 10 | 10 | 8 | 7 | 400 | 16.2 |
| Netherlands | 154 | 146 | 156 | 170 | 167 | 438 | 10.6 |
| Poland | 437 | 439 | 348 | 336 | 310 | 926 | 8.0 |
| Portugal | 25 | 25 | 40 | 49 | 61 | 385 | 6.1 |
| Slovak Republic | 63 | 62 | 55 | 41 | 39 | 693 | 7.2 |
| Spain | 192 | 187 | 212 | 239 | 272 | 393 | 6.9 |
| United Kingdom | 584 | 559 | 572 | 552 | 535 | 435 | 9.0 |
| Switzerland | 40 | 39 | 41 | 38 | 40 | 209 | 5.6 |
| Czech Republic | 165 | 169 | 150 | 125 | 111 | 845 | 10.8 |
| Turkey | 73 | 100 | 138 | 157 | 183 | 466 | 2.8 |
| Germany | 1 074 | 1 021 | 967 | 866 | 822 | 442 | 10.0 |
| Hungary | 81 | 79 | 68 | 59 | 58 | 541 | 5.8 |
| Austria | 57 | 54 | 57 | 57 | 61 | 319 | 7.5 |
| Canada | 429 | 400 | 421 | 452 | 489 | 623 | 16.0 |
| Mexico | 244 | 269 | 297 | 314 | 358 | 472 | 3.7 |
| United States | 4 765 | 4 614 | 4 846 | 5 116 | 5 585 | 647 | 20.5 |
| Japan | 913 | 895 | 1 049 | 1 134 | 1 158 | 377 | 9.1 |
| Republic of Korea | 124 | 154 | 234 | 364 | 410 | 684 | 8.8 |
| Australia | 212 | 221 | 260 | 278 | 322 | 694 | 17.0 |
| New Zealand | 17 | 22 | 23 | 27 | 31 | 445 | 8.1 |

[1]The Norwegian figures in this OECD survey diverge somewhat from the most recent emission calculations. [2]GDP 1999 expressed in 1995 prices adjusted to local purchasing power.
**Source:** OECD (2002).

**Table F.11 International emissions of $SO_X$[1]. Emissions per unit GDP and per capita**

| | 1980 | 1985 | 1990 | 1995 | Late 1990s | Per unit GDP[2] | Per capita |
|---|---|---|---|---|---|---|---|
| | 1000 tonnes | | | | | kg/1000 USD | kg per capita |
| Norway | 137 | 98 | 53 | 34 | 28 | 0.2 | 6.4 |
| Denmark | 452 | 339 | 181 | 149 | 28 | 0.2 | 5.2 |
| Finland | 584 | 382 | 260 | 97 | 76 | 0.6 | 14.6 |
| Sweden | 508 | 266 | 136 | 90 | 71 | 0.4 | 8.0 |
| Belgium | 828 | 400 | 327 | 246 | 205 | 0.9 | 20.1 |
| France | 3 208 | 1 473 | 1 269 | 926 | 837 | 0.7 | 14.2 |
| Italy | 3 841 | 1 963 | 1 719 | 1 262 | 923 | 0.8 | 16.0 |
| Netherlands | 495 | 254 | 202 | 142 | 100 | 0.3 | 6.3 |
| Poland | 4 100 | 4 300 | 3 210 | 2 376 | 1 511 | 4.3 | 39.1 |
| Portugal | 266 | 199 | 359 | 366 | 375 | 2.5 | 37.6 |
| Russia | .. | .. | .. | 6 612 | 5 877 | 6.0 | 39.9 |
| Spain | 2 967 | 2 494 | 2 136 | 1 776 | 1 592 | 2.4 | 40.4 |
| United Kingdom | 4 880 | 3 750 | 3 754 | 2 348 | 1 187 | 1.0 | 19.9 |
| Switzerland | 116 | 76 | 43 | 34 | 28 | 0.1 | 3.9 |
| Czech Republic | 2 257 | 2 277 | 1 876 | 1 091 | 265 | 2.0 | 25.8 |
| Germany | .. | .. | 5 321 | 1 994 | 831 | 0.4 | 10.1 |
| Hungary | 1 633 | 1 404 | 1 010 | 705 | 592 | 5.7 | 58.5 |
| Austria | 385 | 190 | 91 | 54 | 41 | 0.2 | 5.0 |
| Canada | 4 643 | 3 178 | 3 305 | 2 806 | 2 691 | 3.7 | 89.7 |
| United States | 23 501 | 21 463 | 21 481 | 17 407 | 17 116 | 2.0 | 62.7 |
| Japan | 1 263 | .. | 900 | 827 | 870 | 0.3 | 6.9 |
| Republic of Korea | .. | 1 351 | 1 611 | 1 532 | 1 146 | 1.8 | 24.7 |

[1]The Norwegian figures in this OECD survey diverge somewhat from the most recent emission calculations. [2]GDP at 1995 prices and < purchasing parities.
**Source:** OECD (2002).

**Table F.12 International emissions of $NO_X$[1]. Emissions per unit GDP and per capita**

| | 1980 | 1985 | 1990 | 1995 | Late 1990s | Per unit GDP[2] | Per capita |
|---|---|---|---|---|---|---|---|
| | 1000 tonnes | | | | | kg/1000 USD | kg per capita |
| Norway | 194 | 218 | 226 | 223 | 240 | 2.1 | 53.7 |
| Denmark | 273 | 294 | 277 | 261 | 208 | 1.5 | 38.9 |
| Finland | 295 | 275 | 300 | 259 | 236 | 1.9 | 45.6 |
| Sweden | 448 | .. | 349 | 310 | 267 | 1.4 | 30.2 |
| Belgium | 442 | 325 | 314 | 327 | 364 | 1.5 | 35.7 |
| France | 2 032 | 1 830 | 1 882 | 1 716 | 1 654 | 1.3 | 28.1 |
| Italy | 1 569 | 1 630 | 1 944 | 1 795 | 1 485 | 1.2 | 25.8 |
| Netherlands | 584 | 581 | 578 | 489 | 408 | 1.1 | 25.8 |
| Poland | 1 229 | 1 500 | 1 280 | 1 120 | 838 | 2.4 | 21.7 |
| Portugal | 165 | .. | 317 | 358 | 369 | 2.4 | 37.0 |
| Russian Fed. | 3 304 | 3 393 | 4 023 | 3 119 | 3 029 | 3.1 | 20.5 |
| Spain | 1 091 | 989 | 1 226 | 1 304 | 1 299 | 2.0 | 33.0 |
| United Kingdom | 2 583 | 2 544 | 2 760 | 2 094 | 1 603 | 1.3 | 26.9 |
| Switzerland | 170 | 179 | 154 | 120 | 105 | 0.6 | 14.8 |
| Czech Republic | 937 | 831 | 742 | 412 | 397 | 3.0 | 38.6 |
| Germany | .. | .. | 2 706 | 1 967 | 1 637 | 0.9 | 19.9 |
| Hungary | 273 | 263 | 238 | 190 | 221 | 2.1 | 22.0 |
| Austria | 227 | 216 | 202 | 183 | 184 | 0.9 | 22.7 |
| Canada | 1 959 | 2 044 | 2 106 | 1 998 | 2 056 | 2.6 | 67.4 |
| United States | 22 121 | 21 044 | 21 926 | 22 725 | 23 037 | 2.6 | 84.4 |
| Japan | 1 602 | 1 322 | 1 650 | 1 731 | 1 654 | 0.5 | 13.1 |
| Republic of Korea | .. | 722 | 925 | 1 153 | 1 083 | 1.7 | 23.3 |

[1]The Norwegian figures in this OECD survey diverge somewhat from the most recent emission calculations. [2]GDP at 1995 prices and purchasing power parties.
**Source:** OECD (2002).

**Table F.13 Emissions to air of hazardous substances**

| | Lead | Cadmium | Mercury | Arsenic | Chromium | Copper | PAHs | Dioxins |
|---|---|---|---|---|---|---|---|---|
| | Tonnes | kg | | | | | Tonnes | Grammes |
| 1990 | 186 | 1 643 | 1 704 | 3 098 | 12 791 | 21 622 | 156 | 130 |
| 1991 | 143 | 1 572 | 1 583 | 2 998 | 12 712 | 18 750 | 143 | 98 |
| 1992 | 126 | 1 566 | 1 421 | 2 968 | 12 589 | 19 031 | 140 | 96 |
| 1993 | 86 | 1 637 | 1 121 | 3 152 | 12 342 | 19 044 | 144 | 95 |
| 1994 | 23 | 1 182 | 1 171 | 3 558 | 11 648 | 17 588 | 141 | 94 |
| 1995 | 21 | 1 012 | 1 088 | 2 897 | 11 367 | 18 388 | 141 | 70 |
| 1996 | 9 | 1 051 | 1 118 | 2 999 | 11 437 | 18 626 | 146 | 49 |
| 1997 | 8 | 1 073 | 1 130 | 2 823 | 12 372 | 19 114 | 152 | 41 |
| 1998 | 8 | 1 139 | 1 097 | 3 285 | 11 885 | 20 101 | 145 | 35 |
| 1999 | 8 | 978 | 1 154 | 3 285 | 11 272 | 20 266 | 137 | 39 |
| 2000 | 6 | 725 | 997 | 2 457 | 8 775 | 19 069 | 138 | 34 |
| 2001 | 5 | 724 | 958 | 2 176 | 7 011 | 19 383 | 145 | 34 |
| 2002* | 6 | 691 | 904 | 1 775 | 5 828 | 19 105 | 162 | 31 |

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

**Table F.14 Emissions to air of hazardous substances[1] by source. 2002***

| | Lead | Cadmium | Mercury | Arsenic | Chromium | Copper | PAH | Dioxins |
|---|---|---|---|---|---|---|---|---|
| | kg | kg | kg | kg | kg | kg | Tonnes | Grammes |
| **Total** | **6 329.6** | **690.5** | **903.7** | **1 775.1** | **5 828.0** | **19 104.9** | **162.3** | **31.4** |
| Stationary combustion | 977.3 | 398.3 | 482.7 | 742.7 | 2 059.1 | 2 292.2 | 54.4 | 17.3 |
| Process emissions | 2 276.0 | 242.6 | 265.2 | 783.7 | 3 528.9 | 11 048.6 | 97.8 | 8.9 |
| Mobile combustion | 3 076.3 | 49.7 | 155.9 | 248.7 | 239.9 | 5 764.1 | 10.2 | 5.2 |
| | | | | | | | | |
| **Stationary combustion** | | | | | | | | |
| **Total** | **977.3** | **398.3** | **482.7** | **742.7** | **2 059.1** | **2 292.2** | **54.4** | **17.3** |
| Oil and gas extraction | 13.0 | 8.6 | 10.3 | 22.6 | 96.9 | 76.2 | 0.3 | 0.7 |
| Natural gas | 0.9 | 6.1 | 3.6 | 13.7 | 75.7 | 57.7 | 0.1 | 0.2 |
| Flaring | 0.1 | 0.7 | 0.4 | 1.6 | 8.7 | 6.6 | 0.0 | 0.0 |
| Diesel combustion | 11.9 | 1.2 | 5.9 | 5.9 | 4.7 | 5.9 | 0.2 | 0.5 |
| Gas terminals | 0.1 | 0.6 | 0.4 | 1.4 | 7.8 | 5.9 | 0.0 | 0.0 |
| Manufacturing and mining | 705.3 | 228.1 | 237.4 | 449.1 | 1 659.9 | 1 610.1 | 0.4 | 2.5 |
| Refining | 0.4 | 0.0 | 0.2 | 1.6 | 8.3 | 6.4 | 0.0 | 0.0 |
| Manufacture of pulp and paper | 365.7 | 144.9 | 147.4 | 269.7 | 704.8 | 779.4 | 0.2 | 1.3 |
| Manufacture of mineral products | 105.3 | 14.4 | 5.3 | 15.8 | 299.8 | 220.5 | 0.1 | 0.1 |
| Manufacture of chemicals | 40.1 | 4.2 | 8.8 | 30.6 | 309.3 | 231.5 | 0.0 | 0.0 |
| Manufacture of metals | 6.0 | 1.6 | 2.3 | 4.7 | 12.8 | 13.9 | 0.0 | 0.0 |
| Other manufacturing | 187.8 | 62.9 | 73.4 | 126.7 | 325.1 | 358.4 | 0.1 | 1.0 |
| Other industries | 41.4 | 22.2 | 34.9 | 46.4 | 42.3 | 88.8 | 5.3 | 3.1 |
| Dwellings | 99.0 | 127.0 | 135.7 | 216.6 | 204.7 | 456.5 | 47.5 | 9.5 |
| Incineration of waste and landfill gas | 118.5 | 12.3 | 64.4 | 7.9 | 55.2 | 60.6 | 0.8 | 1.5 |
| | | | | | | | | |
| **Process emissions** | | | | | | | | |
| **Total** | **2 276.0** | **242.6** | **265.2** | **783.7** | **3 528.9** | **11 048.6** | **97.8** | **8.9** |
| Oil and gas extraction | - | - | - | - | - | - | 0.2 | 0.1 |
| Venting, leaks, etc. | - | - | - | - | - | - | 0.2 | 0.1 |
| Oil loading at sea | - | - | - | - | - | - | - | - |
| Oil loading, on shore | - | - | - | - | - | - | - | - |
| Gas terminals | - | - | - | - | - | - | - | - |
| Manufacturing and mining | 2 169.0 | 202.1 | 218.0 | 783.7 | 3 132.2 | 1 963.5 | 79.6 | 8.8 |
| Refining | - | - | - | - | - | - | - | - |
| Manufacture of pulp and paper | - | - | - | - | - | - | - | - |
| Manufacture of chemicals | 460.6 | 68.6 | 2.3 | 527.8 | 307.7 | 344.9 | 2.6 | 0.0 |
| Manufacture of mineral products | 135.5 | 23.6 | 23.5 | 3.8 | 93.5 | 116.3 | - | 0.2 |
| Manufacture of metals | 1 572.9 | 109.9 | 192.1 | 252.2 | 2 731.0 | 1 502.3 | 77.0 | 8.5 |
| Iron, steel and ferro-alloys | 1 496.6 | 53.9 | 180.3 | 170.3 | 2 671.0 | 246.5 | 2.0 | 7.2 |
| Aluminium | 2.2 | 2.0 | 0.0 | 0.4 | 9.0 | 5.8 | 73.0 | 1.0 |
| Other metals | 74.0 | 54.0 | 11.8 | 81.5 | 51.0 | 1 250.0 | 2.0 | 0.3 |
| Other manufacturing | - | - | - | - | - | - | 0.0 | 0.1 |
| Petrol distribution | - | - | - | - | - | - | - | - |
| Agriculture | - | - | - | - | - | - | - | - |
| Landfill gas | - | - | - | - | - | - | - | - |
| Solvents | - | - | - | - | - | - | 17.6 | - |
| Road dust | 90.0 | 39.6 | 2.3 | - | 396.6 | 8 094.6 | 0.4 | - |
| Use of products | - | - | 42.0 | - | - | - | - | - |
| Other process emissions | 17.1 | 0.9 | 2.9 | - | 0.1 | 990.6 | - | 0.0 |

**Table F.14 (cont.). Emissions to air of hazardous substances[1] by source. 2002***

| | Lead | Cadmium | Mercury | Arsenic | Chromium | Copper | PAH | Dioxins |
|---|---|---|---|---|---|---|---|---|
| | kg | kg | kg | kg | kg | kg | Tonnes | Grammes |
| **Mobile combustion** | | | | | | | | |
| **Total** | **3 076.3** | **49.7** | **155.9** | **248.7** | **239.9** | **5 764.1** | **10.2** | **5.2** |
| Road traffic | 188.9 | 30.1 | 70.4 | 150.5 | 150.6 | 5 118.1 | 7.2 | 0.3 |
| Petrol engines | 47.2 | 15.7 | - | 78.6 | 78.6 | 2 673.8 | 1.6 | 0.2 |
| Passenger cars | 41.6 | 13.9 | - | 69.3 | 69.3 | 2 354.8 | 1.4 | 0.1 |
| Other light vehicles | 5.2 | 1.7 | - | 8.6 | 8.6 | 293.8 | 0.2 | 0.0 |
| Heavy vehicles | 0.4 | 0.1 | - | 0.7 | 0.7 | 25.2 | 0.0 | 0.0 |
| Diesel engines | 140.8 | 14.1 | 70.4 | 70.4 | 70.4 | 2 393.8 | 5.5 | 0.1 |
| Passenger cars | 19.5 | 2.0 | 9.8 | 9.8 | 9.8 | 331.6 | 0.9 | 0.0 |
| Other light vehicles | 41.1 | 4.1 | 20.5 | 20.5 | 20.5 | 698.4 | 1.8 | 0.0 |
| Heavy vehicles | 80.2 | 8.0 | 40.1 | 40.1 | 40.1 | 1 363.8 | 2.9 | 0.1 |
| Motorcycles, mopeds | 0.9 | 0.3 | - | 1.5 | 1.5 | 50.5 | 0.1 | 0.0 |
| Motorcycles | 0.7 | 0.2 | - | 1.1 | 1.1 | 37.6 | 0.0 | 0.0 |
| Mopeds | 0.2 | 0.1 | - | 0.4 | 0.4 | 12.9 | 0.0 | 0.0 |
| Snow scooters | 0.1 | 0.0 | - | 0.2 | 0.2 | 8.2 | 0.0 | 0.0 |
| Small boats | 2.7 | 0.6 | 0.7 | 2.8 | 2.8 | 96.1 | 0.1 | 0.0 |
| Motorized equipment | 24.3 | 2.6 | 11.9 | 12.8 | 12.8 | 430.3 | 0.8 | 0.0 |
| Railways | 1.4 | 0.1 | 0.7 | 0.7 | 0.7 | 23.3 | 0.0 | 0.0 |
| Air traffic | 2 735.3 | 3.9 | 11.6 | 19.5 | 19.5 | 26.2 | 0.1 | 0.0 |
| Domestic < 1000 m | 538.9 | 1.1 | 3.2 | 5.4 | 5.4 | 6.7 | 0.0 | 0.0 |
| Domestic > 1000 m | 2 196.4 | 2.8 | 8.4 | 14.2 | 14.2 | 19.5 | 0.1 | 0.0 |
| Shipping | 123.6 | 12.4 | 60.6 | 62.1 | 53.3 | 61.9 | 1.9 | 4.8 |
| Coastal traffic, etc. | 68.5 | 6.8 | 33.3 | 34.5 | 30.4 | 34.3 | 1.1 | 2.6 |
| Fishing vessels | 47.8 | 4.8 | 23.6 | 23.9 | 20.0 | 23.9 | 0.8 | 1.9 |
| Mobile oil rigs, etc. | 7.4 | 0.7 | 3.7 | 3.7 | 2.9 | 3.7 | 0.1 | 0.3 |

[1] Does not include international sea and air traffic.
**Source:** Emission inventory from Statistics Norway and Norwegian Pollution Control Authority.

# Waste

## Appendix G

**Table G.1 Waste in Norway. By material type. 1990-2003* and projections for 2004-2010. 1 000 tonnes**

| | Total | Paper, card-board and paste-board | Metals | Plastic | Glass | Wood waste | Textiles | Biode-grada-ble waste | Con-crete | Other | Hazard-ous |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | .. | .. | .. | 271 | .. | 1 263 | 82 | .. | .. | .. | 610 |
| 1991 | .. | .. | .. | 295 | .. | 1 160 | 83 | .. | .. | .. | 613 |
| 1992 | .. | 1 049 | 1 223 | 285 | .. | 1 092 | 83 | .. | .. | .. | 617 |
| 1993 | 7 386 | 1 055 | 1 301 | 324 | 158 | 1 105 | 87 | 878 | 610 | 1 247 | 621 |
| 1994 | 7 407 | 1 040 | 1 348 | 339 | 157 | 1 095 | 90 | 906 | 638 | 1 156 | 640 |
| 1995 | 7 451 | 1 011 | 1 370 | 351 | 159 | 1 103 | 94 | 964 | 661 | 1 109 | 628 |
| 1996 | 7 529 | 1 032 | 1 498 | 366 | 155 | 1 068 | 99 | 1 005 | 665 | 1 032 | 608 |
| 1997 | 7 887 | 1 120 | 1 523 | 367 | 148 | 1 037 | 103 | 1 057 | 726 | 1 211 | 596 |
| 1998 | 8 265 | 1 131 | 1 541 | 380 | 145 | 1 038 | 108 | 1 076 | 751 | 1 386 | 709 |
| 1999 | 8 311 | 1 102 | 1 554 | 381 | 146 | 990 | 109 | 1 091 | 735 | 1 553 | 650 |
| 2000 | 8 564 | 1 334 | 1 563 | 376 | 146 | 1 000 | 110 | 1 102 | 715 | 1 534 | 684 |
| 2001* | 8 661 | 1 246 | 1 611 | 392 | 154 | 1 053 | 117 | 1 128 | 739 | 1 538 | 684 |
| 2002* | 8 752 | 1 265 | 1 627 | 398 | 155 | 1 040 | 120 | 1 156 | 735 | 1 562 | 694 |
| 2003* | 8 837 | 1 288 | 1 636 | 405 | 158 | 1 039 | 125 | 1 185 | 733 | 1 571 | 698 |
| 2004 | 8 961 | 1 319 | 1 656 | 413 | 161 | 1 040 | 130 | 1 223 | 733 | 1 584 | 703 |
| 2005 | 8 927 | 1 303 | 1 669 | 406 | 156 | 1 035 | 125 | 1 192 | 737 | 1 595 | 710 |
| 2006 | 8 933 | 1 305 | 1 682 | 404 | 154 | 1 044 | 123 | 1 183 | 739 | 1 591 | 709 |
| 2007 | 9 054 | 1 324 | 1 703 | 410 | 155 | 1 025 | 126 | 1 211 | 748 | 1 628 | 723 |
| 2008 | 9 181 | 1 349 | 1 718 | 419 | 159 | 1 009 | 131 | 1 253 | 752 | 1 658 | 733 |
| 2009 | 9 328 | 1 376 | 1 736 | 429 | 162 | 991 | 137 | 1 299 | 760 | 1 693 | 744 |
| 2010 | 9 475 | 1 402 | 1 758 | 438 | 165 | 973 | 142 | 1 337 | 770 | 1 730 | 759 |
| **By product type, 2000** | | | | | | | | | | | |
| Total | 8 564 | 1 334 | 1 563 | 376 | 146 | 1 000 | 110 | 1 102 | 715 | 1 534 | 684 |
| Buildings and building products | 940 | 2 | 18 | 51 | 51 | 143 | .. | . | 618 | 58 | .. |
| Electrical and electronic equipment | 169 | . | 113 | 40 | 10 | 2 | .. | . | 3 | .. | .. |
| Packaging | 709 | 379 | 35 | 132 | 46 | 110 | 6 | . | .. | .. | .. |
| Clothing, footwear and other textile products | 45 | . | .. | . | . | .. | 45 | . | . | .. | .. |
| Food | 566 | . | . | . | . | . | . | 566 | . | . | . |
| Furniture and household products | 343 | 91 | 49 | 82 | 15 | 81 | 26 | . | .. | .. | .. |
| Park and garden waste | 94 | . | . | . | . | . | . | 94 | . | . | . |
| Ships and large constructions | .. | .. | .. | .. | .. | .. | .. | . | .. | .. | .. |
| Means of transport excl. ships | 267 | .. | 218 | 14 | 4 | 2 | 2 | . | .. | 28 | .. |
| Printed matter | 642 | 642 | .. | .. | .. | .. | .. | . | .. | .. | .. |
| Other | 2 227 | 84 | 1 002 | 46 | 7 | 11 | 29 | . | 21 | 343 | 684 |
| Residues from manufacturing | 2 562 | 135 | 128 | 11 | 13 | 651 | 3 | 443 | 73 | 1 105 | .. |

**Source:** Waste statistics from Statistics Norway.

**Table G.2 Waste in Norway. By source of origin. 1993-2003* and projections for 2004-2010. 1000 tonnes**

| | Total | Households[1] | Agriculture, forestry and fishing | Mining and quarrying | Manufacturing | Electricity, gas and water supply | Construction | Service industries | Unspecified |
|---|---|---|---|---|---|---|---|---|---|
| 1993 | 7 386 | 1 142 | 39 | 34 | 3 374 | 21 | 624 | 698 | 1 453 |
| 1994 | 7 407 | 1 198 | 41 | 39 | 3 273 | 20 | 662 | 726 | 1 447 |
| 1995 | 7 451 | 1 249 | 73 | 41 | 3 139 | 22 | 698 | 771 | 1 457 |
| 1996 | 7 529 | 1 435 | 102 | 45 | 3 026 | 19 | 702 | 802 | 1 398 |
| 1997 | 7 887 | 1 337 | 107 | 123 | 3 151 | 21 | 754 | 853 | 1 541 |
| 1998 | 8 265 | 1 461 | 86 | 137 | 3 287 | 21 | 793 | 910 | 1 569 |
| 1999 | 8 311 | 1 505 | 123 | 111 | 3 364 | 18 | 772 | 900 | 1 517 |
| 2000 | 8 564 | 1 565 | 97 | 122 | 3 372 | 21 | 757 | 906 | 1 725 |
| 2001* | 8 661 | 1 631 | 96 | 128 | 3 417 | 21 | 789 | 947 | 1 634 |
| 2002* | 8 752 | 1 690 | 100 | 129 | 3 429 | 21 | 777 | 954 | 1 652 |
| 2003* | 8 837 | 1 765 | 100 | 129 | 3 432 | 21 | 774 | 957 | 1 658 |
| 2004 | 8 961 | 1 853 | 104 | 130 | 3 434 | 21 | 772 | 967 | 1 679 |
| 2005 | 8 927 | 1 757 | 109 | 129 | 3 442 | 21 | 776 | 983 | 1 708 |
| 2006 | 8 933 | 1 723 | 113 | 127 | 3 438 | 21 | 780 | 999 | 1 733 |
| 2007 | 9 054 | 1 777 | 119 | 121 | 3 461 | 22 | 787 | 1 010 | 1 758 |
| 2008 | 9 181 | 1 868 | 126 | 116 | 3 478 | 22 | 788 | 1 013 | 1 770 |
| 2009 | 9 328 | 1 968 | 132 | 110 | 3 500 | 22 | 794 | 1 018 | 1 784 |
| 2010 | 9 475 | 2 048 | 139 | 106 | 3 522 | 22 | 804 | 1 027 | 1 808 |
| **By material type, 2000** | | | | | | | | | |
| Total | 8 564 | 1 565 | 97 | 122 | 3 372 | 21 | 757 | 906 | 1 725 |
| Paper, cardboard and pasteboard | 1 333 | 466 | 4 | 3 | 169 | 2 | 22 | 319 | 348 |
| Metals | 1 563 | 152 | .. | .. | 193 | .. | 49 | 96 | 1 073 |
| Plastic | 376 | 178 | .. | .. | 46 | .. | 7 | 128 | 17 |
| Glass | 145 | 54 | .. | .. | 13 | .. | 46 | 19 | 13 |
| Wood waste | 1 001 | 29 | .. | .. | 690 | .. | 129 | 47 | 106 |
| Textiles | 110 | 88 | 5 | - | 6 | - | - | 11 | - |
| Biodegradable waste | 1 101 | 471 | 86 | .. | 445 | .. | 1 | 78 | 20 |
| Concrete | 715 | 3 | .. | .. | 178 | .. | 494 | .. | 40 |
| Other | 1 534 | 112 | .. | 37 | 1 193 | 15 | .. | 149 | 28 |
| Hazardous | 684 | 11 | 1 | 82 | 440 | 3 | 9 | 58 | 80 |

[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 G.3 Waste in Norway. By way of treatment. 1995-2003*. 1 000 tonnes**

| | Total | Material recovery | Biological treatment | Energy recovery | Incineration without energy recovery | Landfill | Other or unspecified |
|---|---|---|---|---|---|---|---|
| 1995 | 7 451 | 1 783 | 137 | 799 | 119 | 1 636 | 2 976 |
| 1996 | 7 529 | 1 951 | 189 | 712 | 126 | 1 757 | 2 793 |
| 1997 | 7 887 | 2 105 | 249 | 746 | 127 | 1 707 | 2 954 |
| 1998 | 8 265 | 2 165 | 282 | 763 | 120 | 1 703 | 3 232 |
| 1999 | 8 308 | 2 294 | 334 | 793 | 97 | 1 391 | 3 399 |
| 2000 | 8 564 | 2 276 | 364 | 842 | 121 | 1 613 | 3 348 |
| 2001* | 8 661 | 2 345 | 407 | 893 | 121 | 1 562 | 3 334 |
| 2002* | 8 752 | 2 426 | 439 | 917 | 124 | 1 526 | 3 321 |
| 2003* | 8 837 | 2 510 | 467 | 933 | 127 | 1 489 | 3 310 |
| **By material type, 2000** | | | | | | | |
| Total | 8 564 | 2 276 | 364 | 842 | 121 | 1 613 | 3 348 |
| Paper, cardboard and pasteboard | 1 333 | 514 | .. | 114 | 51 | 613 | 42 |
| Metals | 1 563 | 693 | . | .. | .. | 46 | 823 |
| Plastic | 376 | 21 | .. | 56 | 6 | 280 | 12 |
| Glass | 145 | 39 | . | . | . | 107 | - |
| Wood waste | 1 001 | 226 | 80 | 378 | 8 | 202 | 106 |
| Textiles | 110 | 10 | .. | 18 | 7 | 76 | - |
| Biodegradable waste | 1 101 | 502 | 189 | 132 | 50 | 219 | 10 |
| Concrete | 715 | 150 | . | . | . | 70 | 495 |
| Other | 1 534 | 120 | 93 | 141 | .. | 129 | 1 051 |
| Hazardous | 684 | .. | . | .. | .. | .. | 684 |

**Source:** Waste statistics from Statistics Norway.

**Table G.4 Hazardous waste generated, by material. 1999-2003*. Tonnes**

| | 1999 | 2000* | 2001* | 2002* | 2003* |
|---|---|---|---|---|---|
| **Total** | **650 252** | **684 397** | **684 207** | **634 098** | **793 737** |
| Waste containing oil | 169 089 | 185 826 | 188 568 | 219 823 | 187 487 |
| Waste containing solvents | 15 672 | 15 090 | 13 858 | 10 538 | 14 282 |
| Other organic hazardous wastes [1] | 15 513 | 15 812 | 15 062 | 22 954 | 65 306 |
| Waste containing heavy metals | 166 761 | 181 368 | 174 135 | 188 805 | 285 896 |
| Corrosive waste | 240 423 | 250 790 | 253 546 | 127 730 | 185 130 |
| Other inorganic hazardous wastes | 1 481 | 1 365 | 1 358 | 837 | 1 267 |
| Photochemicals | 6 897 | 4 660 | 5 481 | 2 816 | 3 599 |
| Contaminated wastewater | 32 301 | 25 198 | 21 513 | 2 830 | 6 125 |
| Nonclassified hazardous waste | 2 115 | 4 288 | 10 686 | 57 765 | 44 645 |

[1] Clean concrete sticked to PCB-containing concrete, is defined as hazardous waste as long as the clean concrete is inseparable from the PCB-containing concrete. This clean concrete is not included in the figures. Frames from PCB-containing glass windows are treated in the same way as hazardous waste, but they are not defined as hazardous waste. These frames are not included in the figures either.
**Source:** Waste statistics from Statistics Norway.

**Table G.5 Hazardous waste to unknown handling. By material.1999-2003*. Tonnes**

| | 1999 | 2000* | 2001* | 2002* | 2003* |
|---|---|---|---|---|---|
| **Total** | **63 302** | **61 216** | **45 760** | **53 133** | **100 879** |
| Waste containing oil | 44 979 | 46 812 | 32 745 | 41 305 | 42 186 |
| Waste containing solvents | 3 688 | 1 767 | 1 634 | - | - |
| Other organic hazardous wastes[1] | 6 921 | 7 134 | 6 763 | 6 533 | 39 687 |
| Waste containing heavy metals | 3 423 | 2 273 | 1 254 | - | 15 000 |
| Corrosive waste | 65 | 72 | 60 | - | - |
| Other inorganic hazardous wastes | 785 | 718 | 819 | - | - |
| Photochemicals | 3 164 | 2 112 | 2 233 | - | - |
| Contaminated wastewater | - | - | 1 | - | - |
| Nonclassified hazardous waste | 277 | 328 | 251 | 5 295 | 4 006 |

[1] Clean concrete sticked to PCB-containing concrete, is defined as hazardous waste as long as the clean concrete is inseparable from the PCB-containing concrete. This clean concrete is not included in the figures. Frames from PCB-containing glass windows are treated in the same way as hazardous waste, but they are not defined as hazardous waste. These frames are not included in the figures either.
**Source:** Waste statistics from Statistics Norway.

**Table G.6 Hazardous waste generated, by source of origin. 1999-2003*. Tonnes**

| | 1999 | 2000* | 2001* | 2002* | 2003* |
|---|---|---|---|---|---|
| **Total** | **650 252** | **684 397** | **684 207** | **634 098** | **793 737** |
| Agriculture and forestry | 291 | 247 | 2 039 | 330 | 441 |
| Fishing | 505 | 441 | 411 | 528 | 534 |
| Mining and quarrying | 70 203 | 81 849 | 83 104 | 101 014 | 64 647 |
| Manufacturing | 409 045 | 439 522 | 447 709 | 381 199 | 500 897 |
| Electricity, gas and water supply | 406 | 3 412 | 10 074 | 16 409 | 21 574 |
| Construction | 10 667 | 9 235 | 12 494 | 11 243 | 15 082 |
| Service industries | 64 692 | 58 464 | 60 381 | 46 328 | 53 616 |
| Waste management | 6 624 | 15 510 | 13 955 | 13 131 | 5 962 |
| Households | 11 190 | 11 322 | 11 411 | 11 683 | 11 755 |
| Unknown | 76 629 | 64 395 | 42 629 | 52 233 | 119 229 |

**Source:** Waste statistics from Statistics Norway.

**Table G.7 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 |
| **2003 by material** | | | | | |
| Paper and cardboard | 125 | 56 | 572 | 256 | 45 |
| Glass | 12 | 8 | 55 | 39 | 71 |
| Plastic | 26 | 1 | 121 | 7 | 6 |
| Metals | 21 | 10 | 96 | 44 | 45 |
| EEE waste | .. | 6 | .. | 27 | .. |
| Wet organic waste | 88 | 31 | 404 | 143 | 35 |
| Wood waste | 30 | 21 | 136 | 94 | 69 |
| Textiles | 17 | 2 | 77 | 9 | 12 |
| Hazardous waste | .. | 3 | .. | 15 | .. |
| Other | 46 | 29 | 211 | 131 | 62 |

[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 G.8 Household waste, by recovery or disposal. 1992-2003. 1 000 tonnes**

| | Total | Separated for recovery | Landfilled | Incinerated | Other | Per cent final disposal[1] |
|---|---|---|---|---|---|---|
| 1992 | 1 012 | 86 | 657 | 269 | 0 | 74 |
| 1995 | 1 174 | 213 | 648 | 314 | 0 | 62 |
| 1998 | 1 365 | 453 | 592 | 320 | 0 | 50 |
| 2000 | 1 454 | 581 | 467 | 406 | 0 | 40 |
| 2001 | 1 507 | 668 | 382 | 445 | 11 | 33 |
| 2002 | 1 613 | 732 | 384 | 492 | 4 | 32 |
| 2003 | 1 671 | 764 | 357 | 544 | 4 | 30 |

[1]Final disposal means landfilling or incineration without energy recovery. Calculated from an average energy recovery rate of 73 per cent at Norwegian waste incineration plants.
**Source:** Waste statistics from Statistics Norway.

**Table G.9 Municipal consumer waste: Investments, costs, fee income, cost coverage ratio, and annual fee. By county. 2003**

| | Invest-ment in collection of waste | Invest-ment in waste treatment | Total in-vestment | Maintenance, running and overhead costs | Capital costs | Annual costs | Fee income | Cost cover-age ratio | Annual fee for a private dwelling of 120 m² |
|---|---|---|---|---|---|---|---|---|---|
| **Total** | | | | 1 000 NOK | | | | Per cent | NOK |
| 2002[1] | 57 955 | 111 748 | 169 703 | 2 806 642 | 204 137 | 3 010 779 | 2 760 925 | 92 | 1 718 |
| 2003[2] | 30 611 | 60 486 | 91 094 | 3 062 346 | 208 991 | 3 271 335 | 2 988 480 | 91 | 1 774 |
| **Counties, 2003** | | | | | | | | | |
| Østfold | 6 481 | 558 | 7 039 | 166 141 | 13 154 | 179 295 | 179 964 | 100 | 1 298 |
| Akershus | 1 424 | 20 993 | 22 417 | 299 028 | 8 019 | 307 047 | 339 370 | 111 | 1 676 |
| Oslo | 5 375 | 2 591 | 7 966 | 331 480 | 83 000 | 414 480 | 345 009 | 83 | 1 581 |
| Hedmark | 199 | 951 | 1 150 | 106 007 | 981 | 106 988 | 107 973 | 101 | 1 537 |
| Oppland | 3 306 | - | 3 306 | 117 384 | 3 709 | 121 093 | 117 575 | 97 | 1 531 |
| Buskerud | -20 150 | -2 358 | -22 508 | 69 619 | 3 070 | 72 688 | 80 088 | 110 | 1 693 |
| Vestfold | -3 601 | 75 | -3 526 | 147 853 | 6 325 | 154 178 | 155 189 | 101 | 1 610 |
| Telemark | 2 192 | 6 078 | 8 269 | 135 041 | 9 800 | 144 841 | 148 587 | 103 | 1 596 |
| Aust-Agder | 1 286 | -646 | 640 | 82 323 | 1 112 | 83 435 | 80 813 | 97 | 1 732 |
| Vest-Agder | 618 | 148 | 766 | 130 321 | 5 999 | 136 320 | 129 689 | 95 | 1 871 |
| Rogaland | 8 263 | 11 218 | 19 481 | 225 195 | 21 996 | 247 191 | 240 199 | 97 | 1 878 |
| Hordaland | -272 | 1 849 | 1 578 | 374 642 | 12 280 | 386 923 | 366 724 | 95 | 1 710 |
| Sogn og Fjordane | 696 | 227 | 922 | 138 773 | 3 524 | 142 297 | 65 767 | 46 | 1 849 |
| Møre og Romsdal | 6 815 | 5 358 | 12 173 | 185 504 | 10 096 | 195 600 | 184 180 | 94 | 1 787 |
| Sør-Trøndelag | 7 261 | 2 310 | 9 572 | 146 589 | 9 099 | 155 687 | 154 928 | 100 | 1 825 |
| Nord-Trøndelag | 2 397 | 5 093 | 7 490 | 57 059 | 5 192 | 62 251 | 55 917 | 90 | 1 973 |
| Nordland | 602 | 1 879 | 2 477 | 49 022 | 5 459 | 54 481 | 49 087 | 90 | 1 989 |
| Troms | 7 635 | 3 977 | 11 613 | 118 769 | 5 184 | 123 952 | 116 918 | 94 | 1 967 |
| Finnmark | 84 | 185 | 269 | 181 596 | 992 | 182 588 | 70 503 | 39 | 2 205 |

[1] Annual fee for the year 2003. [2] Annual fee for the year 2004.
**Source:** Environmental protection expenditure statistics from Statistics Norway.

# Water resources and water pollution Appendix H

**Table H.1 Water sources, number of water works and number of people supplied. By county. 2002**

| | 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]** | **1 544** | **4 117 689** | **622** | **3 355 994** | **379** | **356 746** | **574** | **404 949** |
| Østfold | 24 | 231 156 | 13 | 155 728 | 4 | 56 706 | 8 | 18 722 |
| Akershus | 30 | 443 813 | 19 | 321 883 | 2 | 119 153 | 10 | 2 777 |
| Oslo | 1 | 520 000 | 1 | 520 000 | | | | |
| Hedmark | 97 | 158 037 | 11 | 78 136 | 8 | 1 620 | 80 | 78 281 |
| Oppland | 76 | 127 803 | 19 | 70 606 | 7 | 3 170 | 50 | 54 027 |
| Buskerud | 63 | 224 509 | 16 | 152 622 | | | 47 | 71 887 |
| Vestfold | 37 | 215 521 | 13 | 209 580 | | | 24 | 5 941 |
| Telemark | 58 | 142 388 | 23 | 113 385 | 3 | 12 693 | 34 | 16 310 |
| Aust-Agder | 32 | 84 294 | 17 | 75 950 | 5 | 2 371 | 10 | 5 973 |
| Vest-Agder | 39 | 143 613 | 14 | 123 501 | 5 | 1 088 | 20 | 19 024 |
| Rogaland | 53 | 361 886 | 37 | 353 654 | 7 | 2 760 | 12 | 5 472 |
| Hordaland | 160 | 379 598 | 89 | 332 662 | 34 | 26 293 | 38 | 20 643 |
| Sogn og Fjordane | 103 | 79 836 | 43 | 49 144 | 37 | 15 010 | 27 | 15 682 |
| Møre og Romsdal | 155 | 224 898 | 57 | 178 114 | 53 | 25 853 | 49 | 20 931 |
| Sør-Trøndelag | 117 | 255 116 | 53 | 223 244 | 13 | 2 546 | 52 | 29 326 |
| Nord-Trøndelag | 78 | 108 060 | 41 | 98 119 | 8 | 1 751 | 31 | 8 190 |
| Nordland | 213 | 212 133 | 88 | 166 753 | 86 | 38 110 | 43 | 7 270 |
| Troms | 127 | 132 486 | 32 | 99 497 | 78 | 28 495 | 20 | 4 494 |
| Finnmark | 80 | 70 842 | 35 | 32 246 | 28 | 18 597 | 19 | 19 999 |
| Svalbard[2] | 1 | 1 700 | 1 | 1 170 | 1 | 530 | | |

[1] Including 3 waterworks supplying 280 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 H.2 Number of municipal treatment plants. By county. 2002**

| County/region | Total[1] | Direct discharges | Mecha-nical | Biological | Chemical | Chemical-biological | Other treatment | Individual treatment facilities (<50 PE) |
|---|---|---|---|---|---|---|---|---|
| **Total 2001** | **2 639** | **700** | **976** | **125** | **256** | **299** | **283** | **336 321** |
| **Total 2002** | **2 530** | **570** | **1 027** | **129** | **250** | **278** | **276** | **340 204** |
| North Sea counties (01-10) | 628 | 10 | 35 | 32 | 202 | 209 | 140 | 177 230 |
| Rest of the counties (11-20) | 1 902 | 560 | 992 | 97 | 48 | 69 | 136 | 162 974 |
| 01 Østfold | 36 | 0 | 1 | 1 | 11 | 20 | 3 | 16 791 |
| 02-03 Akershus and Oslo | 58 | 3 | 1 | 1 | 29 | 16 | 8 | 24 166 |
| 04 Hedmark | 95 | 3 | - | 3 | 32 | 36 | 21 | 34 047 |
| 05 Oppland | 157 | - | 4 | 3 | 13 | 64 | 73 | 30 340 |
| 06 Buskerud | 76 | - | 1 | 0 | 41 | 18 | 16 | 18 241 |
| 07 Vestfold | 39 | - | 2 | 2 | 12 | 18 | 5 | 21 598 |
| 08 Telemark | 66 | - | 1 | 12 | 30 | 14 | 9 | 12 190 |
| 09 Aust-Agder | 38 | - | 6 | 2 | 17 | 12 | 1 | 11 243 |
| 10 Vest-Agder | 63 | 4 | 19 | 8 | 17 | 11 | 4 | 8 614 |
| 11 Rogaland | 195 | 17 | 130 | 8 | 12 | 4 | 24 | 20 406 |
| 12 Hordaland | 331 | 39 | 236 | 22 | 3 | 12 | 19 | 30 637 |
| 14 Sogn og Fjordane | 186 | 27 | 136 | 10 | 3 | 8 | 2 | 12 347 |
| 15 Møre og Romsdal | 496 | 214 | 240 | 2 | 4 | 4 | 32 | 22 813 |
| 16 Sør-Trøndelag | 102 | 4 | 43 | 20 | 7 | 11 | 17 | 19 555 |
| 17 Nord-Trøndelag | 106 | 9 | 33 | 19 | 9 | 21 | 15 | 13 850 |
| 18 Nordland | 249 | 123 | 91 | 12 | 4 | 2 | 17 | 25 440 |
| 19 Troms | 124 | 52 | 58 | 2 | 4 | 3 | 5 | 10 817 |
| 20 Finnmark | 113 | 75 | 25 | 2 | 2 | 4 | 5 | 7 109 |

[1] Individual treatment facilities are not included.
**Source:** Waste water treatment statistics from Statistics Norway.

**Table H.3 Hydraulic capacity (1 000 PE) of waste water treatment plants. Whole country 1993-2002. By county, 2002**

| County/region | Total | Direct discharges | Mechanical | Biological | Chemical | Chemical-biological | Other treatment |
|---|---|---|---|---|---|---|---|
| **Total 1993** | **[1]4 837** | **..** | **1 282** | **61** | **2 685** | **752** | **49** |
| **Total 1995** | **[1]5 219** | **..** | **1 318** | **70** | **3 326** | **411** | **68** |
| **Total 1997** | **5 801** | **576** | **1 358** | **95** | **2 568** | **1 115** | **89** |
| **Total 1999** | **6 250** | **541** | **1 744** | **72** | **2 189** | **1 575** | **129** |
| **Total 2000** | **6 257** | **541** | **1 750** | **71** | **2 194** | **1 574** | **127** |
| **Total 2001** | **6 326** | **554** | **1 420** | **116** | **2 289** | **1 566** | **382** |
| **Total 2002** | **5 912** | **529** | **1 294** | **123** | **2 295** | **1 591** | **80** |
| North Sea counties (01-10) | 3 438 | 40 | 49 | 53 | 1 750 | 1 506 | 39 |
| Rest of the counties (11-20) | 2 474 | 488 | 1 245 | 70 | 545 | 84 | 41 |
| 01 Østfold | 350 | - | 0 | 0 | 327 | 21 | 0 |
| 02-03 Akerhus and Oslo | 1 390 | 2 | 0 | 0 | 293 | 1 093 | 2 |
| 04 Hedmark | 224 | 15 | - | 2 | 88 | 105 | 14 |
| 05 Oppland | 303 | - | 14 | 2 | 77 | 193 | 17 |
| 06 Buskerud | 298 | - | 0 | - | 254 | 41 | 2 |
| 07 Vestfold | 257 | - | 1 | 0 | 238 | 16 | 2 |
| 08 Telemark | 229 | - | 1 | 9 | 203 | 15 | 2 |
| 09 Aust-Agder | 157 | - | 8 | 22 | 112 | 15 | 0 |
| 10 Vest-Agder | 231 | 23 | 25 | 17 | 157 | 7 | 1 |
| 11 Rogaland | 458 | 66 | 103 | 26 | 255 | 2 | 5 |
| 12 Hordaland | 544 | 40 | 408 | 8 | 66 | 18 | 4 |
| 14 Sogn og Fjordane | 124 | 14 | 95 | 4 | 0 | 11 | 0 |
| 15 Møre og Romsdal | 321 | 115 | 175 | 0 | 20 | 1 | 10 |
| 16 Sør-Trøndelag | 369 | 13 | 187 | 9 | 140 | 18 | 3 |
| 17 Nord-Trøndelag | 142 | 2 | 52 | 16 | 56 | 13 | 4 |
| 18 Nordland | 231 | 95 | 124 | 6 | 2 | 2 | 2 |
| 19 Troms | 176 | 78 | 73 | 0 | 7 | 9 | 9 |
| 20 Finnmark | 109 | 66 | 29 | 1 | 1 | 11 | 2 |

[1] Direct discharges are not included.
**Source:** Waste water treatment statistics from Statistics Norway

**Table H.4 Number of people connected to different types of treatment plants. Whole country 2000-2002. By county, 2002[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** |
| North Sea counties (01-10) | 2 193 268 | 18 840 | 28 770 | 1 091 209 | 35 652 | 985 159 | 33 638 | 391 079 | 88 |
| Rest of the counties (11-20) | 1 446 905 | 275 792 | 748 732 | 317 201 | 45 275 | 41 616 | 18 289 | 478 082 | 71 |
| 01 Østfold | 221 125 | - | - | 208 773 | 200 | 12 056 | 96 | 31 515 | 87 |
| 02-03 Akershus and Oslo | 956 783 | 5 454 | - | 178 624 | 2 | 772 619 | 84 | 52 575 | 97 |
| 04 Hedmark | 139 037 | 2 | - | 58 947 | 737 | 74 041 | 5 310 | 70 359 | 74 |
| 05 Oppland | 126 156 | - | 3 900 | 40 946 | 992 | 79 207 | 1 111 | 72 278 | 69 |
| 06 Buskerud | 178 458 | - | 165 | 154 743 | - | 22 875 | 675 | 49 987 | 74 |
| 07 Vestfold | 204 314 | - | 942 | 168 358 | 168 | 9 469 | 25 377 | 29 453 | 94 |
| 08 Telemark | 124 728 | - | - | 115 229 | 4 095 | 4 809 | 595 | 36 513 | 75 |
| 09 Aust-Agder | 84 152 | - | 5 403 | 55 100 | 16 722 | 6 853 | 74 | 24 570 | 82 |
| 10 Vest-Agder | 158 515 | 13 384 | 18 360 | 110 489 | 12 736 | 3 230 | 316 | 23 829 | 98 |
| 11 Rogaland | 275 723 | 25 015 | 64 362 | 158 093 | 24 978 | 1 280 | 1 995 | 58 897 | 72 |
| 12 Hordaland | 321 956 | 23 143 | 228 272 | 54 015 | 3 846 | 10 396 | 2 284 | 86 738 | 73 |
| 14 Sogn og Fjordane | 61 977 | 9 147 | 48 054 | 155 | 2 385 | 2 107 | 129 | 42 429 | 58 |
| 15 Møre og Romsdal | 203 189 | 65 980 | 117 931 | 12 527 | 82 | 1 104 | 5 565 | 67 451 | 83 |
| 16 Sør-Trøndelag | 191 187 | 7 665 | 113 176 | 51 461 | 4 127 | 12 672 | 2 086 | 51 112 | 72 |
| 17 Nord-Trøndelag | 77 513 | 1 931 | 21 723 | 38 523 | 5 795 | 7 951 | 1 590 | 35 565 | 61 |
| 18 Nordland | 138 921 | 50 702 | 82 172 | 790 | 3 463 | 718 | 1 076 | 77 013 | 58 |
| 19 Troms | 113 349 | 47 904 | 58 337 | 1 395 | 309 | 2 505 | 2 899 | 44 562 | 75 |
| 20 Finnmark | 63 090 | 44 305 | 14 705 | 242 | 290 | 2 883 | 665 | 14 417 | 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 H.5 Discharges of phosphorus by county and treatment methods. 2002. Tonnes**

| County/region | Total[1] | Direct discharges | Mechanical | Chemical | Biological | Chemical-biological | Other treatment | Individual treatment facilities (<50 PE) | Discharges per inhabitant, kilograms[1] | Average treatment efficiency, Per cent[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total 1993** | [2] **534.00** | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **Total 1995** | [2] **601.00** | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **Total 1997** | [2] **570.00** | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **Total 1999** | **836.0** | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **Total 2000** | **825.4** | **197.8** | **481.6** | **86.7** | **9.7** | **45.1** | **4.6** | .. | **0.18** | **66.8** |
| **Total 2001** | **794.8** | **182.0** | **442.5** | **88.6** | **13.0** | **57.7** | **10.9** | **362.1** | **0.18** | **67.6** |
| **Total 2002** | **725.1** | **170.5** | **416.0** | **76.2** | **9.6** | **45.5** | **7.3** | **346.5** | **0.16** | **69.9** |
| North Sea counties (01-10) | 123.3 | 9.2 | 12.2 | 51.2 | 3.2 | 43.2 | 4.3 | 125.9 | 0.05 | 91.7 |
| Rest of the counties (11-20) | 601.8 | 161.2 | 403.9 | 25.0 | 6.4 | 2.3 | 3.0 | 220.6 | 0.30 | 35.1 |
| 01 Østfold | 11.0 | - | - | 10.5 | 0.0 | 0.5 | 0.0 | 13.4 | 0.04 | 91.6 |
| 02-03 Akershus and Oslo | 46.0 | 3.2 | 0.2 | 5.7 | 0.0 | 36.9 | 0.0 | 20.8 | 0.05 | 93.1 |
| 04 Hedmark | 7.4 | 0.0 | - | 4.9 | - | 2.2 | 0.3 | 17.5 | 0.04 | 92.5 |
| 05 Oppland | 3.5 | - | 0.0 | 1.4 | 0.0 | 2.0 | 0.1 | 17.0 | 0.02 | 96.1 |
| 06 Buskerud | 9.2 | - | 0.1 | 8.2 | - | 0.8 | 0.1 | 16.5 | 0.04 | 92.3 |
| 07 Vestfold | 14.0 | - | 0.5 | 9.4 | 0.1 | 0.3 | 3.7 | 14.1 | 0.06 | 90.3 |
| 08 Telemark | 6.9 | - | - | 6.2 | 0.4 | 0.3 | 0.1 | 12.6 | 0.04 | 92.6 |
| 09 Aust-Agder | 6.2 | - | 2.5 | 1.7 | 1.8 | 0.2 | 0.0 | 7.2 | 0.06 | 87.9 |
| 10 Vest-Agder | 19.0 | 6.1 | 8.9 | 3.2 | 0.8 | 0.1 | 0.0 | 6.9 | 0.12 | 77.4 |
| 11 Rogaland | 56.8 | 14.6 | 31.9 | 9.2 | 0.7 | 0.0 | 0.3 | 24.2 | 0.15 | 65.2 |
| 12 Hordaland | 132.4 | 13.5 | 113.6 | 3.2 | 1.6 | 0.3 | 0.3 | 38.0 | 0.30 | 28.1 |
| 14 Sogn og Fjordane | 31.9 | 5.3 | 25.5 | 0.0 | 0.6 | 0.3 | 0.1 | 18.2 | 0.30 | 22.9 |
| 15 Møre og Romsdal | 99.4 | 38.5 | 59.3 | 0.6 | 0.0 | 0.0 | 1.0 | 33.9 | 0.41 | 28.9 |
| 16 Sør-Trøndelag | 96.5 | 4.7 | 80.6 | 9.1 | 1.4 | 0.5 | 0.3 | 23.2 | 0.36 | 38.7 |
| 17 Nord-Trøndelag | 19.4 | 1.1 | 13.2 | 2.8 | 1.4 | 0.6 | 0.2 | 17.7 | 0.15 | 64.2 |
| 18 Nordland | 69.2 | 29.6 | 38.8 | 0.0 | 0.5 | 0.0 | 0.2 | 38.5 | 0.29 | 11.7 |
| 19 Troms | 62.7 | 28.0 | 33.9 | 0.1 | 0.1 | 0.2 | 0.4 | 22.2 | 0.41 | 9.7 |
| 20 Finnmark | 33.5 | 25.9 | 7.0 | 0.1 | 0.1 | 0.3 | 0.1 | 4.7 | 0.45 | 13.7 |

[1] Discharges from individual treatment facilities are not included. [2] Direct discharges are not included.
**Source:** Waste water treatment statistics from Statistics Norway.

**Table H.6 Discharges of nitrogen by county and treatment methods. 2002. Tonnes**

| County/region | Total[1] | Direct dis-charges | Mecha-nical | Chem-ical | Biolo-gical | Chemical-biological | Other treat-ment | Indivi-dual treat-ment facilities (<50 PE) | Discharg-es per in-habitant, kilo-grams[1] | Average treatment efficiency,[1] Per cent |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total 1998** | **13 554.0** | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **Total 1999** | **13 492.0** | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **Total 2000** | **13 191.4** | **1 478.0** | **3 823.8** | **4 921.3** | **126.2** | **2 685.8** | **156.2** | .. | **2.95** | **27.7** |
| **Total 2001** | **12 302.9** | **1 384.2** | **3 021.7** | **5 145.7** | **247.2** | **2 199.6** | **304.4** | **3 560.1** | **2.73** | **28.3** |
| **Total 2002** | **11 785.3** | **1 284.3** | **2 979.1** | **5 133.8** | **279.8** | **1 925.3** | **182.9** | **3 246.1** | **2.61** | **29.0** |
| North Sea counties (01-10) | 6 246.2 | 73.4 | 117.2 | 4 025.3 | 125.0 | 1 788.5 | 116.7 | 1 361.9 | 2.50 | 38.7 |
| Rest of the counties (11-20) | 5 539.1 | 1 210.9 | 2 861.9 | 1 108.5 | 154.8 | 136.8 | 66.2 | 1 884.1 | 2.73 | 13.7 |
| 01 Østfold | 760.1 | - | - | 709.1 | 0.7 | 49.6 | 0.7 | 109.3 | 3.01 | 19.6 |
| 02-03 Akershus and Oslo | 1 918.3 | 23.9 | - | 742.1 | 0.0 | 1 152.0 | 0.3 | 196.3 | 1.94 | 59.2 |
| 04 Hedmark | 510.4 | - | - | 254.9 | - | 237.9 | 17.6 | 224.8 | 2.72 | 26.4 |
| 05 Oppland | 431.5 | - | 14.5 | 220.7 | 3.5 | 188.8 | 3.9 | 243.9 | 2.35 | 38.0 |
| 06 Buskerud | 596.3 | - | 0.6 | 510.5 | - | 82.8 | 2.4 | 173.6 | 2.49 | 19.7 |
| 07 Vestfold | 774.2 | - | 3.5 | 650.6 | 0.6 | 31.1 | 88.4 | 111.6 | 3.58 | 17.9 |
| 08 Telemark | 460.6 | - | - | 428.4 | 14.3 | 15.8 | 2.1 | 132.1 | 2.78 | 13.5 |
| 09 Aust-Agder | 291.2 | - | 34.4 | 168.3 | 65.6 | 22.5 | 0.3 | 87.8 | 2.83 | 19.8 |
| 10 Vest-Agder | 503.7 | 49.5 | 64.1 | 340.8 | 40.3 | 7.9 | 1.1 | 82.4 | 3.19 | 10.8 |
| 11 Rogaland | 1 000.5 | 109.3 | 239.6 | 552.9 | 87.5 | 4.2 | 7.0 | 228.4 | 2.62 | 17.2 |
| 12 Hordaland | 1 198.2 | 101.4 | 852.0 | 189.2 | 13.5 | 34.2 | 8.0 | 328.9 | 2.73 | 15.2 |
| 14 Sogn og Fjordane | 238.7 | 40.1 | 181.8 | 0.5 | 8.4 | 6.9 | 1.1 | 164.5 | 2.23 | 13.4 |
| 15 Møre og Romsdal | 801.2 | 290.2 | 445.6 | 42.0 | 0.3 | 3.5 | 19.6 | 273.4 | 3.29 | 10.6 |
| 16 Sør-Trøndelag | 698.4 | 35.2 | 419.5 | 180.3 | 14.5 | 41.6 | 7.3 | 198.1 | 2.62 | 16.5 |
| 17 Nord-Trøndelag | 276.3 | 8.5 | 80.9 | 135.0 | 20.3 | 26.1 | 5.6 | 140.5 | 2.17 | 18.6 |
| 18 Nordland | 547.0 | 222.1 | 306.1 | 2.8 | 8.3 | 2.6 | 5.2 | 312.6 | 2.30 | 9.8 |
| 19 Troms | 514.2 | 209.8 | 280.1 | 4.9 | 1.1 | 8.2 | 10.2 | 182.6 | 3.39 | 9.3 |
| 20 Finnmark | 264.4 | 194.4 | 56.4 | 0.8 | 1.0 | 9.5 | 2.3 | 55.2 | 3.59 | 5.0 |

[1] Discharges from individual treatment facilities are not included.
**Source:** Waste water treatment statistics from Statistics Norway.

**Table H.7 Disposal of sewage sludge. By county. 2002. Tonnes dry weight**

| County | Total[1] | Agriculture | Parks and green spaces | Delivered producer of fertilizer | Cover on landfills | Deposited | Other use | Delivered treatment plant |
|---|---|---|---|---|---|---|---|---|
| **Total 2001** | **107 101** | **48 039** | **14 160** | .. | **4 217** | **11 659** | **29 026** | **4 995** |
| **Total 2002** | **103 135** | **43 560** | **8 995** | **5 714** | **6 160** | **9 929** | **28 776** | **40 364** |
| Østfold | 8 815 | 3 947 | 1 754 | 694 | 876 | 602 | 941 | 1 222 |
| Akershus and Oslo | 30 860 | 23 119 | 558 | 243 | 273 | 1 139 | 5 528 | 1 323 |
| Hedmark | 5 909 | - | - | 851 | 1 450 | 613 | 2 995 | 2 079 |
| Oppland | 4 796 | 90 | 569 | 287 | 658 | 1 261 | 1 931 | 8 113 |
| Buskerud | 9 195 | 2 265 | 1 938 | 2 800 | 345 | 462 | 1 385 | 8 128 |
| Vestfold | 9 160 | 6 421 | 522 | 135 | - | 38 | 2 044 | 3 074 |
| Telemark | 6 020 | 3 420 | 1 348 | 8 | 530 | 121 | 593 | 943 |
| Aust-Agder | 2 503 | 1 165 | 249 | 442 | 25 | 187 | 435 | 1 089 |
| Vest-Agder | 2 356 | - | 67 | - | - | 309 | 1 981 | 2 733 |
| Rogaland | 3 144 | 105 | | - | 178 | 60 | 2 801 | 115 |
| Hordaland | 760 | 52 | 96 | - | 22 | 62 | 528 | 1 905 |
| Sogn og Fjordane | 1 790 | 300 | 233 | - | 301 | 256 | 700 | 914 |
| Møre og Romsdal | 4 635 | 1 400 | 100 | - | 947 | 1 276 | 912 | 3 429 |
| Sør-Trøndelag | 5 638 | 870 | 992 | - | 3 | 1 187 | 2 585 | 1 181 |
| Nord-Trøndelag | 2 127 | 378 | 320 | 255 | 20 | 180 | 974 | 587 |
| Nordland | 3 607 | 28 | 100 | - | 518 | 1 732 | 1 230 | 1 893 |
| Troms | 1 466 | - | 150 | - | - | 224 | 1 092 | 1 121 |
| Finnmark | 353 | - | - | - | 13 | 220 | 121 | 516 |

[1] "Delivered treatment plant" is not included.
**Source:** Waste water treatment statistics from Statistics Norway.

**Table H.8 Municipal water sector: Investment, costs, income and cost coverage ratio. Counties. 2003**

| | Invest-ment in production of water | Invest-ment in distribution | Total investment | Mainte-nance, running and overhead costs | Capital costs | Annual costs | Fee income | Cost coverage ratio |
|---|---|---|---|---|---|---|---|---|
| | NOK Million | | | | | | | Per cent |
| Total | 368 | 1 112 | 1 480 | 2 082 | 1 203 | 3 285 | 3 325 | 101 |
| Østfold | 4 | 55 | 59 | 128 | 54 | 182 | 186 | 102 |
| Akershus | 6 | 104 | 110 | 270 | 82 | 352 | 363 | 103 |
| Oslo | 81 | 126 | 207 | 119 | 106 | 226 | 240 | 107 |
| Hedmark | 19 | 20 | 39 | 71 | 33 | 104 | 114 | 109 |
| Oppland | 27 | 69 | 96 | 87 | 54 | 141 | 144 | 102 |
| Buskerud | 4 | 81 | 85 | 106 | 55 | 161 | 182 | 113 |
| Vestfold | 5 | 49 | 54 | 114 | 47 | 162 | 169 | 104 |
| Telemark | 9 | 34 | 43 | 60 | 49 | 109 | 121 | 112 |
| Aust-Agder | 23 | 19 | 42 | 47 | 27 | 75 | 75 | 100 |
| Vest-Agder | 11 | 22 | 32 | 66 | 33 | 99 | 94 | 95 |
| Rogaland | 12 | 102 | 114 | 217 | 93 | 310 | 312 | 101 |
| Hordaland | 41 | 59 | 100 | 225 | 137 | 362 | 340 | 94 |
| Sogn og Fjordane | 39 | 58 | 97 | 43 | 42 | 85 | 85 | 100 |
| Møre og Romsdal | 11 | 71 | 82 | 112 | 69 | 181 | 181 | 100 |
| Sør-Trøndelag | 10 | 56 | 66 | 112 | 85 | 197 | 205 | 104 |
| Nord-Trøndelag | 5 | 28 | 34 | 64 | 40 | 104 | 102 | 98 |
| Nordland | 37 | 84 | 121 | 122 | 101 | 223 | 203 | 91 |
| Troms | 12 | 49 | 60 | 72 | 67 | 138 | 133 | 96 |
| Finnmark | 13 | 27 | 39 | 44 | 29 | 73 | 76 | 105 |

**Source:** Environmental protection expenditure statistics from Statistics Norway.

**Table H.9 Municipal wastewater sector: Investment, costs, fee income, and cost coverage ratio. Total for Norway, 1993-2003. County figures, 2003**

| | Investment in wastewater treatment plants | Investment in sewerage network | Total investment | Maintenance, running and overhead costs | Capital costs | Annual costs | Fee income | Cost coverage ratio |
|---|---|---|---|---|---|---|---|---|
| | NOK Million | | | | | | | Per cent |
| 1993 | 347 | 964 | 1 311 | .. | .. | .. | .. | .. |
| 1994 | 392 | 1 044 | 1 436 | 1 596 | 1 340 | 2 936 | 2 753 | 94 |
| 1995 | 313 | 1 118 | 1 431 | 1 706 | 1 407 | 3 113 | 2 957 | 95 |
| 1996 | 279 | 1 066 | 1 344 | 1 776 | 1 411 | 3 187 | 3 094 | 97 |
| 1997 | 196 | 1 229 | 1 424 | 1 846 | 1 339 | 3 184 | 3 280 | 103 |
| 1998 | 471 | 1 337 | 1 807 | 1 929 | 1 499 | 3 428 | 3 455 | 101 |
| 1999 | 601 | 1 362 | 1 963 | 2 074 | 1 832 | 3 906 | 3 668 | 94 |
| 2000 | 503 | 1 256 | 1 759 | 2 181 | 1 826 | 4 007 | 4 024 | 100 |
| 2001 | 436 | 1 250 | 1 686 | 2 394 | 2 003 | 4 397 | 3 993 | 91 |
| 2002 | 338 | 1 407 | 1 745 | 2 415 | 1 802 | 4 216 | 4 067 | 96 |
| 2003 | 401 | 1 456 | 1 857 | 2 574 | 1 706 | 4 280 | 4 280 | 100 |
| North Sea counties | 171 | 867 | 1 038 | 1 620 | 991 | 2 611 | 2 619 | 102 |
| Rest of the counties | 230 | 589 | 819 | 954 | 715 | 1 669 | 1 661 | 100 |
| Østfold | -3 | 108 | 105 | 180 | 144 | 323 | 331 | 102 |
| Akershus | 40 | 139 | 179 | 321 | 158 | 479 | 496 | 104 |
| Oslo | 5 | 131 | 136 | 294 | 159 | 453 | 375 | 83 |
| Hedmark | 13 | 53 | 66 | 117 | 61 | 178 | 184 | 104 |
| Oppland | 50 | 86 | 136 | 144 | 77 | 221 | 230 | 104 |
| Buskerud | 10 | 127 | 137 | 138 | 106 | 244 | 280 | 115 |
| Vestfold | 7 | 84 | 91 | 144 | 93 | 236 | 250 | 106 |
| Telemark | 22 | 46 | 68 | 109 | 68 | 178 | 170 | 96 |
| Aust-Agder | 7 | 43 | 50 | 78 | 63 | 141 | 137 | 97 |
| Vest-Agder | 19 | 52 | 71 | 97 | 62 | 159 | 166 | 105 |
| Rogaland | 4 | 133 | 137 | 189 | 136 | 325 | 332 | 102 |
| Hordaland | 22 | 96 | 118 | 227 | 149 | 376 | 368 | 98 |
| Sogn og Fjordane | 7 | 37 | 43 | 42 | 31 | 73 | 72 | 98 |
| Møre og Romsdal | 13 | 69 | 81 | 100 | 72 | 172 | 176 | 102 |
| Sør-Trøndelag | 116 | 57 | 172 | 109 | 109 | 218 | 230 | 105 |
| Nord-Trøndelag | 27 | 31 | 57 | 82 | 54 | 136 | 132 | 97 |
| Nordland | 11 | 84 | 95 | 104 | 84 | 189 | 174 | 92 |
| Troms | 29 | 59 | 88 | 65 | 64 | 129 | 123 | 96 |
| Finnmark | 2 | 25 | 27 | 35 | 16 | 51 | 55 | 107 |

**Source:** Environmental protection expenditure statistics from Statistics Norway.

**Table H.10 Water fees, for a private dwelling of 120 m$^2$. Counties. 2004. NOK**

| | Fixed annual fee | Two-level fee system | | Payment by water used | | Connection fee | |
|---|---|---|---|---|---|---|---|
| | | Variable portion (per m$^3$ water used) | Fixed portion | Variable portion (per m$^3$ water used) | Minimum use charged. m$^3$ | Lowest level | Highest level |
| **Whole country** | **2 076** | **7.06** | **1 145** | **9.16** | **146** | **7 331** | **10 556** |
| Østfold | 1 747 | 7.52 | 603 | 10.44 | 90 | 5 428 | 7 912 |
| Akershus | 2 071 | 10.32 | 765 | 9.27 | 97 | 8 713 | 17 104 |
| Oslo | 846 | 4.92 | 78 | - | - | - | 10 905 |
| Hedmark | 2 413 | 11.21 | 764 | 10.84 | 83 | 9 541 | 12 436 |
| Oppland | 2 079 | 9.90 | 928 | 11.89 | 125 | 5 672 | 13 636 |
| Buskerud | 2 257 | 12.46 | 1 333 | 10.32 | 104 | 7 641 | 12 687 |
| Vestfold | 1 729 | 5.67 | 752 | 7.97 | 135 | 9 809 | 14 295 |
| Telemark | 1 976 | 5.01 | 998 | 8.82 | 154 | 3 461 | 4 262 |
| Aust-Agder | 1 868 | 5.37 | 1 062 | 6.54 | 129 | 9 759 | 9 815 |
| Vest-Agder | 1 446 | 5.44 | 756 | 5.37 | 68 | 10 071 | 11 470 |
| Rogaland | 1 596 | 5.36 | 835 | 6.60 | 195 | 7 380 | 10 303 |
| Hordaland | 2 310 | 7.35 | 1 312 | 9.50 | 179 | 9 813 | 12 629 |
| Sogn og Fjordane | 2 477 | 7.89 | 1 410 | 9.17 | 173 | 7 000 | 10 118 |
| Møre og Romsdal | 2 136 | 7.97 | 1 750 | 7.81 | 193 | 6 539 | 9 483 |
| Sør-Trøndelag | 2 454 | 7.05 | 1 451 | 9.01 | 200 | 10 195 | 12 526 |
| Nord-Trøndelag | 2 094 | 7.13 | 1 390 | 8.59 | 156 | 6 269 | 8 936 |
| Nordland | 2 080 | 6.31 | 1 324 | 8.58 | 163 | 5 853 | 8 666 |
| Troms | 1 963 | 5.04 | 1 463 | 8.12 | 309 | 4 135 | 5 184 |
| Finnmark | 2 062 | 5.29 | 1 321 | 7.25 | - | 6 939 | 10 318 |

**Source:** Environmental protection expenditure statistics from Statistics Norway.

**Table H.11 Wastewater treatment fees, for a private dwelling of 120 m$^2$. Counties. 2004. NOK**

| | Fixed annual fee | Two-level fee system | | Payment by water used | | Connection fee | |
|---|---|---|---|---|---|---|---|
| | | Variable portion (per m$^3$ wastewater) | Fixed portion | Variable portion (per m$^3$ wastewater) | Minimum use charged. m$^3$ | Lowest level | Highest level |
| **Whole country** | **2 491** | **7.06** | **1 145** | **9.16** | **143** | **8 369** | **13 039** |
| North Sea counties | 3 172 | 12.06 | 1 338 | 16.17 | 108 | 9 697 | 15 744 |
| Rest of the counties | 2 076 | 7.23 | 1 232 | 8.40 | 177 | 7 450 | 10 942 |
| Østfold | 3 682 | 19.51 | 964 | 17.72 | 95 | 7 023 | 11 003 |
| Akershus | 3 077 | 11.94 | 1 468 | 14.67 | 110 | 12 246 | 23 641 |
| Oslo | 1 231 | 7.39 | 78 | - | - | - | 16 350 |
| Hedmark | 3 450 | 14.51 | 1 073 | 18.40 | 77 | 12 042 | 15 408 |
| Oppland | 3 303 | 15.55 | 1 349 | 18.54 | 111 | 9 269 | 20 327 |
| Buskerud | 3 604 | 13.57 | 1 408 | 16.37 | 103 | 8 737 | 14 651 |
| Vestfold | 2 739 | 8.37 | 1 100 | 14.22 | 131 | 12 299 | 18 981 |
| Telemark | 3 128 | 8.82 | 1 680 | 14.16 | 155 | 3 455 | 4 415 |
| Aust-Agder | 3 138 | 10.07 | 1 766 | 10.45 | 129 | 10 944 | 8 987 |
| Vest-Agder | 2 535 | 9.61 | 1 314 | 8.48 | 68 | 11 414 | 16 424 |
| Rogaland | 1 903 | 6.04 | 765 | 6.98 | 206 | 7 932 | 14 058 |
| Hordaland | 2 000 | 7.11 | 1 050 | 9.12 | 185 | 10 084 | 12 286 |
| Sogn og Fjordane | 2 365 | 8.49 | 1 439 | 7.84 | 173 | 6 961 | 9 887 |
| Møre og Romsdal | 1 768 | 6.55 | 1 117 | 7.89 | 189 | 8 013 | 10 929 |
| Sør-Trøndelag | 2 252 | 7.99 | 1 098 | 8.55 | 206 | 9 722 | 13 500 |
| Nord-Trøndelag | 2 853 | 12.28 | 2 155 | 11.62 | 149 | 7 016 | 11 178 |
| Nordland | 1 809 | 7.04 | 1 180 | 7.43 | 152 | 5 420 | 8 557 |
| Troms | 2 148 | 6.46 | 1 687 | 8.87 | 226 | 4 399 | 5 947 |
| Finnmark | 1 948 | 5.36 | 1 093 | 8.25 | - | 7 009 | 9 085 |

**Source:** Environmental protection expenditure statistics from Statistics Norway.

# Land use

## Appendix I

### Table I.1 Urban settlements with more than 20 000 inhabitants.

| | 1 January 2004 | | | Percentage urb. settlemt. area built on. 1 January 2002 | Percentage urb. settlemt. area covered by roads. 1 January 2002 | Percentage change urb. settlemt. pop. 2000-2004 | Percentage change urb. settlemt. area 2000-2004 |
|---|---|---|---|---|---|---|---|
| | Population | Inhabitants per km² | Total urb. settlemt. area km² | | | | |
| All urban settlements in Norway | 3 536 454 | 1 595 | 2 217.3 | 9.5 | 14.9 | 4.1 | 3.7 |
| Oslo | 801 028 | 2 897 | 276.5 | 11.8 | 14.5 | 3.6 | 2.8 |
| Bergen | 212 626 | 2 411 | 88.2 | 10.6 | 17.4 | 3.3 | 2.5 |
| Stavanger/Sandnes | 171 342 | 2 364 | 72.5 | 14.0 | 15.6 | 5.7 | 3.8 |
| Trondheim | 145 691 | 2 452 | 59.4 | 12.0 | 11.9 | 3.6 | 2.1 |
| Fredrikstad/Sarpsborg | 96 595 | 1 527 | 63.3 | 10.0 | 14.8 | 3.6 | 1.3 |
| Drammen | 89 976 | 1 886 | 47.7 | 11.0 | 16.1 | 3.7 | 2.5 |
| Porsgrunn/Skien | 84 882 | 1 542 | 55.0 | 9.3 | 15.9 | 1.8 | 3.1 |
| Kristiansand | 63 368 | 2 109 | 30.1 | 14.5 | 16.2 | 3.2 | 2.6 |
| Tromsø | 52 116 | 2 374 | 22.0 | 11.1 | 16.5 | 5.6 | 3.3 |
| Tønsberg | 44 746 | 1 504 | 29.8 | 9.7 | 15.1 | 3.2 | 1.3 |
| Ålesund[1] | 43 972 | 1 513 | 29.1 | 8.6 | 15.0 | 22.7 | 37.0 |
| Haugesund | 40 271 | 1 787 | 22.5 | 11.4 | 18.1 | 3.0 | 3.5 |
| Sandefjord | 39 387 | 1 497 | 26.3 | 9.1 | 14.7 | 5.8 | 7.0 |
| Moss | 34 329 | 1 964 | 17.5 | 10.7 | 13.5 | 3.8 | 6.9 |
| Bodø | 33 473 | 2 433 | 13.8 | 12.1 | 17.4 | 3.5 | 3.7 |
| Arendal | 30 806 | 1 238 | 24.9 | 7.6 | 15.2 | 2.2 | 3.6 |
| Hamar | 28 564 | 1 644 | 17.4 | 12.2 | 16.8 | 3.8 | 4.9 |
| Larvik | 23 040 | 1 684 | 13.7 | 11.9 | 16.2 | 3.8 | 4.5 |
| Halden | 21 916 | 1 615 | 13.6 | 10.7 | 16.1 | 2.9 | 8.6 |

[1] As of 1 January 2002, urban settlement 6025 Ålesund/Spjelkavik was combined with Langevåg urban settlement to form 6025 Ålesund urban settlement.

**Source:** Source: Land use statistics and population statistics from Statistics Norway.

### Table I.2 Urban settlement area (km²) and main categories land use in urban settlements. Grouped by size of population. Per cent

| Grouped by size of population | Total urb. settlemt. area. 1 January 2004. km | Land-use categories as of 1 January 2000. Per cent | | | | | |
|---|---|---|---|---|---|---|---|
| | | Total area built on or near buildings | Housing, holiday homes and assocd. buildings | Business activity | Transport and communication | Other built on area | Unbuilt |
| All urban settlements | 2 217.28 | 60.6 | 32.4 | 9.7 | 15.7 | 2.7 | 39.4 |
| 200 - 499 | 159.67 | 49.7 | 23.2 | 10.4 | 14.7 | 1.3 | 50.3 |
| 500 - 999 | 182.80 | 53.5 | 26.6 | 9.8 | 15.6 | 1.7 | 46.5 |
| 1 000 - 1 999 | 205.33 | 56.8 | 29.5 | 10.0 | 15.5 | 1.7 | 43.2 |
| 2 000 - 99 999 | 1 172.85 | 62.1 | 34.0 | 9.8 | 16.1 | 2.1 | 37.9 |
| 100 000 - | 496.64 | 65.5 | 35.4 | 9.1 | 15.4 | 5.5 | 34.5 |

**Source:** Source: Land use statistics from Statistics Norway.

**Table I.3 Percentage day care centres, schools, residential housing and residents with safe access to recreational areas. 2002*.**

| | Day care centres | Schools | Blocks of flats | Row, detached, etc. houses | Residents |
|---|---|---|---|---|---|
| **Whole country** | **87** | **88** | **66** | **84** | **81** |
| Østfold | 86 | 87 | 68 | 78 | 77 |
| Akershus | 84 | 88 | 78 | 77 | 78 |
| Oslo | 77 | 76 | 65 | 65 | 70 |
| Hedmark | 89 | 90 | 68 | 86 | 83 |
| Oppland | 92 | 93 | 72 | 90 | 88 |
| Buskerud | 85 | 89 | 72 | 85 | 82 |
| Vestfold | 82 | 81 | 56 | 74 | 72 |
| Telemark | 91 | 93 | 77 | 87 | 86 |
| Aust-Agder | 92 | 81 | 63 | 88 | 87 |
| Vest-Agder | 90 | 84 | 63 | 88 | 86 |
| Rogaland | 79 | 84 | 60 | 74 | 72 |
| Hordaland | 90 | 89 | 57 | 89 | 85 |
| Sogn og Fjordane | 92 | 96 | 72 | 94 | 92 |
| Møre og Romsdal | 88 | 87 | 66 | 89 | 86 |
| Sør-Trøndelag | 85 | 86 | 62 | 84 | 80 |
| Nord-Trøndelag | 89 | 90 | 71 | 88 | 86 |
| Nordland | 90 | 94 | 77 | 92 | 90 |
| Troms | 94 | 97 | 75 | 93 | 90 |
| Finnmark | 95 | 93 | 81 | 91 | 89 |

**Source:** Source: Land use statistics from Statistics Norway.

**Table I.4 Percentage of coastline within 100 m from buildings**

| | 1985 | 1990 | 2000 | 2004 |
|---|---|---|---|---|
| **Whole country** | **22.2** | **22.5** | **23.3** | **23.5** |
| County nos. 01-03 and 06-12 | 37.0 | 37.5 | 38.7 | 39.1 |
| 01 Østfold | 41.6 | 41.8 | 42.3 | 42.4 |
| 02 Akershus | 70.8 | 71.0 | 71.5 | 71.7 |
| 03 Oslo | : | : | : | 79.1 |
| 06 Buskerud | 67.0 | 67.7 | 68.5 | 68.6 |
| 07 Vestfold | 43.2 | 43.6 | 44.3 | 44.5 |
| 08 Telemark | 57.3 | 57.9 | 59.5 | 59.9 |
| 09 Aust-Agder | 49.3 | 49.7 | 50.5 | 50.9 |
| 10 Vest-Agder | 34.6 | 35.5 | 36.9 | 37.4 |
| 11 Rogaland | 30.4 | 30.9 | 32.1 | 32.4 |
| 12 Hordaland | 32.4 | 32.9 | 34.0 | 34.4 |
| 14 Sogn og Fjordane | 21.9 | 22.4 | 23.1 | 23.4 |
| 15 Møre og Romsdal | 27.8 | 28.2 | 29.0 | 29.3 |
| 16 Sør-Trøndelag | 14.7 | 14.9 | 15.4 | 15.6 |
| 17 Nord-Trøndelag | 13.6 | 13.8 | 14.4 | 14.6 |
| 18 Nordland | 13.2 | 13.5 | 14.1 | 14.3 |
| 19 Troms | 27.4 | 27.6 | 28.4 | 28.7 |
| 20 Finnmark | 12.3 | 12.4 | 12.7 | 12.9 |

**Source:** Source: Land use statistics from Statistics Norway.

**Table I.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 |
| **2003** | | | | | | | | |
| Østfold | - | - | 73 | 6 922 | 4 | 1 017 | - | - |
| Akershus and Oslo | - | - | 102 | 12 352 | 9 | 6 020 | 4 | 155 |
| Hedmark | 5 | 103 591 | 84 | 47 767 | 10 | 88 528 | - | - |
| Oppland | 6 | 251 498 | 86 | 20 792 | 15 | 87 309 | 6 | 451 |
| Buskerud | 1 | 84 679 | 90 | 17 228 | 10 | 44 180 | - | - |
| Vestfold | - | - | 68 | 1 600 | 6 | 486 | 1 | 26 |
| Telemark | 1 | 77 264 | 103 | 10 008 | 11 | 71 496 | 4 | 3 322 |
| Aust-Agder | - | - | 83 | 10 239 | 8 | 163 225 | - | - |
| Vest-Agder | - | - | 85 | 4 817 | 6 | 82 806 | 14 | 453 |
| Rogaland | - | - | 118 | 6 115 | 13 | 105 320 | 11 | 1 410 |
| Hordaland | 1 | 182 533 | 136 | 8 407 | 11 | 52 314 | - | - |
| Sogn og Fjordane | 2 | 155 407 | 87 | 9 711 | 6 | 111 828 | 4 | 370 |
| Møre og Romsdal | 1 | 58 302 | 128 | 13 872 | 7 | 168 750 | 17 | 571 |
| Sør-Trøndelag | 3 | 142 455 | 78 | 18 367 | 19 | 110 577 | 9 | 254 |
| Nord-Trøndelag | 2 | 68 807 | 99 | 38 702 | 1 | 272 | 23 | 4 843 |
| Nordland | 4 | 325 262 | 174 | 53 299 | 18 | 83 940 | 4 | 454 |
| Troms | 4 | 161 300 | 53 | 12 300 | 6 | 12 810 | 2 | 97 |
| Finnmark Finnmárku | 4 | 228 357 | 51 | 36 092 | 9 | 37 527 | - | - |
| Svalbard[5] | 6 | 1 381 300 | 21 | 2 582 800 | - | - | 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. 12. 2003 onwards the area figures are calculated based on digital overlay analysis, a higher accuracy are 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/ .

# Publications by Statistics Norway concerning natural resources and the environment. 2000-2004

**Official Statistics of Norway (NOS)**

C 557 Transport and Communication Statistics 1998.

C 560 Agricultural Statistics 1998.

C 580 Oil and gas activity, 3rd quarter 1999. Statistics and analysis.

C 582 Maritime Statistics 1998.

C 584 Forestry Statistics 1997.

C 592 Oil and gas activity, 4th quarter 1999. Statistics and analysis.

C 595 Energy Statistics 1998.

C 600 Statistical Yearbook of Norway 2000.

C 601 Electricity statistics 1997.

C 605 Oil and gas activity, 1st quarter 2000. Statistics and analysis.

C 608 Salmon and Sea Trout Fisheries 1999.

C 609 Fish Farming 1998.

C 612 Forestry Statistics 1998.

C 615 Oil and gas activity, 2nd quarter 2000. Statistics and analysis.

C 618 Hunting Statistics 1999.

C 619 Electricity Statistics 1998.

C 623 Fishery Statistics 1996-1997.

C 625 Waste Statistics. Municipal Waste 1998.

C 628 Transport and Communication Statistics 1999.

C 633 Maritime Statistics 1999.

C 642 Agricultural Statistics 1999.

C 647 Oil and gas activity, 3rd quarter 2000. Statistics and analysis.

C 648 Forestry Statistics 1999.

C 651 Oil and gas activity, 4th quarter 2000. Statistics and analysis.

C 652-C669 1999 Agricultural Census 1999 (county reports).

C 670 Agricultural census 1999.

C 678 Oil and gas activity, 1st quarter 2001. Statistics and analysis.

C 682 Hunting Statistics 2000.

C 683 Fishery Statistics 1997-1998.

C 685 Salmon and Sea Trout Fisheries 2000.

C 690 Oil and gas activity 2nd quarter 2001. Statistics and analysis.

C 691 Electricity Statistics 1999.

C 694 Oil and gas activity 3rd quarter 2001. Statistics and analysis.

C 698 Fishery Statistics 1998-1999.

C 700 Fish farming 1999.

C 702 Oil and gas activity 4th quarter 2001. Statistics and analysis.

C 703 Energy statistics 2000.

C 704 Survey of Living Conditions 1996-1998.

C 708 Agricultural Statistics 2000.

C 709 Forestry Statistics 2000.

C 711 Fish farming 2000.

C 712 Fishery Statistics 1999-2000.

C 716 Salmon and Sea Trout Fisheries 2001.

C 717 Oil and gas activity 1st quarter 2002. Statistics and analysis.

C 728 Hunting Statistics 2001.

C 729 Oil and gas activity 2nd quarter 2002. Statistics and analysis.

C 730 Oil and gas activity, 4th quarter 2002. Statistics and analysis.

C 731 Forestry Statistics 2001.

C 736 Agricultural Statistics 2001.

C 742 Oil and gas activity 3rd quarter 2002. Statistics and analysis.

C 746 Census of Agriculture 1999.

D 252 Salmon and Sea Trout Fisheries 2002.

D 253 Svalbard Statistics 2003.

D 256 Waste Accounts for Norway 1993-2000.

D 259 Fish farming 2001.

D283 Hunting Statistics 2002.

D286 Agricultural Statistics 2002.

D288 Forestry Statistics 2002.

D290 Fishery Statistics 2000-2001.

D291 Oil and gas activity 1st quarter 2003. Statistics and analysis.

D292 Oil and gas activity 2nd quarter 2003. Statistics and analysis.

D295 Oil and gas activity 3rd quarter 2003. Statistics and analysis.

D298 Fishery Statistics 2001-2002.

D302 Salmon and Sea Trout Fisheries 2003.

D303 Oil and gas activity, 4th quarter 2003. Statistics and analysis.

D311 Hunting Statistics 2003.

D312 Emissions to Air 1973-2003.

D313 Oil and Gas Activity, 1st Quarter 2004.Statistics and Analysis.

D317 Fish Farming 2002.

D320 Forestry Statistics 2003.

**Reports (RAPP)**

00/1 Flugsrud, K., E. Gjerald, G. Haakonsen, S. Holtskog, H. Høie, K. Rypdal, B. Tornsjø and F. Weidemann: The Norwegian Emission Inventory. Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants.

00/2 Skullerud, Ø.: Avfallsregnskap for Norge - Metoder og foreløpige resultater for metaller (Waste accounts for Norway. Methods and preliminary results for metals).

00/8 Rønningen, O.: Bygg- og anleggsavfall. Avfall fra nybygging, rehabilitering og riving. Resultater og metoder (Construction waste. Waste from building, rehabilitation and demolition. Results and methods).

00/12 Frøyen, B.K. and Ø. Skullerud: Avfallsregnskap for Norge. Metoder og resultater for treavfall (Waste accounts for Norway. Methods and results for wood waste).

00/13 Rypdal, K. and L.-C. Zhang: Uncertainties in the Norwegian Greenhouse Gas Emission Inventory.

00/15 Skullerud, Ø. and S.E. Stave: Avfallsregnskap for Norge. Metoder og resultater for plast (Waste accounts for Norway. Methods and results for plastics).

0/17 Hass, J.L., R.O. Solberg and T.W. Bersvendsen: Industriens investeringer og utgifter tilknyttet miljøvern - pilotundersøkelse 1997 (Environmental investments and expenditure in manufacturing industries - pilot survey 1997).

00/19 Smith, T.: Utvikling av arealstatistikk for tettstedsnære områder - muligheter og begrensninger (Development of land use statistics for areas near urban settlements - possibilities and limitations).

00/20 Bye, A.S., K. Mork, T. Sandmo and B. Tornsjø: Resultatkontroll jordbruk 2000. Jordbruk og miljø, med vekt på gjennomføring av tiltak mot forureining (Result monitoring in agriculture, 2000. Agriculture and environment. Implementation of measures against pollution).

00/23 Haakonsen, G.: Utslipp til luft i Oslo, Bergen, Drammen og Lillehammer 1991-1997. Fordeling på utslippskilder og bydeler (Emissions to air in Oslo, Bergen, Drammen and Lillehammer 1991-1997 by sources and urban districts).

00/26 Johnsen, T.A., F.R. Aune and A. Vik: The Norwegian Electricity Market. Is There Enough Generation Capacity Today and Will There Be Sufficient Capacity in Coming Years?

00/27 Mork, K., T. Smith and J. Hass: Ressursinnsats, utslipp og rensing i den kommunale avløpssektoren. 1999 (Inputs of resources, discharges and waste water treatment in the municipal waste water sector 1999).

01/2 Halvorsen, B., B.M. Larsen and R. Nesbakken: Hvordan utnytte resultater fra mikroøkonometriske analyser av husholdningenes energiforbruk i makromodeller? En diskusjon av teoretisk og empirisk litteratur om aggregering (How can the results of micro-econometric analyses of household energy use be used in macro-models? A discussion of theoretical and empirical literature on aggregation).

01/6 Tornsjø, B.: Utslipp til luft fra innenriks sjøfart, fiske og annen sjøtrafikk mellom norske havner (Emissions to air from domestic shipping, fishing vessels and other sea traffic between Norwegian ports).

01/14 Martinsen, T.: Energibruk i norsk industri (Energy use in Norwegian industry).

01/15 Kvingedal, E.: Indikatorer for energibruk og utslipp til luft i industri- og energisektorene (Indicators for energy use and emissions to air in the manufacturing and energy sectors).

1/16 Holtskog, S.: Direkte energibruk og utslipp til luft fra transport i Norge 1994 og 1998 (Direct energy use and emissions to air from transport in Norway 1994 and 1998).

01/17 Finstad, A., G. Haakonsen, E. Kvingedal and K. Rypdal: Utslipp til luft av noen miljøgifter i Norge. Dokumentasjon av metode og resultater (Emissions of some hazardous chemicals to air in Norway. Documentation of a method and results).

01/19 Bye, A.S. and S.E. Stave: Resultatkontroll jordbruk 2001. Jordbruk og miljø (Result monitoring in agriculture, 2001. Agriculture and environment).

01/23 Halvorsen, B., B.M. Larsen and R. Nesbakken: Fordelingseffekter av elektrisitetsavgift belyst ved ulike fordelingsbegreper (Distributional effects of the electricity tax reviewed using various ways of measuring distribution).

01/31 Aune, F.R. T. A. Johnsen and E. Lund Sagen: Regional og nasjonal utvikling i elektrisitetsforbruket til 2010 (Regional and national developments in electricity consumption up to 2010).

01/36 Haakonsen and E. Kvingedal: Utslipp til luft fra vedfyring i Norge. Utslipps-faktorer, ildstedsbestand og fyringsvaner (Emissions to air from fuelwood use in Norway. Emission factors, numbers of wood-burning stoves and open fireplaces, and heating habits).

01/37 Rypdal, K. and Li-Chun Zhang: Uncertainties in Emissions of Long-Range Air Pollutants.

01/38 Frøyen, B.K. and Ø. Skullerud: Avfallsregnskap for Norge. Metoder og resultater for tekstilavfall (Waste accounts for Norway. Methods and results for textile waste).

01/39 Gundersen, G.I. and O. Rognstad: Lagring og bruk av husdyrgjødsel (Storage and use of manure).

01/41 Engelien, E. and P. Schøning: Friluftsliv og tilgjengelighet - metode for beregning av nøkkeltall (Recreation and availability - method of calculating key figures).

01/43 Smith, T. and S. E. Stave: Ressursinnsats, utslipp og rensing i den kommunale avløpsektoren 2000 (Inputs of resources, discharges and waste water treatment in the municipal waste water sector 2000).

02/2 Bloch Holst, V.V: Arealstatistikk for tettstedsnære områder 1999-2000 (Land use statistics for areas near urban settlements 1999-2000).

02/7 Finstad, A., G. Haakonsen and K. Rypdal: Utslipp til luft av dioksiner i Norge - Dokumentasjon av metode og resultater (Emissions of dioxins to air in Norway - Documentation of methods and results).

02/8 Finstad, A. K. Flugsrud and K. Rypdal: Utslipp til luft fra norsk luftfart (Emissions to air from Norwegian air traffic).

02/11 Bye, T., O. J. Olsen and K. Skytte. Grønne sertifikater - design og funksjon (Green energy certificates - design and function).

02/16 Bloch Holst, V.V: Brune arealer i tettsteder. En pilotundersøkelse (Brownfield areas in urban settlements. A pilot study).

02/19 Bye, A. S., G. I. Gundersen and S. E. Stave: Resultatkontroll jordbruk 2002. Jordbruk og miljø (Result monitoring in agriculture, 2002. Agriculture and environment).

02/24 Skullerud, Ø. and S.E. Stave: Waste Generation in the Service Industry Sector in Norway 1999. Results and Methodology based on Exploitation of Waste Data from a Private Recycling Company.

02/27 Bye, T.A., M. Greaker and K. E. Rosendahl: Grønne sertifikater og læring (Green energy certificates learning).

02/32 Gundersen, G.I., O. Rognstad and L. Solheim: Bruk av plantevernmidler i jordbruket i 2001 (Use of plant protection products in agriculture 2001).

02/35 Smith, T., S. E. Stave and J. K. Undelstvedt: Ressursinnsats, utslipp og rensing i den kommunale avløpsektoren 2001(Inputs of resources, discharges and waste water treatment in the municipal waste water sector 2001).

03/01 Bloch Holst, V. V. and M. Steinnes: Fritidshusområder 2002 (Concentrations of weekendand holiday homes 2002).

03/7 Finstad, A. and K. Rypdal: Utslipp til luft av kobber, krom og arsen i Norge. Dokumentasjon av metode og resultater (Emissions to air of copper, chromium and arsenic in Norway. Documentation of a method and results).

03/6 Walle, M. A.: Overholder bedriftene i Norge miljøreguleringene? (Do industrial companies in Norway comply with environmental legislation?)

03/11 Aune, F. R.: Fremskrivninger for kraftmarkedet til 2020. Virkninger av utenlandskabler og fremskyndet gasskraftutbygging (Projections for the Norwegian electricity market up to 2020. Effects of transmission cables to other countries and of bringing forward the construction of gas-fired power plants).

03/15 Finstad, A., G. Haakonsen and K. Rypdal: Utslipp til luft av partikler i Norge. Dokumentasjon av metode og resultater (Emissions to air of particles in Norway. Documentation of a method and results).

03/16 Bye, A. S., G. I. Gundersen and J. K. Undelstvedt: Resultatkontroll jordbruk 2003. Jordbruk og miljø (Result monitoring in agriculture, 2003. Agriculture and environment).

03/17 Straumann, R.: Exporting Pollution? Calculating the embodied emissions in trade for Norway.

03/19 Bye, T. and P. M. Bergh: Utviklingen i energiforbruket i Norge i 2002-2003 (Developments in energy use in Norway in 2002-2003).

03/20 Halvorsen, B. and R. Nesbakken: Hvilke husholdninger rammes av høye strømpriser? En fordelingsanalyse på mikrodata.(Which households are hardest hit by high electricity prices? A distributional analysis of microdata).

03/21 Bye, T., P. V. Hansen and F. R. Aune: Utviklingen i energimarkedet i Norden i 2002-2003. (Developments in the energy market in the Nordic countries in 2002-2003).

04/3 Spilde, D. and K. Aasestad.: Energibruk i norsk industri 1991-2001. (Energy use in Norwegian manufacturing industries, 1991-2001).

04/5 Finstad, A., K. Flugsrud, G. Haakonsen and K. Aasestad: 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).

04/10 Undelstvedt, J. K.: Utslipp og rensing i den kommunale avløpssektoren 2002.(Discharges and waste water treatment in the municipal waste water sector 2002).

04/12 Engelien, E. and M. Steinnes: Utprøving av nordisk tettstedsdefinisjon i Norge. Metode og resultater.(Test of the Nordic definition of "urban settlement" in Norway. Method and results).

04/21 Gundersen, G. I.: Bruk av plantevernmidler i jordbruket i 2003. (Use of plant protection products in agriculture in 2003).

04/22 Bye, A. S., G. I. Gundersen, T. Sandmo and G. Berge: Jordbruk og miljø. Resultatkontroll jordbruk 2004 (Result monitoring in agriculture, 2004. Agriculture and environment).

04/27 Flugsrud, K., G. Haakonsen and K. Aasestad: 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).

### Statistical Analyses (SA)

34 Naturressurser og miljø 2000 (Natural Resources and the Environment 2000, Norwegian edition).

37 Natural Resources and the Environment 2000. Norway

45 Naturressurser og miljø 2001 (Natural Resources and the Environment 2001, Norwegian edition).

47 Natural Resources and the Environment 2001. Norway

55 Naturressurser og miljø 2002 (Natural Resources and the Environment 2002, Norwegian edition).

58 Natural Resources and the Environment 2002. Norway

59 Naturressurser og miljø 2003 (Natural Resources and the Environment 2003, Norwegian edition).

61 Natural Resources and the Environment 2003. Norway

65 Naturressurser og miljø 2004 (Natural Resources and the Environment 2004, Norwegian edition).

### Discussion Papers (DP)

267 Kverndokk, S., L. Lindholt and K.E. Rosendahl: Stabilisation of $CO_2$ concentrations: Mitigation scenarios using the Petro model.

275 Bruvoll, A. og H. Medin: Factoring the environmental Kuznets curve Evidence from Norway.

277 Aslaksen, I. og K.A. Brekke: Valuation of Social Capital and Environmental Externalities.

279 Nyborg, K. og M. Rege: The Evolution of Considerate Smoking Behavior.

280 Søberg, M.: Imperfect competition, sequential auctions, and emissions trading: An experimental evaluation.

281 Lindholt, L.: On Natural Resource Rent and the Wealth of a Nation. A Study Based on National Accounts in Norway 1930–95.

282 Rege, M.: Networking Strategy: Cooperate Today in Order to Meet a Cooperator Tomorrow.

286 Aune, F.R., T. Bye og T.A. Johnsen: Gas power generation in Norway: Good or bad for the climate? Revised version.

290 Brekke, K.A., S. Kverndokk og K. Nyborg: An Economic Model of Moral Motivation.

298 Fæhn, T. og E. Holmøy: Trade Liberalisation and Effects on Pollutive Emissions and Waste A General Equilibrium Assessment for Norway.

300 Nyborg, K. og M. Rege: Does Public Policy Crowd Out Private Contributions to Public Goods?

305 Røed Larsen, E.: Revealing Demand for Nature Experience Using Purchase Data of Equipment and Lodging.

316 Bruvoll, A., og Karine Nyborg: On the value of households' recycling efforts.

321 Aasness, J. og E. Røed Larsen: Distributional and Environmental Effects of Taxes on Transportation.

322. E. Røed Larsen: The Political Economy of Global Warming. From Data to Decisions.

332 Greaker, M.: Eco-labels, Production Related Externalities and Trade.

337 Bruvoll, A. og B. M. Larsen. Greenhouse gas emissions in Norway Do carbon taxes work?

338 Halvorsen, B. og R. Nesbakken: A conflict of interests in electricity taxation? A micro econometric analysis of household behaviour.

341 Bruvoll, A., T. Fæhn og B. Strøm: Quantifying Central Hypotheses on Environmental Kuznets Curves for a Rich Economy: A Computable General Equilibrium Study.

346 Larsen, B. M. og Nesbakken, R.: How to quantify household electricity end-use consumption.

347 Halvorsen, B. og B. M. Larsen: Possibility for hedging from price increases in residential energy demand.

349 Holtsmark, B.: The Kyoto Protocol without USA and Australia - with the Russian Federation as a strategic permit seller.

351 Bye, T.: On the Price and Volume Effects from Green Certificates in the Energy Market.

355 Aslaksen, I. og T. Synnestvedt: Corporate environmental protection under uncertainty.

356 Glomsrød, S. og Wei Taoyuan: Coal cleaning: A viable strategy for reduced carbon emissions and improved environment in China?

357 Bruvoll, A., T. Bye, J. Larsson og K. Telle: Technological changes in the pulp and paper industry and the role of uniform versus selective environmental policy.

362 Røed Larsen, E.: Are Rich Countries Immune to the Resource Curse? Evidence from Norway's Management of Its Oil Riches.

366 Holtsmark, B. J. og K. H. Alfsen: PPP-correction of the IPCC emission scenarios - does it matter?

370 Dagsvik, J. K. og A. L. Mathiassen: Agricultural Production with Uncertain Water Supply.

371 Greaker, M.: Industrial Competitiveness and Diffusion of New Pollution Abatement Technology - a new look at the Porter-hypothesis.

372 Ringlund, G. B., K. E. Rosendahl og T. Skjerpen: Does oilrig activity react to oil price changes?

373 Liu, G.: Estimating Energy Demand Elasticities for OECD Countries. A Dynamic Panel Data Approach.

374 Telle, K. og J. Larsson: Do environmental regulations hamper productivity growth? How

accounting for improvements of firms' environmental performance can change the conclusion.

376 Holtsmark. B. J. og K. H. Alfsen: Implementation of the Kyoto Protocol without Russian participation.

379 Sagen, E. L. og F. R. Aune: The Future European Natural Gas Market - are lower gas prices attainable?

381 Telle, K.: Effects of inspections on plants' regulatory and environmental performance - evidence from Norwegian manufacturing industries.

384 Bruvoll, A. og T. Fæhn; Transboundary environmental policy effects: Markets and emission leakages.

385 Hansen, P. V. og L. Lindholt: The market power of OPEC 1973-2001.

387 Bjertnæs, G. H. og T. Fæhn: Energy Taxation in a Small, Open Economy: Efficiency Gains under Political Restraints.

389 Halvorsen, B.: Effects of norms, warm-glow and time use on household recycling.

393 Greaker, M. and E. Lund Sagen: Explaining experience curves for LNG liquefaction costs: Competition matter more than learning.

394 Telle, K., I. Aslaksen and T. Synnestvedt: "It pays to be green" - a premature conclusion?

398 Aslaksen, I., B. Natvig and I. Nordal: Environmental risk and the precautionary principle. "Late lessons from early warnings" applied to genetically modified plants.

**Documents**

00/3 Rypdal, K. and B. Tornsjø: Environmental Pressure Information System (EPIS) for the Pulp and Paper Industry in Norway.

00/4 Rypdal, K. and B. Tornsjø: Chemicals in Environmental Pressure Information System (EPIS).

00/6 Rosendahl, K.E.: Industrial Benefits and Costs of Greenhouse Gas Abatement Strategies: Applications of E3ME. Modelling external secondary benefits in the E3ME model.

00/7 Ellingsen, G.A., K.E. Rosendahl and A. Bruvoll: Industrial Benefits and Costs of Greenhouse Gas Abatement Strategies: Applications of E3ME. Inclusion of 6 greenhouse gases and other pollutants into the E3ME model.

00/12 Engelien, E. and P. Schøning: Land use statistics for urban settlements.

01/2 Sørensen, K.Ø., J.L. Hass, H. Sjølie, P. Tønjum and K. Erlandsen: Norwegian Economic and Environmental Accounts (NOREEA). Phase 2.

01/03 Haakonsen, G., K. Rypdal, P. Schøning and S.E. Stave: Towards a National Indicator for Noise Exposure and Annoyance. Part I: Building a Model for Traffic Noise Emissions and Exposure.

01/12 Hoem, B.: Environmental Pressure Information System (EPIS) for the household sector in Norway.

01/14 Rypdal, K.: $CO_2$ Emission Estimates for Norway. Methodological Difficulties.

01/16 Rogstad, L.: GIS-projects in Statistics Norway. 2001/2001.

02/01 Hoem, B., K. Erlandsen and T. Smith: Comparisons between two Calculation Methods: LCA using EPIS-data and Input-Output Analysis using Norway's NAMEAAir Data.

02/03 Hass, J.L. and T. Smith: Methodology Work for Environmental Protection Investment and Current Expenditures in the Manufacturing Industry. Final Report to Eurostat.

02/09 Bye, T.A.: Climate Change and Energy Consequences.

02/11 Røed Larsen, E.: An Introductory Guide to the Economics of Sustainable Tourism.

02/12 Halvorsen, B. and R. Nesbakken: Distributional Effects of Household Electricity Taxation.

02/15 Hass, J.L., K.Ø. Sørensen and K. Erlandsen: Norwegian Economic and Environment Accounts (NOREEA) Project Report - 2001.

03/8 Bergh, P. M. and A. S. Abrahamsen: Energy consumption in the services sector. 2000.

04/5 Glomsrød, S. and L. Lindholt: The petroleum business environment: A reader's digest.

04/12 Engelien, E., R. Klæboe and M. Steinnes: Neighbourhood sonoscapes. Context sensitive noise impact mapping.

04/13 Hansen, P. V.: Regional electricity spot price responses in Norway.

04/15 Hass, J. L.: Compilation of data on expenditure in Environmental protection by businesses. Report to the European Commission DG for Environment.

**Notater**

00/12 Engelien, E.: Arealbrukstatistikk for tettsteder. Dokumentasjon av arbeid med metodeutvikling 1999 (Land use statistics for urban settlements. Documentation of methodological development 1999).

00/14 Martinsen, T.: Prosjekt over industriens energibruk (Project on industrial energy use).

00/16 Halvorsen, B. and R. Nesbakken: Fordelingseffekter av økt elektrisitetsavgift for husholdningene (Distributional effects of raising the electricity tax for households).

00/46 Schøning, P.: Fagseminar om arealpolitikk og arealstatistikk i opptakten til et nytt årtusen. Seminarrapport 30. mars 2000 (Report from a seminar on land-use policy and land-use statistics at the beginning of a new millennium. 30 March 2000).

00/54 Flugsrud, K. and G. Haakonsen: Utslipp av klimagasser i norske kommuner. En gjennomgang av datakvaliteten i utslippsregnskapet (Greenhouse gas emissions in

Norwegian municipalities. A review of data quality in the emission inventory).

00/68 Bruvoll, A., K. Flugsrud and H. Medin: Dekomponering av endringer i utslipp til luft i Norge - dokumentasjon av data (Decomposition of changes in emissions to air in Norway - documentation of the data).

00/69 Dysterud, M.V. and E. Engelien: Tettstedsavgrensing. Teknisk dokumentasjon 2000 (Delimitation of urban settlements. Technical documentation 2000).

01/5 Bye, T., M. Hansen and B. Strøm: Hvordan framskrive utslipp av klimagasser? (How can we make projections of greenhouse gas emissions?)

01/9 Rogstad, L., N.M. Stølen, T. Jakobsen and P. Schøning: Regional statistikk og analyse - strategi og prioriteringer (Regional statistics and analyses - strategy and priorities).

01/17 Martinsen, T.: Statistikk over energibruk i Statistisk sentralbyrå - evaluering, brukerbehov og forutsetninger (Statistics Norway's statistics on energy use: evaluation, user needs and requirements)

01/20 Indahl, B., D.E. Sommervoll and J. Aasness: Virkninger på forbruksmønster, levestandard og klimagassutslipp av endringer i konsumentpriser (Effects of changes in consumer prices on consumption patterns, living standards and greenhouse gas emissions).

01/44 KOSTRA -VAR-rapport 2001 (Municipal report on water, waste water and waste. 2001)

01/45 KOSTRA -Kulturminner, natur og nærmiljø (Municipal report on cultural heritage, natural environment and local environment).

01/55 Brunvoll, F., S. Homstvedt and H. Høie: Mulighetenes marked? SSB-statistikk til regjeringens resultatoppfølging på miljøvernområdet. Potensial og foreløpige prioriteringer (Market of opportunity? Statistics from Statistics Norway for Government follow-up on environmental issues. Potential and preliminary priorities).

01/59 Krüger Enge, A., V. Hansen and B. Tornsjø: Planlegging av et statistikksystem for energibruk i næringsbygg (Planning a statistical system for energy use in commercial buildings).

01/77 Haakonsen, G.: Beregninger av utslipp til luft av klimagasser. En gjennomgang av arbeidsprosess og dokumentasjon (Calculations of emissions to air of greenhouse gases. A review of the working process and documentation).

02/01 Schøning, P.: Statistikk for 16 tettsteder og deres sentrumsarealer. Et innspill til programmet for utvikling av miljøvennlige og attraktive tettsteder i distriktene (Statistics for 16 urban settlements and their centre areas. A comment on the programme for the development of environmentally friendly and attractive urban settlements in rural areas).

02/02 Bloch Holst, V.V: Arealbruksklassifisering av bebygde arealer. Revidert rutine for tilordning av arealbruksklasse til bygning (Land use classification of built areas. Revised procedure for assigning land use categories to buildings).

02/03 Bloch Holst, V.V: Metode og datagrunnlag for produksjon av arealstatistikk for tettstednære områder. Teknisk dokumentasjon (Methods and background data for the production of land use statistics for areas close to urban settlements. Technical documentation).

02/36 Bruvoll, A. and T.A. Bye: 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).

02/48 Finstad, A.: Utslippsfaktorer for benzen (Emission factors for benzene).

02/64 Bloch Holst, V.V: Arealbruksstatistikk for tettsteder - Områdemodellering (Land use statistics for urban settlements - Modelling of areas).

02/68 Bloch Holst, V.V: 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).

02/72 Bloch Holst, V.V: 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 area figures).

02/82 Kleven, Ø. and D. Roll-Hansen: Dokumentasjon av undersøkelse om livsstil og energi 1999 (Documentation of lifestyles and energy 1999).

03/08 Smith, T.: Vann- og avløpsgebyrer - en gjennomgang av kommunenes praksis (Water and waste water fees - a review of the practice in municipalities).

03/10 Engelien, E. and M. Steinnes: Tilgang til friluftsområder - metode og resultater 2002 (Access to outdoor recreational areas - method and results 2002).

03/45 Dale, T., H. Høie and A.-K. Johnsen: Evaluering av "Naturressurser og miljø" (Evaluation of Natural Resources and the Environment).

03/62 Eika, T. and J.-A. Jørgensen: Makroøkonomiske virkninger av høye strømpriser i 2003. En analyse med den makroøkonometriske modellen KVARTS (Macroeconomic effects of abnormally high electricity prices in 2003. An analysis using the economic model KVARTS).

03/91 Larsson, J. and K. Telle: Dokumentasjon av DEED. En database over bedriftsspesifikke miljødata og økonomiske data for forurensende norske industribedrifter (Documentation of DEED. A database of environmental data for specific enterprises and financial data for polluting industrial enterprises in Norway).

04/20 Bloch Holst, V.V., E. Engelien and M. Steinnes: Arealklassifikasjon i tettsteder. Uttesting av nasjonal arealdekkeklassifikasjon i deler av Fredrikstad tettsted (Land use classification in urban settlements. Test of Norwegian system of land cover classification in parts of the town of Fredikstad).

04/38 Bruvoll, A. and Ø. Skullerud: Framskrivninger av organisk avfall for 2001-2020 (Projections of quantities of organic waste for the period 2001-2020).

04/43 Engelien, E., G. Haakonsen and M. Steinnes: 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).

## Social and economic studies

102 Bye, T.A., M. Hoel and S. Strøm: Et effektivt kraftmarked - konsekvenser for kraftkrevende næringer og regioner (An efficient electricity market - consequences for energy-intensive industries and regions).

## Reprints (REPR)

147 Nesbakken, R.: Price sensitivity of residential energy consumption in Norway.

149 Bruvoll, A., S. Glomsrød and H. Vennemo: Environmental drag: evidence from Norway.

160 Nyborg, K.: Informational Aspect of Environment Policy Deserves More Attention: Comment on the Paper by Frey.

162 Rosendahl, K.E. and A.C. Hansen: Valuation of Crop Damage due to Air Pollution.

172 Nyborg, K.: Voluntary Agreements and Non-Verifiable Emissions.

180 Nyborg, K.: Homo Economicus and Homo Politicus: interpretation of aggregation of environmental values.

181 Nyborg, K.: Project analysis as input to public debate: Environmental valuation versus physical unit indicators.

183 Bye, B.: Environmental Tax Reform and Producer Foresight: An Intertemporal Computable General Equilibrium Analysis.

185 Barker, T. and K.E. Rosendahl: Ancillary benefits of GHG mitigation in Europe: SO2, NOx and PM10 reductions from policies to meet Kyoto targets using the E3ME model and EXTERNE valuations.

186 Halvorsen, B. and B.M. Larsen: The flexibility of household electricity demand over time.

187 Kverndokk, S., L. Lindholt and K.E. Rosendahl: Stabilization of CO2 concentrations: mitigation scenarios using the Petro model.

189 Halvorsen, B. and B.M. Larsen: Norwegian residential electricity demand - a microeconometric assessment of the growth from 1976 to 1993.

193 Bye, B.: Labor Market Rigidities and Environmental Tax Reforms: Welfare Effects of Different Regimes.

195 Rypdal, K. and W. Winiwarter: Uncertainties in greenhouse gas emission inventories - evaluation, comparability and implications.

196 Rypdal, K. and K. Flugsrud: Sensitivity analysis as a tool for systematic reductions in greenhouse gas inventory uncertainties.

198 Nesbakken, R.: Energy Consumption for Space Heating: A Discrete-Continuous Approach. 201Berg, E., P. Boug and S. Kverndokk: Norwegian gas sales and the impacts on European CO2 emissions.

215 Dagsvik, J.K., T. Wennemo, D.G. Wetterwald and R. Aaberge: Potential demand for alternative fuel vehicles.

216 Bye, B.: Taxation, Unemployment and Growth: Dynamic Welfare Effects of "Green" Policies.

253 Holtsmark, B.: Russian behaviour in the market for permits under the Kyoto Protocol.

**Økonomiske analyser (ØA) (Economic Analyses)**

1/00 Økonomisk utsyn over året 1999 (Economic Survey 1999).

4/00 Lindholt, L. and K.E Rosendahl: Virkninger på energibruk og utslipp av å stabilisere CO2-konsentrasjonen (Effects on energy use and emissions of stabilizing the CO2 concentration).

1/01 Økonomisk utsyn over året 2000 (Economic Survey 2000).

2/01 Aune, F.R. and T.A. Johnsen: Kraftmarkedet med nye rekorder (New records set in the electricity market).

2/01 Telle, K. and K.A. Brekke: Viser reduserte blyutslipp at økonomisk vekst er bra for miljøet? (Do lower lead emissions prove that economic growth is good for the environment?).

3/01 Telle, K.: Er utslippene til luft lavere i dag enn for 50 år siden? (Are emissions to air lower today than they were 50 years ago?).

3/01 Sommervoll, D.E. and J. Aasness: Klimagassutslipp, konsumentpriser og levestandard (Greenhouse gas emissions, consumer prices and standards of living).

6/01 Johnsen, T.A. and C. Lindh: Økende knapphet i kraftmarkedet: Vil prisoppgang påvirke forbruket? (Increasing shortages in the electricity market. Will a higher price influence consumption?)

6/01 Sagen, E.L.: Mot et liberalisert europeisk gassmarked (Towards a liberalised European gas market).

1/02 Økonomisk utsyn over året 2001 (Economic Survey 2001).

3/02 Glomsrød, S.: Et renere og rikere Kina? (A cleaner and wealthier China?).

4/02 Rypdal, K.: Kan vi stole på utslippsdata? (Can we rely on emissions data?).

5/02 Bruvoll, A. and B. M. Larsen: Kva ligg bak utviklinga i klimagassutsleppa på 1990-tallet? (What were the factors influencing emissions of greenhouse gases in the 1990s?).

5/02 Bøeng, A. C.: Mer effektiv energibruk i næringslivet (More efficient use of energy in industry).

5/02 Aune, F. R., R. Golombek, S. A. Kittelsen and K. E. Rosendahl: Friere energimarkeder i Vest-Europa (Freer energy markets in Western Europe).

5/02 Greaker, M.: Miljømerking og handel (Environmental labelling and trade).

6/02 Aune, F. R. and T. Bye: Kraftkrise i Norge? (Energy crisis in Norway?).

6/02 Røed Larsen, E. and J. Aasness: Fordelingsvirkninger av grønne skatter på transport (Distributional effects of green taxes on transport).

6/02 Byfuglien J. and J. Stensrud: Strukturindikatorer for å sammenligne Norge med EU (Structural indicators for comparing Norway with the EU).

1/03 Økonomisk utsyn over året 2002 (Economic Survey 2002).

2/03 Nyborg, K., K. Telle and M. A. Walle: Norske bedrifter bryter miljøreguleringer (Breaches of environmental rules by many Norwegian companies).

3/03 Holtsmark, B. and K. H. Alfsen: Russisk rullett? Kyoto-protokollen og Russland (Russian roulette? The Kyoto Protocol and Russia).

4/03 Straumann, R.: Forurenser vi andre land? (Are we exporting pollution?).

5/03 Halvorsen, B. and R. Nesbakken: Hvilke husholdninger ble rammet av vinterens høye strømpriser? (Which households were hit hardest by the high electricity prices this winter?).

1/04 Økonomisk utsyn over året 2003 (Economic Survey 2003).

2/04 Greaker, M. and T.-R. Heggedal: Klimapolitikk og teknologisk endring (Climate policy and technological change).

2/04 Ringlund, G. B., K. E. Rosendahl and T. Skjerpen: Fører høy oljepris til økt oljeboring? (Do high oil prices result in more drilling?).

4/04 Sagen, E. L.: Usikkerhet i tilbudet av gass til Vest-Europa. Vil verdien av norsk gass være truet i et liberalisert marked? (Uncertainty of gas supplies to Western Europe. Will the value of Norwegian gas be threatened in a liberalised market?).

4/04 Alfsen, K. H. and B. J. Holtsmark: Kyoto-samarbeid uten Russland og Ukraina: Effekter på utslippsreduksjoner og kvotepriser (Kyoto cooperation without Russia and Ukraine. Effects on emission reductions and emission allowance prices).

4/04 Glomsrød, S. and K. E. Rosendahl: Virker Den grønne utviklingsmekanismen mot sin hensikt? (Will Clean Development Mechanism projects be counterproductive?).

**Economic Survey (ES)**

4/00 Bruvoll, A., B. Halvorsen and K. Nyborg: Household sorting of waste at source.

1/01 Hass, J.L.: Factors influencing municipal recycling rates of household waste in Norway.

4/02 Byfuglien, J. and J. Stensrud: Structural indicators for comparing Norway with the EU.

4/03 Bye, T.: A Nordic energy market under stress.

# De sist utgitte publikasjonene i serien Statistiske analyser

*Recent publications in the series Statistical Analyses*

48 D. Ellingsen: Kriminalitet og rettsvesen. 2001. 73s. 180 kr inkl. mva. ISBN 82-537-5010-2

49 R. Kjeldstad og M. Rønsen: Enslige foreldre på arbeidsmarkedet 1980-1999. En sammenligning med gifte mødre og fedre. 2002. 122s. 180 kr inkl. mva. ISBN 82-537-5027-7

50 B. Lie: Innvandring og innvandrere 2002. 2002. 117s. 210 kr inkl. mva. ISBN 82-537-5044-7

51 J.E. Lystad: IKT-barometer 2001. 2002. 88s. 180 kr inkl. mva. ISBN 82-537-5046-3

52 O.F. Vaage: Til alle døgnets tider. Tidsbruk 1971-2000. 2002. 254s. 260 kr inkl. mva. ISBN 82-537-5055-2

53 O.F. Vaage: Norsk mediebarometer 2001. 2002. 83s. 180 kr inkl. mva. ISBN 82-537-5061-7

54 B. Lie: Immigration and immigrants. 2002. 188s. 210 kr inkl. mva. ISBN 82-537-5108-7

55 F. Brunvoll og H. Høie: Naturressurser og miljø 2002. 2002. 197s. 260 kr inkl. mva. ISBN 82-537-5162-1

56 D. Ellingsen og J. Ramm: Helse- og omsorgstjenester. 2002. 121s. 210 kr inkl. mva. ISBN 82-537-5167-2

57 O.F. Vaage: Norsk mediebarometer 2002. 2003. 86s. 180 kr inkl. mva. ISBN 82-537-5344-6

58 F. Brunvoll og H. Høie: Natural Resources and the Environment 2002. 2003. 205s. 300 kr inkl. mva. ISBN 82-537-5348-9

59 F. Brunvoll og H. Høie: Naturressurser og miljø 2003. 2003. 233s. 300 kr inkl. mva. ISBN 82-537-6479-0

60 M. Raabe: Utdanning 2003 - ressurser, rekruttering og resultater. 2003. 230s. 300 kr . inkl. mva. ISBN 82-537-6503-7

61 F. Brunvoll og H. Høie: Natural Resources and Environment 2003. 2003. 236s. 210 kr inkl. mva. ISBN 82-537-6519-3

62 I. Melby, O.E. Nygård, T.O. Thoresen og A. Walseth: Inntekt, skatt og overføringer 2003. 2003. 158S. 260 kr inkl.mva. ISBN 82-537-6551-7

63 O. Vaage: Norsk mediebarometer 2003. 2003. 86s. 180 kr inkl. mva. ISBN 82-537-6576-2

64 A. Barstad og O. Hellevik: På vei mot det gode samfunn? 2004. 153s. 260 kr inkl.mva. ISBN 82-537-6621-1

65 F. Brunvoll, H. Høie og S.E. Stave: Naturressurser og miljø 2004. 2004. 239s. 210 kr inkl. mva. ISBN 82-537-6680-7

66 K. Rose Tronstad: Innvandring og innvandrere 2004. 2004. 143s. 210 kr inkl. mva. ISBN 82-537-6701-3