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Norwegian Pollution Control Authority (SFT) was established in 1974 as a directorate under the Norwegian Ministry of Environment.

Our goal is to promote sustainable development. We are working to ensure that pollution, hazardous substances and waste do not cause health problems, affect people´s well-being or harm nature´s own powers of regeneration.

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Greenhouse Gas Emissions in Norway 1990–1999. Reporting According to the UNFCCC Guidelines.

Climate change, air pollution and noise

Greenhouse Gas Emissions in Norway 1990–1999

1801/2001

Reporting According to the UNFCCC Guidelines

Preface

The United Nations Framework Convention on Climate Change (UNFCCC) entered into force in 1994. It requires parties to report emissions and sinks of greenhouse gases annually.

This report has been prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories adopted in November 1999 by decision 3/CP.5. The methodology used in the calculation of emissions is according to the revised IPCC Guidelines for emission inventories approved by the UNFCCC.

The Norwegian Pollution Control Authority is responsible for the report, and Statistics Norway (SN) has supplied data and valuable comments as part of the SN/SFT co-operation programme on emission inventories.

Janne Sollie

The Norwegian Pollution Control Authority

Oslo, April 2001

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Summary

This report presents an inventory of greenhouse gas (GHG) emissions and removals in Norway from 1990 to 1999. Emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), tetrafluoromethane (CF_4), hexafluoroethane (C_2F_6), sulphur hexafluoride (SF_6) and HFCs (HFC-134a, HFC-125, HFC-143a, HFC-23, HFC-32, HFC-152a and HCF227ea) are described with regard to source categories.

This report has been prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories, and as a general rule the estimation methods follow the Guidelines for National Greenhouse Gas Inventories published by the Intergovernmental Panel on Climate Change (IPCC). However, other methods have been used where appropriate, as described in chapter 5. According to the Guidelines, national methods may be used when they better reflect national circumstances and are well documented.

Table 1: Emissions of greenhouse gases for the years 1990-1999.
Overall emissions of the greenhouse gases are also given as CO_2 -equivalents, based on Global Warming Potential (GWP) values. Actual emissions of HFCs are given (Tier 2).

Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	SF_6	HFC 134a	HFC 125	HFC 143a	HFC23, 32, 152a and 227ea	CO_2 - EQU.
	Mtonnes	ktonnes	ktonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	Mtonnes
1990	35.1	312	16.7	441	18	92				0.1	52.0
1991	33.5	316	16.2	369	14	87	0			0.4	49.7
1992	34.3	322	14.0	294	11	29	0.2			0.6	48.1
1993	35.8	328	15.2	290	10	30	1.7			0.8	50.1
1994	37.7	335	15.5	251	9	36	5.4	0.5	0.2	0.8	52.1
1995	37.8	337	15.7	229	8	24	10.1	2.4	1.5	1.0	51.9
1996	40.9	341	15.7	214	5	24	17.2	5.5	3.9	1.5	55.0
1997	41.2	343	15.6	201	8	23	26.2	9.7	6.8	2.7	55.2
1998	41.4	338	16.4	185	7	29	38.2	14.7	10.4	5.3	55.7
1999	41.6	337	17.2	164	6	35	50.2	19.9	14.7	6.9	56.2
1990-99	19%	8%	3%	-63%	-65%	-62%	-	-	-	-	8%

Sources: SFT, SN

The **total emissions of greenhouse gases,** measured as CO_2 –equivalents, were about 56.2 million tonnes in 1999 (see table 1). From 1998 to 1999 the emissions have increased by less than 1%. For the period 1990-1999 the increase in the emissions was 8%. The emissions decreased by 8% from 1990 to 1992, but from 1992 to 1999 they again increased by 17%, mainly as a result of higher CO_2-emissions due to increased economic activity.

The **emissions of CO_2** in 1999 were 41.6 million tonnes. This is approximately 0.6% higher than in 1998 and 19% above 1990 emissions. The increase from 1990 to 1999 is mainly a result of growth in oil- and gas production, including transport of natural gas in pipelines, and higher emissions from mobile sources.

The **emissions of CH_4** have been slowly increasing during most of the 1990s, and the emissions in 1999 were 337 ktonnes. From 1997 this trend was reversed due to a small decrease emissions from oil- and gas industry.

Anthropogenic **emissions of N_2O** in 1999 were estimated at 17.2 ktonnes. The emissions increased by 4% from 1998 to 1999, and are now at the same level as in 1990, after a decrease of around 10% during the mid 1990s. This trend is mainly influenced by variations in activity in the fertiliser industry, and steadily rising emissions from road traffic due to increased use of catalytic converters.

The **emissions of PFCs** (CF_4 and C_2F_6) from Norwegian aluminium plants in 1999 were calculated to be approximately 1.1 Mtonnes CO_2-equivalents. From 1998 to 1999 there was a decrease by 11% in the emissions of PFC-gases. From 1990 to 1999 the emissions of PFC-gases were reduced by as much as 63%. This is due to improved technology and process control.

The **emissions of SF_6** in 1999 were estimated at approximately 0.83 Mtonnes CO_2-equivalents. In the period 1990-1997, the emissions were reduced by 75% as a result of reduced production levels for magnesium in addition to improved production routines. From 1997 to 1999 emissions have increased by 67%, due to increased production. The use of SF_6 as a cover gas in magnesium production accounts for 86% of the total SF_6 emissions in 1999.

In the IPCC Guidelines there are tiered methods for calculation of emissions of HFCs, PFCs and the SF_6 as substitutes for ozone-depleting substances. Emissions of these gases are reported as both potential emissions (Tier 1) and actual emissions (Tier 2). In the summary tables etc. actual emissions are reported.

The actual **emissions of HFCs** in Norway were about 0,18 Mtonnes of CO_2-equivalents in 1999, and they increased by 36% from 1998. The emissions in 1990 were insignificant. As the phasing out of CFCs, HCFCs and halons continues, a further strong growth in consumption of HFCs is expected in the years to come.

In this year's report a new chapter on emissions by sector according to the UNFCCC sector nomenclature has been included.

The Energy sector accounts for around 2/3 of Norwegian greenhouse gas emissions. Road traffic and offshore gas turbines (electricity generation and pumping of natural gas) are the sector's largest single contributors, while coastal navigation and energy used for the production of raw materials are other major contributors. During most of the 1990s the energy related emissions have been increasing, mainly due to higher activity in the offshore- and transport sector. From 1998 to 1999 this trend continued because of increased emissions from transport.

Production of raw materials is also the main source of process-related industrial emissions of both CO_2 and other greenhouse gases such as N_2O (fertiliser production), SF_6 (magnesium foundries) and PFCs (aluminium production). The industrial process sector accounts for 20% of national emissions of greenhouse gases. From 1992 and onwards these emissions have been relatively stable, with a trend of lower emissions of PFCs, being counterbalanced by rising emissions of CO_2.

Emissions from waste and agriculture were relatively stable during the 1990s, with emission levels of around 4, respectively 5 Mtonnes CO_2-equivalents.

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

The gross increment of carbon in Norwegian forests was estimated at 34.1 million tonnes of CO_2 in 1999. A total of 16.4 million tonnes of CO_2 was harvested or depleted, which resulted in a net removal of 17.7 million tonnes of CO_2. The sequestration of CO_2 in forest soil and harvested wood products is not included in this figure. This considerable accumulation is due to a large increment in the standing volume of forests. During the 1990s the net sequestration of CO_2 from land-use change and forestry activities has almost doubled. The net sequestration of CO_2 in 1999 is equivalent to about 34% of the total greenhouse gas emissions that year.

At the time of writing preliminary aggregated emission figures for the year 2000 have also been published. These figures indicate a small decrease - approximately 1 percent - in overall national emissions of greenhouse gases compared to 1999. The decrease is expected to be a result of a mild winter in 2000 and the oil companies' reduction of stocks of gasoline and diesel in the anticipation of a decrease in the CO_2 tax on these fuels from 1 January 2001. Hence it is doubtful that this decrease represents a change in the long-range emission trend.

1. Introduction

This report presents the national emissions of greenhouse gases (GHG) and the biotic CO_2-sinks in Norway. The following greenhouse gases are included: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), PFCs (CF_4 and C_2F_6), sulphur hexafluoride (SF_6) and HFCs (HFC-134a, HFC-125, HFC-143a, HFC-23, HFC-32, HFC-152a and HCF227ea). Emission data for precursors (NO_X, CO and NMVOC) and SO_2 are also given.

The greenhouse gas (GHG) emissions are presented as CO_2-equivalents based on Global Warming Potentials (GWP), calculated for a time horizon of 100 years according to the IPCC Guidelines (1995).

This report has been prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories adopted on November 1999 by decision 3/CP.5.

As a general rule, the estimation methods follow the IPCC Guidelines for national Greenhouse Gas Inventories. However, other methods have been used where necessary, as described in chapter 5. Emissions are calculated in accordance with IPCC Good Practice Guidelines.

Statistics Norway (SN) and the Norwegian Pollution Control Authority (SFT) co-operate to provide emission inventories for several air pollutants in Norway. SFT is responsible for developing the emission factors and providing data reported for industrial plants and specific industries. SN is responsible for developing the emission models, for the collection of activity data and for the calculations. The emission figures for CO_2, CH_4 and N_2O, as well as for NO_X, CO, NMVOC, HFCs and SO_2, have been prepared this way. Emission figures for PFCs and SF_6 have been provided by SFT.

The methodology used in the emission inventory is described in the report ”The Norwegian Emission Inventory – Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants” (SN/SFT 2000).

When emissions and trends are described in Chapter 2 (Emissions by gas) the focus is on ”national” nomenclature and source categories. This approach better reflects distinctive Norwegian sources like the oil- and gas industry and some other industrial sectors. In Chapter 3 (Emissions and removals by sector), however, all emissions are in accordance with the IPCC source categories.

Figures for emissions and removal from land-use change and forestry are calculated on the basis of emissions from fuelwood, wood waste and annual CO_2 accumulation in Norwegian forests. However, in accordance with the IPCC Guidelines, the net change from this category is not included in the overall Norwegian GHG inventory.

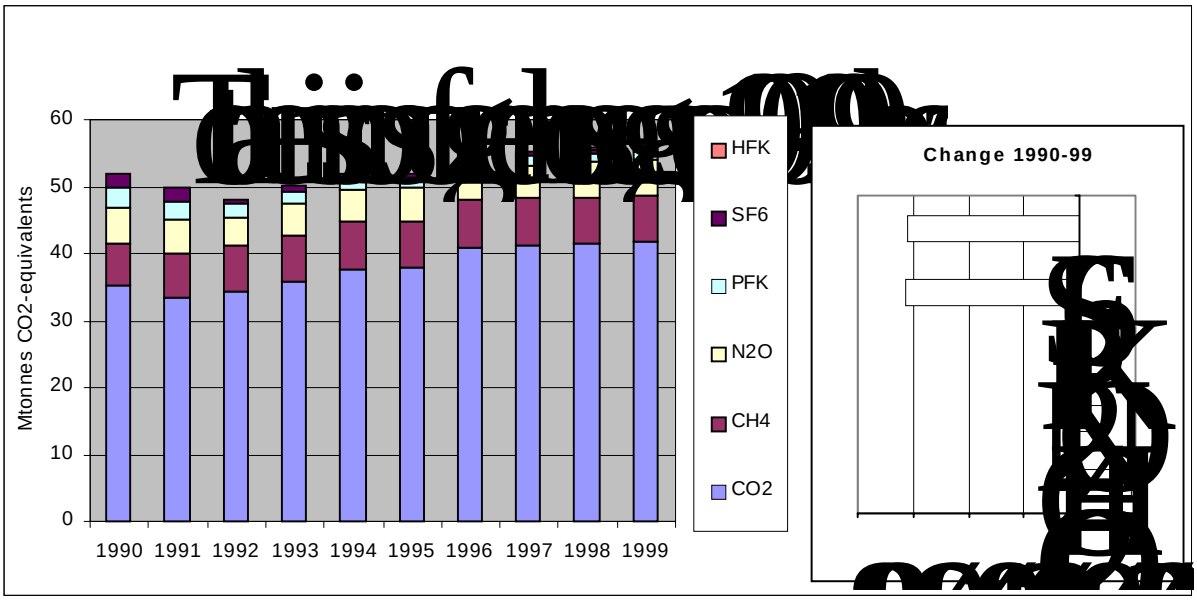
In accordance with the UNFCCC Reporting Guidelines, emissions from international aviation and marine bunker fuels are not included in the overall Norwegian greenhouse gas inventory. However, the inventory includes emissions from fishing vessels, coastal navigation and aircraft in national traffic. In Chapter 4 we present separate emission data based upon fuel sold to ships in international traffic which bunkered in Norwegian harbours and to aircraft in international traffic which bunkered at Norwegian airports.

2. Emissions by gas

In 1999 the total emissions of greenhouse gases, measured as CO_2-equivalents, were about 56.2 million tonnes. Since 1990 the total emissions of greenhouse gases have increased by 8%.

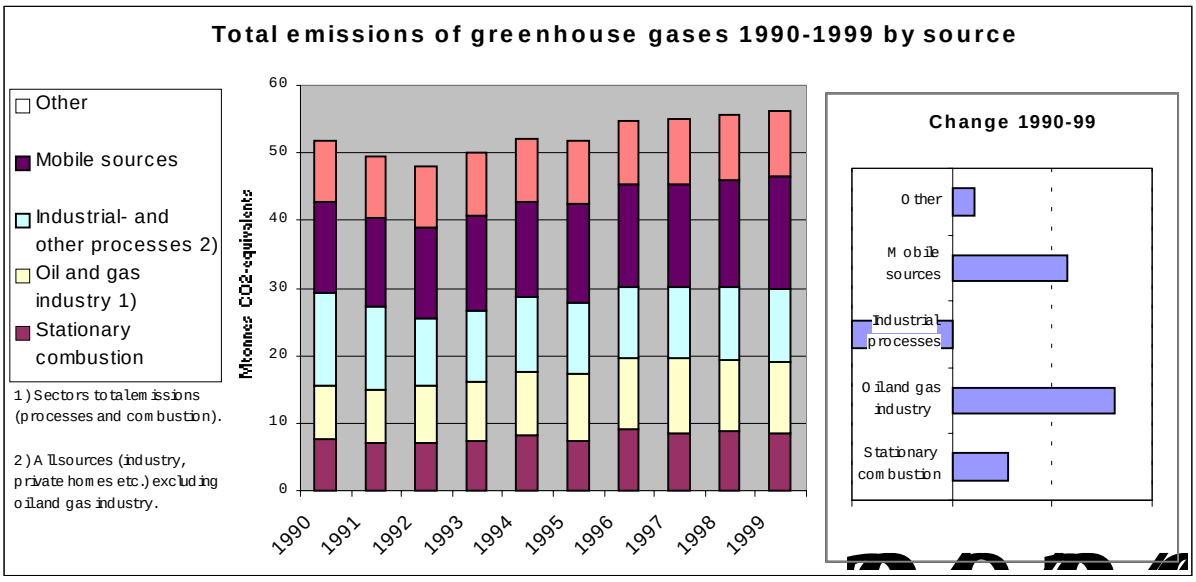
The increase is mainly due to economic growth in general, which has resulted in higher CO_2-emissions from most sources. This trend has to some degree been counteracted by decreased emissions of PFCs and SF_6 from aluminium- and magnesium plants. Emissions of CH_4 and N_2O have been relatively stable over the same period, except for minor changes related to emissions from oil/gas-industry and fertiliser production. There has been a strong rise in emissions of N_2O from road traffic.

Figure 1: Emissions of greenhouse gases 1990-99 by gas.



Sources: SFT, SN

Figure 2: Emissions of greenhouse gases 1990-99 by source.



Sources: SFT, SN

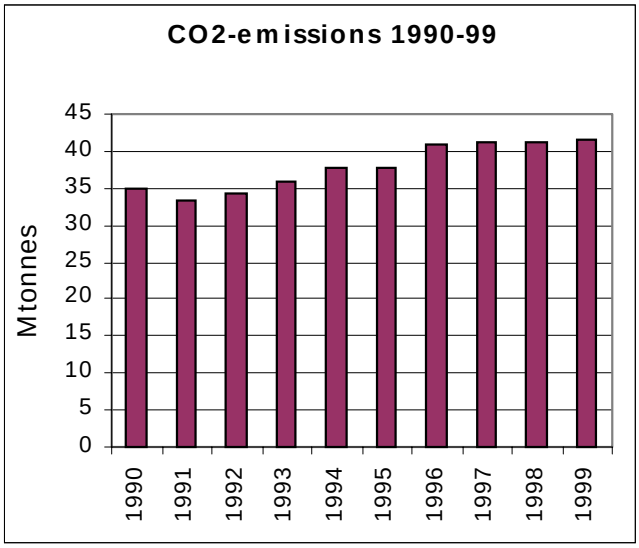
2.1. Carbon dioxide (CO_2)

The Norwegian CO_2-emissions are characterised by industrial sources related to oil- and gas extraction and the production of metals, minerals and chemicals. A relatively large share of the transport-related emissions originates from coastal navigation and the fishing fleet. Since generation of electricity is almost exclusively hydroelectric, emissions from stationary combustion are dominated by industrial sources.

From 1990 to 1999 the total CO_2-emissions have increased by 19%. Most major sectors have contributed to this increase, but the increases from the oil- and gas extraction industry have been the most pronounced.

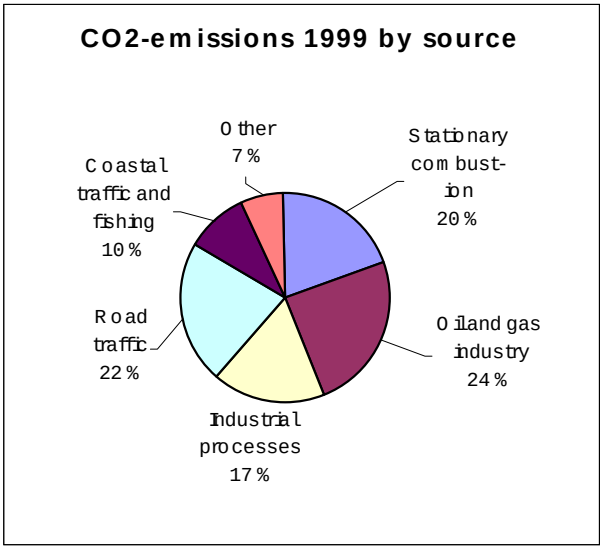
In 1999 the total Norwegian emissions of CO_2 were 41.6 Mtonnes – an increase of less than 1% from 1998. The increase was caused by the continuation of the trend of rising emissions from mobile sources - aviation, coastal navigation and diesel vehicles in particular.
The increase was somewhat counteracted by lower industrial emissions.

Figure 3: CO_2- emissions 1990-99.



Sources: SFT, SN

Figure 4: CO_2- emissions by source 1999.



Sources: SFT, SN

The increased CO_2-emissions from the oil- and gas industry in the 1990s are a result of large increases in production volume and the export of natural gas in pipelines. Because of technical and administrative improvements, induced by a CO_2-taxation regime, the emissions per unit produced oil/gas have been decreasing. Due to technical factors related to a shift to older and more marginal oil-and gas fields, this trend has however been reversed in the last few years.

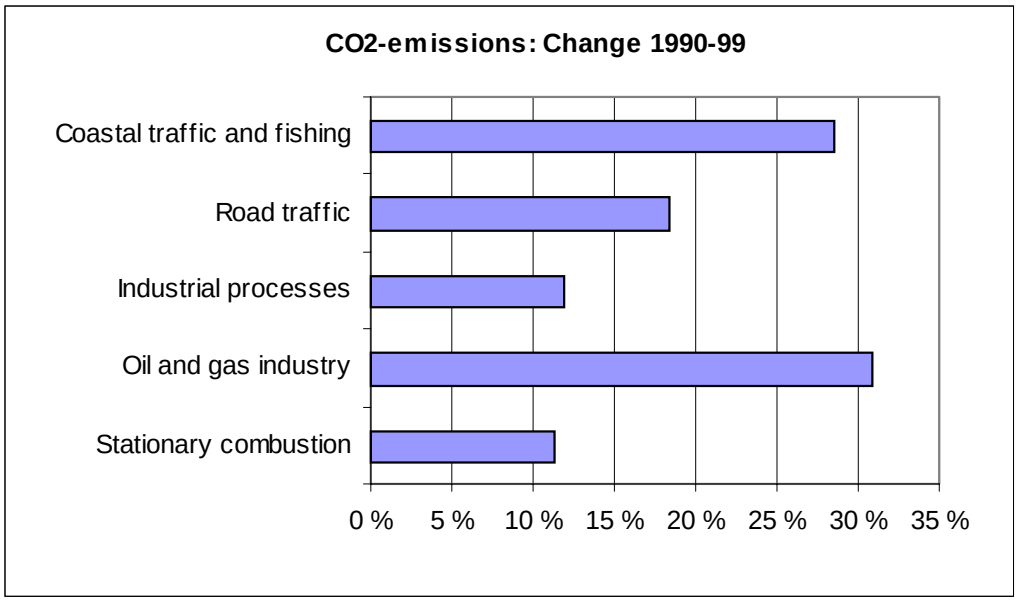
For road traffic the increase in emissions from 1990 to 1999 are particularly due to increased traffic by heavy-duty vehicles (42%). The increase in emissions from light vehicles (10%) has been somewhat slowed down because of a significant shift from gasoline- to diesel-powered vehicles and the general improvement of fuel efficiency in newer vehicles.

Emissions of CO_2 from domestic air traffic (civil and military) increased by 43% from 1990 to 1999, due to an increase in the number of civil flights.

Emissions from ships and boats increased by 27%, mainly due to increased activity in the petroleum sector.

Chemical production (fertiliser, carbides, petrochemical) and domestic heating are the only significant sources with decreasing emissions.

Figure 5: CO_2 –emissions; change in emissions from important sources 1990-99.



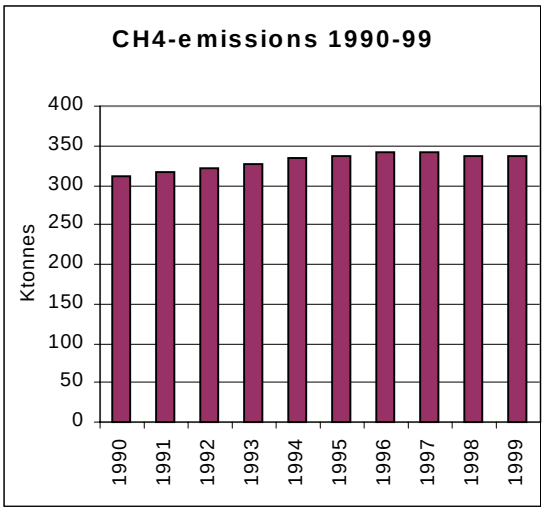
Sources: SFT, SN

2.2. Methane (CH_4)

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

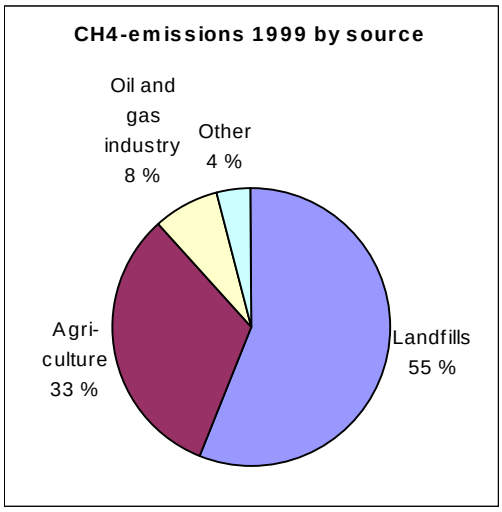
Emissions have now stabilised after a moderate increase in the first half of the 1990s. This trend is mainly caused by fluctuations in emissions from the oil- and gas industry, caused by changes in production volumes. Emissions from waste treatment were relatively stable throughout the 1990s, as higher waste volumes were offset by increased recycling of waste and increased burning of methane from landfills.

Figure 6: Methane emissions 1990-99



Sources: SFT, SN

Figure 7: Methane emissions by source in 1999.



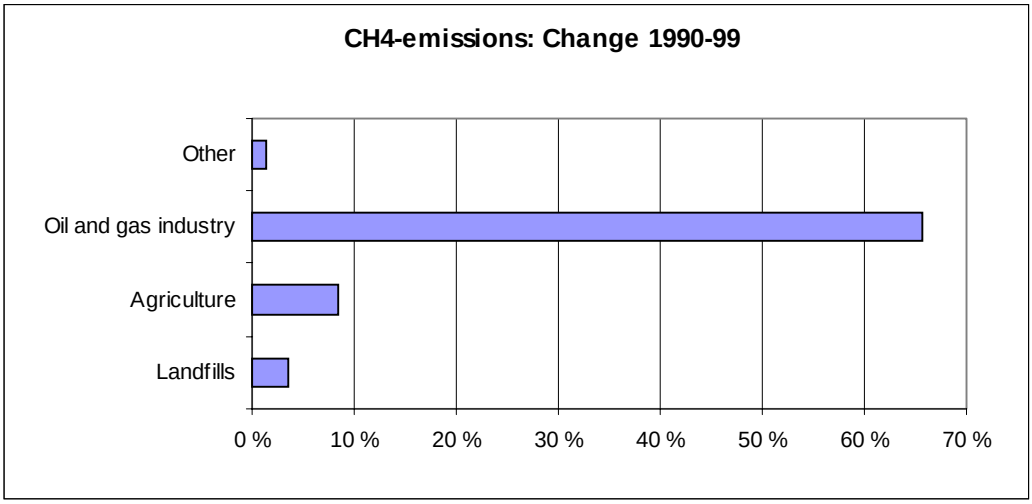
Sources: SFT, SN

From 1990 to 1999 the total CH_4-emissions increased by 8%. This increase has, in absolute terms, been approximately equally divided between the three important sectors landfills, agriculture and oil- and gas industry.

The emissions from agriculture are mainly from animal manure.

Emissions from oil- and gas extraction industry are largely caused by landing and loading of crude oil, and the rises in these emissions are influenced by increased production.

Figure 8: CH_4 -emissions; change in emissions from important sources 1990-99.



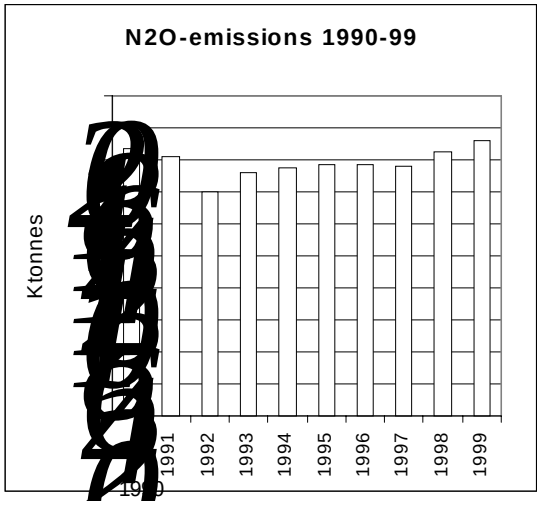
Sources: SFT, SN

2.3. Nitrous oxide (N_2O)

The emissions from agriculture (manure and nitrogenous fertiliser) account for half of the Norwegian emissions of N_2O. These emissions have been rather stable through the 1990s. The other major source is the two plants manufacturing nitrogenous fertiliser. Changes in production processes led to decreased emission in the beginning of the 1990s, while there was a moderate increase in emission in the following years due to increased production volumes. From 1998 to 1999 there was an 11 % increase in these emissions.

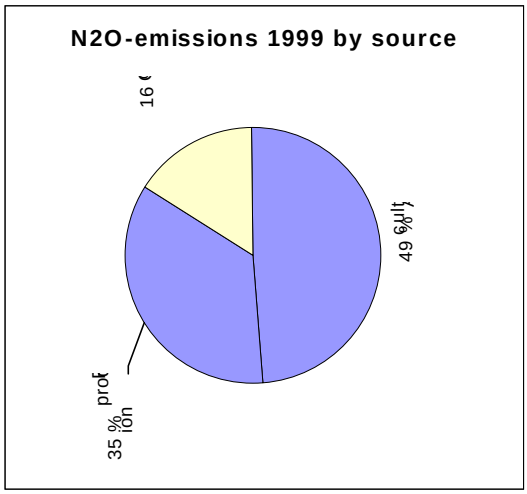
Emissions from mobile sources are increasing considerably because of the introduction of catalytic converters, and now account for 11% of the total N_2O-emissions.

Figure 9: Emissions of N_2O 1990-99.



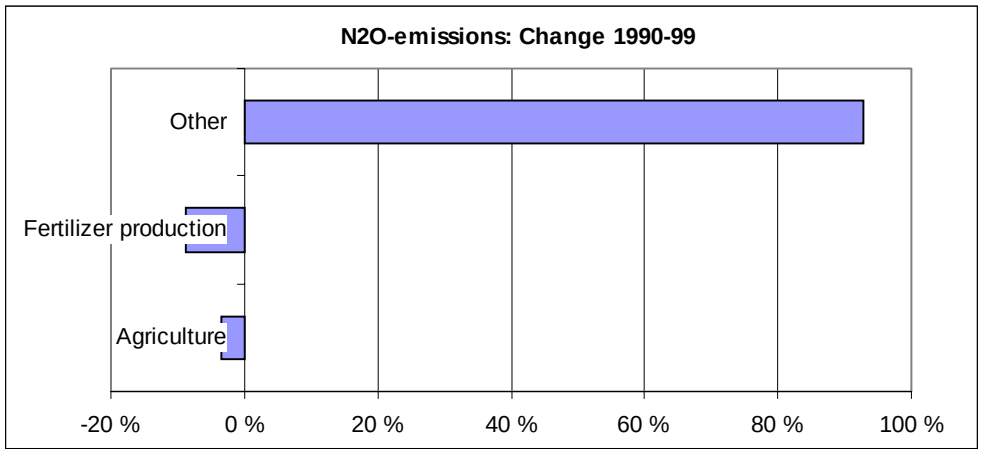
Sources: SFT, SN

Figure 10: Emissions of N_2O 1999 by source.



Sources: SFT, SN

Figure 11: N_2O emissions; change in emissions from important sources 1990-99. Change in source "other" is mainly due to large increases in emissions from road traffic (6x from 1990 to –99). In 1999 ½ of emissions from source category "other" were from road traffic.



Sources: SFT, SN

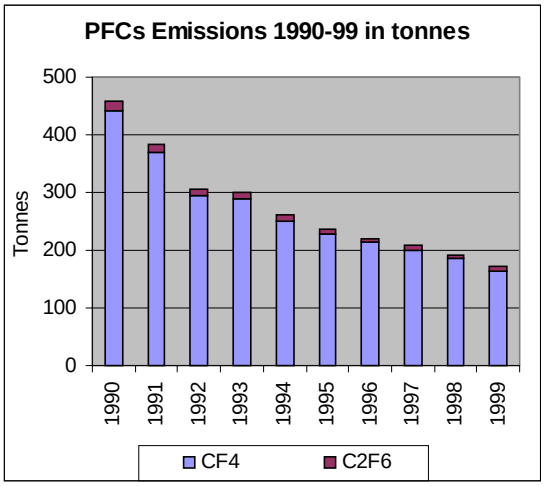
2.4. Perfluorcarbons (PFCs)

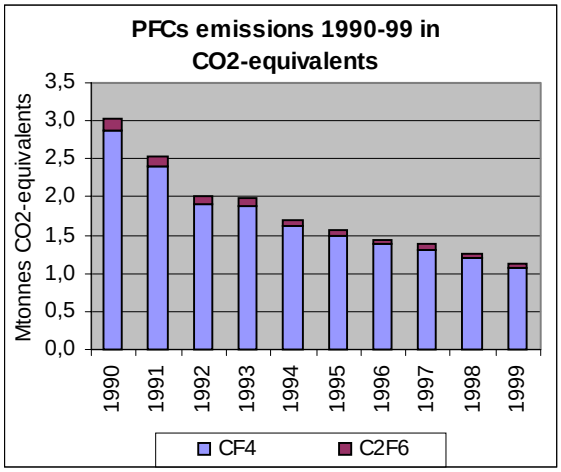
The emissions of the perfluorcarbons tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) from Norwegian aluminium plants in 1999 were calculated to 164 and 7 tonnes respectively, corresponding to 1.13 million tonnes of CO_2-equivalents.

From 1990 to 1999 the emissions of PFC-gases were reduced by 63%. This is explained by improved technology and process control, which has caused a reduction of the PFC emissions per tonne aluminium produced from 3.49 to 1.11 kg CO_2-equivalent from 1990 to 1999.

PFCs may be used as substitutes for ozone-depleting substances. In Norway, only one compound is used for this purpose, namely C_3F_8 (PFC-218). The actual emissions of C_3F_8 have been calculated at 60 kg in 1999, corresponding to 420 tonnes of CO_2-equivalents (see also chapter 2.6).

Figure 12 and figure 13: Emissions of PFC gases (CF_4 and C_2F_6) 1990-99 in tonnes and Mtonnes CO_2-equivalents.





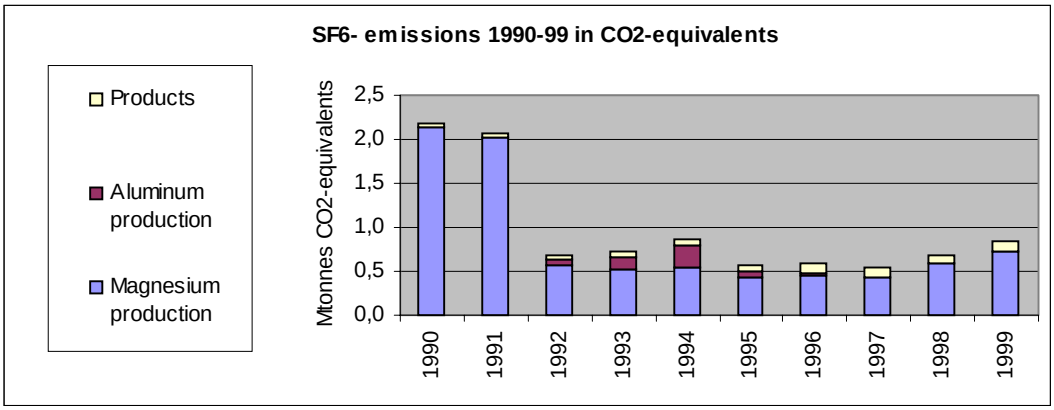
Sources: SFT, SN

2.5. Sulphur hexafluoride (SF_6)

The largest emission source in Norway is magnesium production where SF_6 is used to cover the surface of liquid magnesium to prevent it from oxidising. The covering gas is emitted to air after use. Emissions have been reduced through the 1990s due to improvements in technology and process-management. In the period 1990-1997, the emissions were reduced by 75%. From 1997 to 1999 emissions have increased by 67% due to increased production and higher shares of primary production versus recycled metal.

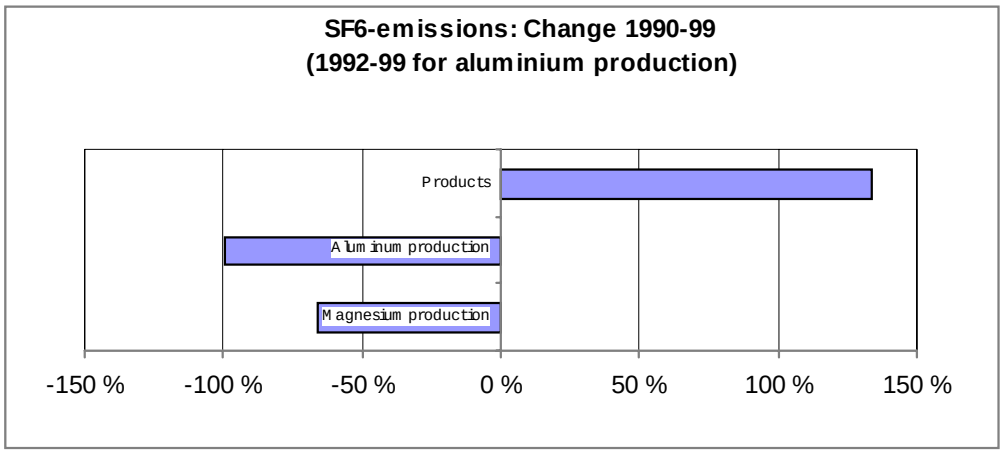
Similar use of SF_6 in the aluminium industry has been phased out because of changes in process (from Soederberg to Pre-baked).

Figure 14: Emissions of Sulphur hexafluoride (SF_6) 1990-99 by source.



Sources: SFT, SN

Figure 15: SF_6- emissions; change in emissions from important sources 1990-99.



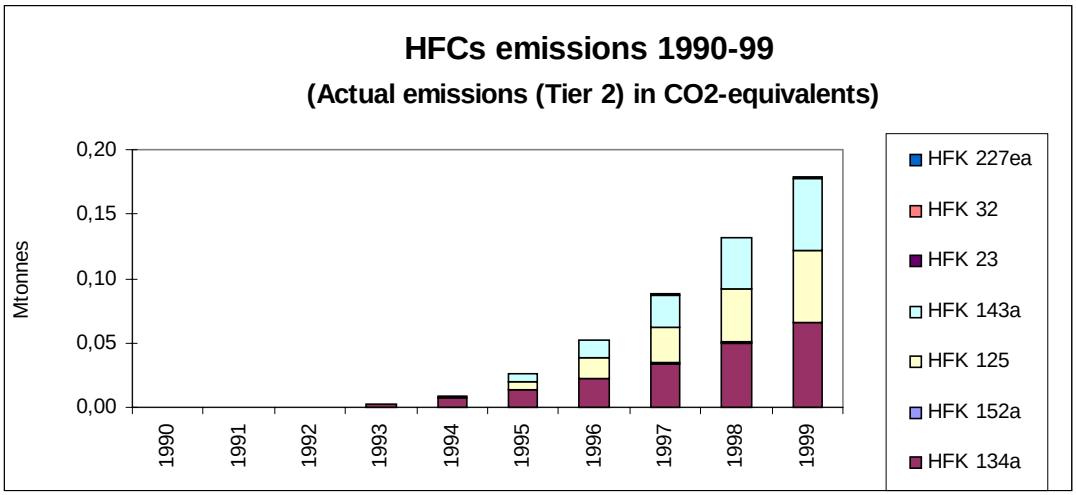
Sources: SFT, SN

2.6. Substitutes for ozone depleting substances (HFCs and PFCs)

The total actual emissions from HFCs and PFCs used as substitues for ozone depleting substances amounted to 0.18 Mtonnes of CO_2-equivalents in 1999. Compared to the emissions in 1998, this represents an increase of about 36%. The application category refrigeration and air conditioning contributed by far with the largest part of the HFC and PFC emissions in 1999. The other categories, foam and foam blowing, fire extinguishing products and solvents and aerosol propellants contributed small amounts to the overall emissions.

We have also calculated the potential emissions employing the Tier 1a methodology, which includes the import of chemicals in bulk. HFC/PFC imported in products is hence not included The ratio between potential and actual emissions in 1999 was about five.

Figure 16: Emissions of HFC-gases 1990-99 by gas.



Sources: SFT, SN

Table 2: Actual and potential emissions of HFCs and PFCs in Norway 1990-99 (tonnes).

Halocarbons; Emissions in tonnes	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Actual emissions (Tier 2)										
- HFC-134a	0	0.04	0.19	1.74	5.39	10.15	16.83	25.94	38.20	50.20
- HFC-143a	0	0	0	0	0.19	1.52	3.86	6.84	10.43	14.70
- HFC-152a	0.13	0.41	0.65	0.79	0.82	0.99	1.47	1.56	4.79	6.00
- HFC-125	0	0	0	0	0.47	2.38	5.47	9.71	14.73	19.90
- HFC-23	0	0	0	0	0	0	0.01	0.04	0.07	0.10
- HFC-32	0	0	0	0	0	0.01	0.03	0.15	0.33	0.60
- HFC-227ea	0	0	0	0	0	0	0.05	0.11	0.15	0.20
- PFC-218	0	0	0	0	0	0	0	0.06	0.06	0.06
Potential emissions (Tier 1a)										
- HFC-134a	0	1.0	2.2	31	40	47	51	69	94	110
- HFC-143a	0	0	0	0	4	25	25	43	41	68
- HFC-152a	3.0	3.0	3.0	1.0	1.1	4.5	3.4	6.8	17	12
- HFC-125	0	0	0	0	11	31	38	61	60	76
- HFC-23	0	0	0	0	0	0	0.1	0.5	0.1	0.1
- HFC-32	0	0	0	0	0.1	0.1	0.3	2.3	1.2	6.1
- HFC-227ea	0	0	0	0	0	0	1.6	1.3	0.6	0.2
- PFC-218	0	0	0	0	0	0.3	0.3	0	1	1

Sources: SFT, SN

2.7. Precursors (CO, NO_X and NMVOC) and SO_2

Precursors are gases, e.g. NO_X, CO and NMVOC, which have an indirect effect on the climate through their influence on greenhouse gases, especially ozone. SO_2 has a climate effect by increasing the level of aerosols, which have a cooling effect on the atmosphere.

Mobile sources make the most important contribution to emissions of CO and NO_X. Oil and gas production, particularly crude oil loading to ships, is the most important source of NMVOCs in Norway. Raw material producing industries, metal production in particular, is the most important SO_2 source.

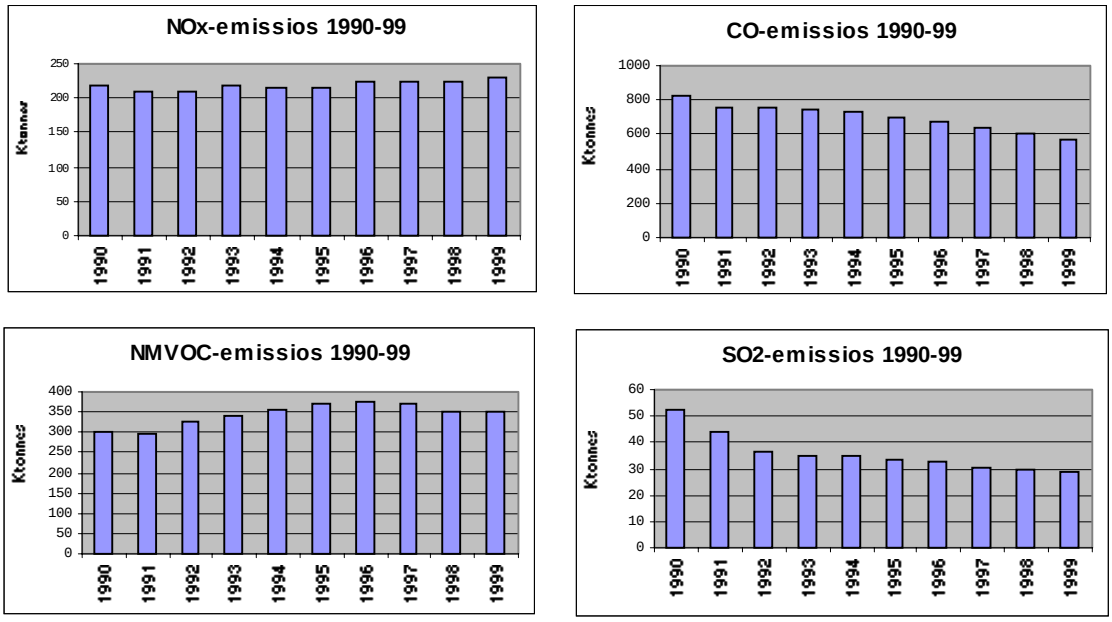
From 1990 to 1999 the emissions of CO have decreased by 32%, mainly because of new emission standards for motor vehicles.

Emissions of NO_X decreased by 2% from 1990 to 1995, but have since then been climbing to a level in 1999 that is about 5% higher than the 1990 level. Reduced emissions from road traffic due to the introduction of stricter emission regulations have been counteracted by increased emissions from oil/gas production and coastal navigation.

Emissions of NMVOCs increased by 24% from 1990 to 1996 due to a rise in oil production, and in spite of reduced emissions from road traffic. However from 1996 and onwards this trend was reversed, due to installation of a vapour recovery unit at one of the oil terminals onshore.

Emissions of SO_2 were reduced by 46% from 1990 to 1999. Stationary sources and industrial processes are the most important contributors to these emissions. The reduction is mainly explained by a reduction in the sulphur content of all oil products and lower process emissions from ferro-alloy and aluminium production and refineries.

Figure 17: Emissions of NO_X, CO, NMVOC and SO_2 1990-99.



Sources: SFT, SN

3. Emissions and removals by sector

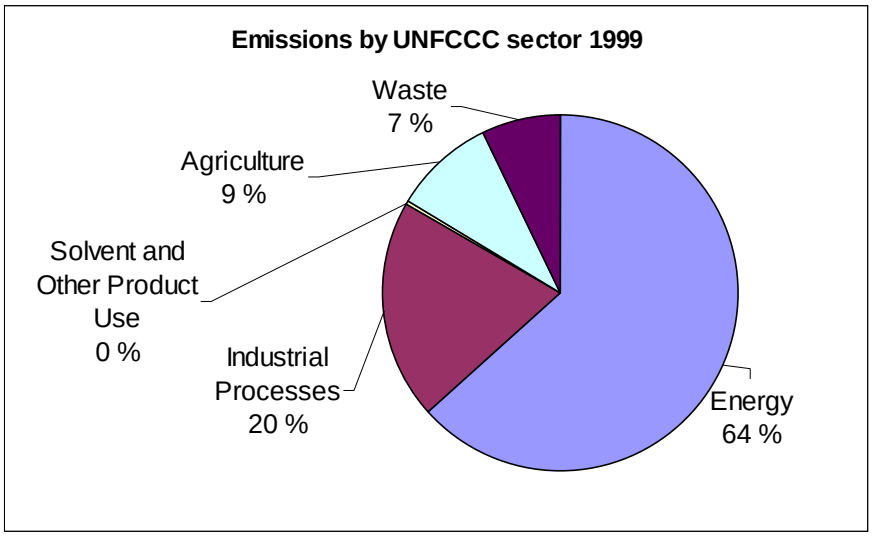
The Energy sector accounts for around 2/3 of Norwegian greenhouse gas emissions. Road traffic and offshore gas turbines (electricity generation and pumping of natural gas in pipelines) are the sector's largest single contributors, while coastal navigation and energy used for the production of raw materials are other major contributors. During most of the 1990s the energy related emissions have been increasing, mainly due to higher activity in the offshore and transport sector. From 1998 to 1999 this trend continued because of increased emissions from transport.

Production of raw materials is also the main source of process-related industrial emissions of both CO_2 and other greenhouse gases such as N_2O (fertiliser production), SF_6 (magnesium foundries) and PFCs (aluminium production). The industrial process sector accounts for 20% of national emissions of greenhouse gases. From 1992 and onwards these emissions have been relatively stable, with a trend of lower emissions of PFCs, being counterbalanced by rising emissions of CO_2.

Emissions from waste and agriculture were relatively stable during the 1990s, with emission levels of around 4, respectively 5 Mtonnes CO_2-equivalents.

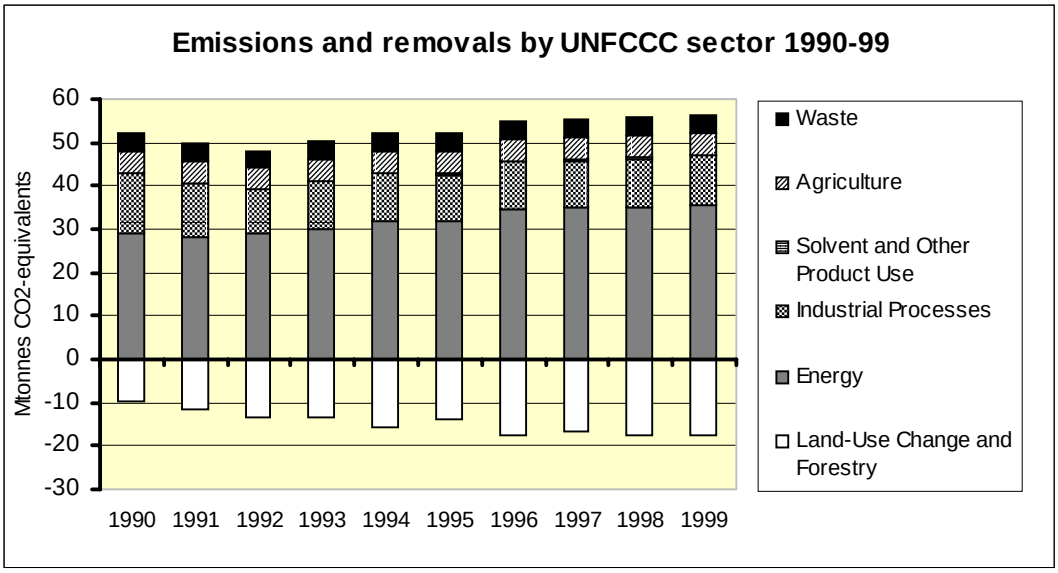
During the 1990s the net uptake of CO_2 from land-use change and forestry activities has almost doubled. The net removal of CO_2 in 1999 represents 34% of the total greenhouse gas emissions that year. The uptake of CO_2 in forest soil and harvested wood products is not included in these figures.

Figure 18: Norwegian emissions of greenhouse gases in 1999 according to UNFCCC sector classification.



Sources: SFT, SN

Figure 19: Norwegian emissions of greenhouse gases and CO_2 removals 1990-99 according to UNFCCC sector classification.



Sources: SFT, SN

3.1 Energy

The Norwegian energy sector has traditionally been characterised by large amounts of readily available hydroelectric power. This has resulted in a preference of electricity in favour of fossil fuels in heating and many manufacturing processes.

In recent decades offshore oil- and gas extraction has played an important role in the national economy. On the offshore oil- and gas installations, electricity and pumping power is principally produced by gas turbines and, to a lesser extent, diesel engines. Emissions from these sources dominate the Norwegian emissions from UNFCCC sector "Manufacturing of Solid Fuels and Other Energy Industries". From 1990 to –97 there was a 46% increase in the total greenhouse gas emissions from offshore energy production. From 1997 to -99 the rising trend was reversed, and in 1999 emissions were 29% above the 1990 level. Oil refineries and gas terminals constitute the major onshore energy industries emissions.

Public generation of electricity and heat is completely dominated by hydroelectric generation, the only important exception being waste incineration plants and a small coal combustion plant (6MW) on the island of Spitsbergen.

Industrial emissions related to fuel combustion[1] originate to a large extent from the production of raw-materials and semi-manufactured goods, e.g. alloys, petrochemicals, paper and minerals. From 1990 to -99 the combined increase in emissions from manufacturing and construction was 24%, with the most pronounced increase being in the petrochemical (opening of a new methanol production plant) and in the pulp and paper industry.

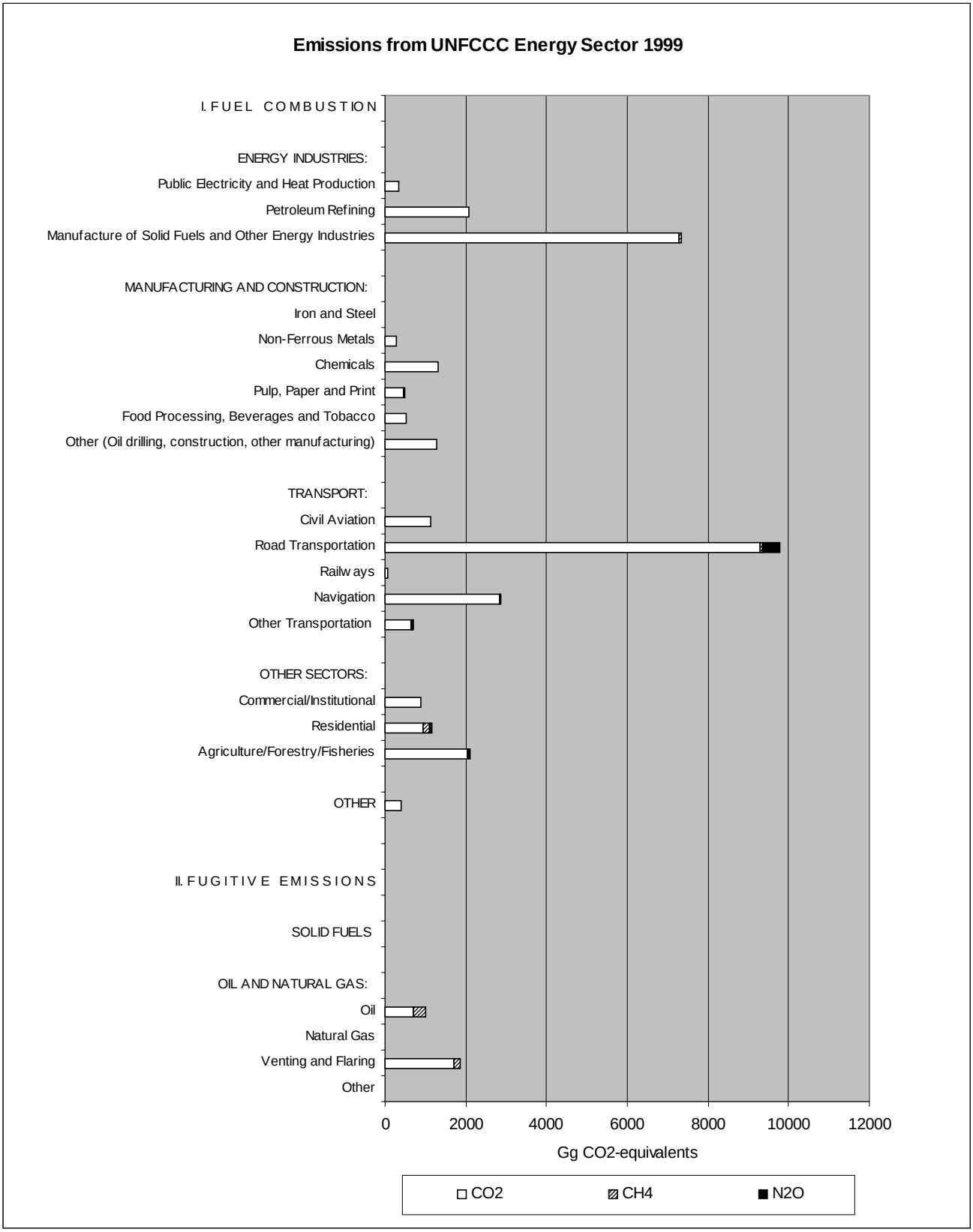
Emissions from transport showed an overall increase of 29% from 1990 to –99, while the increase from 1998-99 was 5%. Road traffic accounts for around 2/3 of total mobile emissions, while the strongest increase in emissions has been in civil aviation (about 64% from 1990 to –99). Emissions from navigation increased by 48% from 1990 to –99, mainly because of increased activity related to the oil- and gass extraction sector. Both direct and indirect emissions from railways are low due to electrification of major lines.

Due to electrification of heating infrastructure, residential emissions have decreased by 1/3 since 1990. New technologies and occasional electricity shortages might, however, reverse this trend.

Fugitive energy sector emissions originate from the extraction and handling of crude oil. This includes leakages of methane and indirect emissions of CO_2 during drilling and extraction, as well as emissions of NMVOCs from loading and unloading of oil tankers. Due to increased activity these emissions have increased by 74% from 1990 to –99. The other major source is venting and flaring on oil- and natural gas fields. Technical measures have been implemented to minimise these emissions, however due to the large increases in production, emissions have increased by 19% from 1990 to 1999.

[1] Mainly emissions from use of oil or gas for heating purposes. Does not include consumption of coal as feedstock and reduction medium, which is included in the industrial processes category.

Figure 20: Norwegian emissions of greenhouse gases from UNFCCC energy sector in 1999.



3.2 Industrial processes

During the first half of the 19-century there was a large-scale industrialisation in Norway. Particularly in the western parts, many industrial communities based around the large hydroelectric resources appeared. Typical products were raw materials and semi manufactured goods, such as aluminium and ferro-alloys. The main energy source was, and is, hydroelectric. Fossil fuels are, however, used as reducing agents or raw materials, and other greenhouse gases are emitted as process related gases.

Cement is today produced in two plants in Norway. The GHG emissions from cement production is CO_2 that originates from coal and waste used in direct fired furnaces, and from carbon in limestone - the latter is considered as process related emissions. Due to growth in production emissions increased by 35% from 1990 to –94, and have now stabilised on the emission level of 1994.

Chemical industry in Norway primarily includes production of fertilisers and silicon carbide. Nitric acids and ammonia are formed as steps during fertiliser production. The largest emission sources are N_2O from nitric acid production and CO_2 from production of ammonia and carbides. N_2O emissions from nitric acid production constitute around 1/3 of national N_2O emissions. Changes in production processes led to decreases in this emission in the beginning of the 1990s, while recent years have shown significant increases in emissions due to higher production volumes.

Norway is, with 7 plants, one of the worlds leading producer of primary aluminium. Both the prebaked anode and the Søderberg production methods are used. The main energy source is electricity, but CO_2 is emitted from the use of petrol coke, coke of coal and from coal electrodes. In addition, production of aluminium causes emissions of PFCs (perfluorcarbons). From 1990 to 1999 the emissions of PFCs were reduced by 63% while the total emissions of GHG decreased by 37%. PFCs reduction is explained by improved technology and process control, which has caused a reduction of the PFC emissions per tonne aluminium produced from 3.49 to 1.11 tonnes CO_2 equivalents in the years 1990 to 1999. In 1997 the aluminium producers and the Ministry of Environment signed an agreement to reduce emissions of greenhouse gases from production. Emissions measured as CO_2-equivalents per tonne primary aluminium produced are to be reduced by 50% in 2000 and 55% in 2005. In 1999 the emissions of greenhouse gases i.e CO_2 and PFC, were reduced by almost 45% since 1990 and accounted to 2.88 tonnes per tonne aluminium.

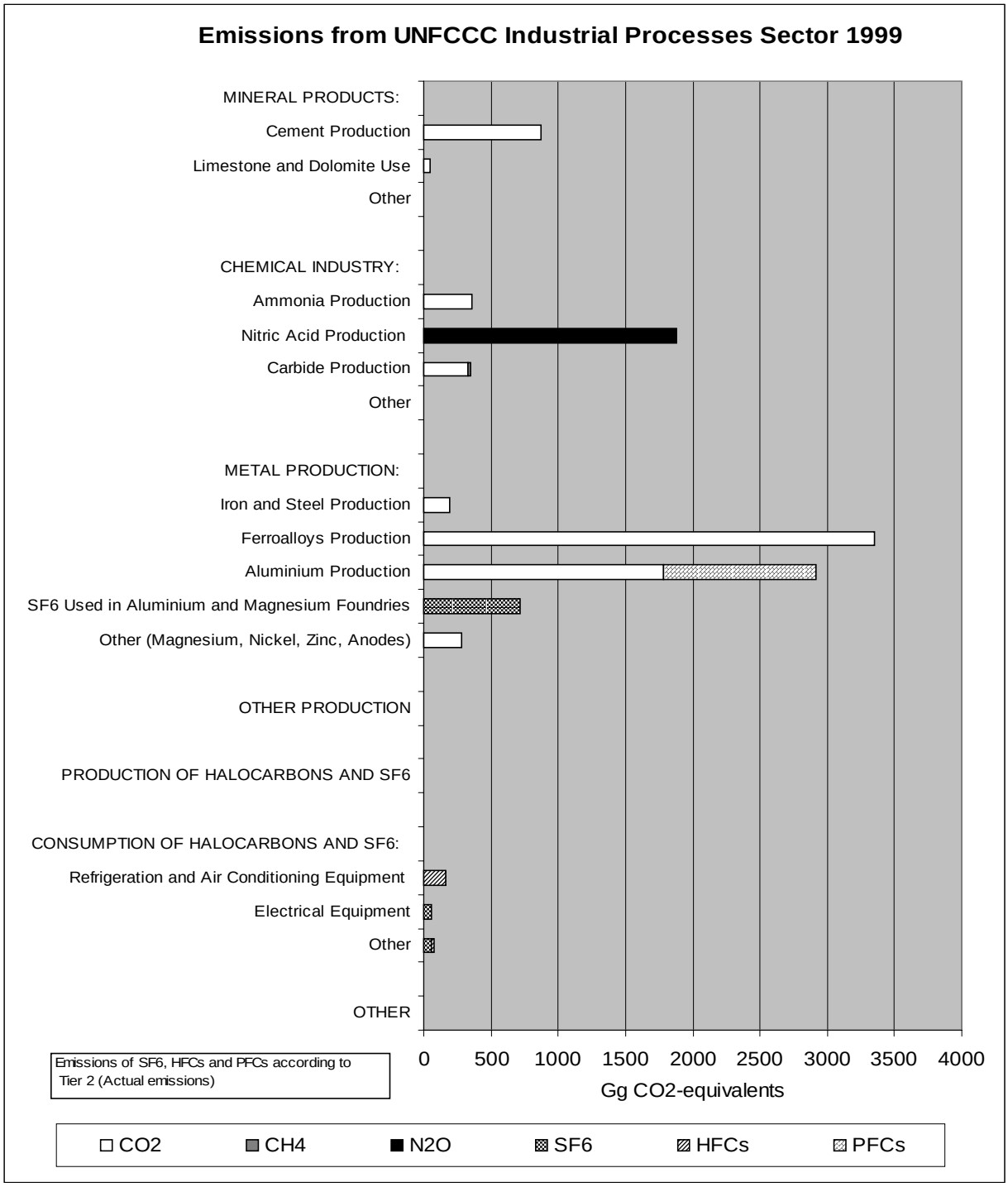
The major source of SF_6 emissions is magnesium production, where the gas is used to cover the surface of liquid magnesium to prevent oxidising. These emissions have been reduced through the 1990s due to improvements in technology and process-management. The emissions in 1999 were 66% lower than in 1990. However there was a significant increase in 1999 emissions due to growth in production and due to increased production and higher shares of primary production versus recycled metal (Consumption of SF_6 per tonne primary magnesium produced is higher than for recycled magnesium).

Norway is a major producer of ferroalloys, with 15 plants in operation. CO_2 is emitted from these plants due to the use of coal and coke of coal as reducing agents. These emissions have increased by 22% from 1990 to –99.

The major iron producing plant was closed down in 1988, but a minor plant still exists. Other metal producing plants in Norway today are one nickel and one zinc plant.

Refrigeration and air conditioning equipment are the largest source of halocarbon emissions. Increased application of air-conditioning systems in new cars amplifies the rapid growth in these emissions. Electrical switchgears and the use of SF_6 as trace gas are the most important source of non-process emissions of SF_6. Norway does not manufacture halocarbons or SF_6.

Figure 21: Norwegian emissions of greenhouse gases from UNFCCC industrial processes sector in 1999.



Sources: SFT, SN

3.3 Solvent and other product use

Use of solvents and products containing solvent leads to emissions of NMVOC, which oxidise in the atmosphere to CO_2. This emission source represent a share of 0.2% of national totals of GHGs. The share has been more or less unchanged since 1990.

Table 3: Emissions of greenhouse gases from Solvents and other products (Ktonnes CO_2 equivalents).

	1990	**1998**	**1999**
Solvents losses	144	137	137
% of national totals	0.2	0.2	0.2

Sources: SFT, SN

3.4 Agriculture

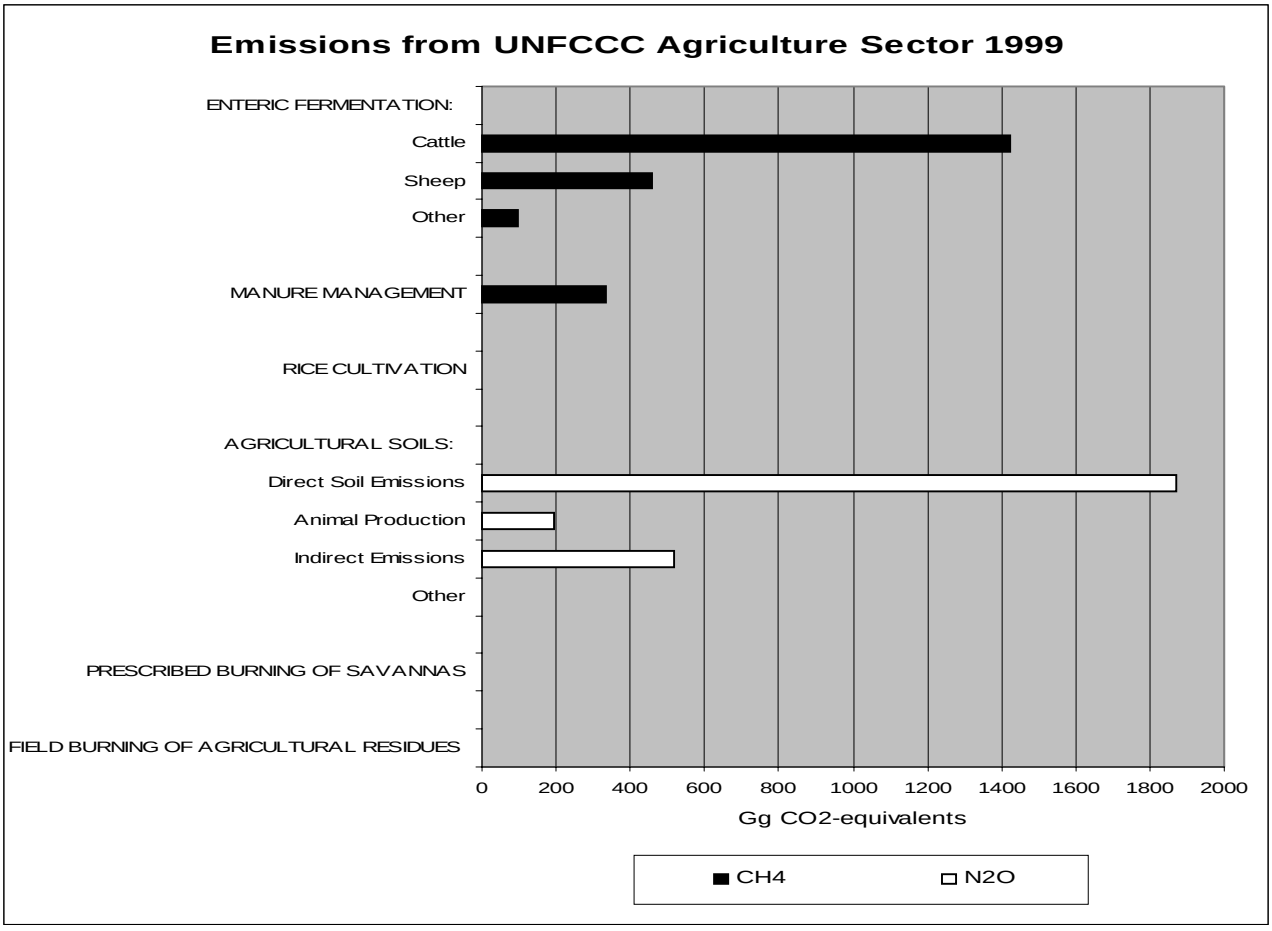
GHG emissions from agriculture consist mainly of methane and nitrous oxide, contributing almost evenly to 4.9 Mtonnes of CO_2-equivalents in 1999. This was approximately 9% of the overall Norwegian GHG emissions in 1999.

The largest sources for agricultural GHG emissions are N_2O from soil processes and CH_4 from enteric fermentation from cattle and sheep with almost 40% each of the total agricultural emissions. The remaining approximately 22% originates from indirect emissions of N_2O, animal production outdoors (N_2O), and CH_4 from manure management.

Over the period 1990-99 the methane emissions from agriculture increased by about 8.5 %, mainly from enteric fermentation, while nitrous oxide has shown a decrease of 3,3%, resulting in an overall increase of about 2%.

These figures reflect the stability of the production in the agricultural sector and the absence of improvements resulting in lower emissions of GHG's.

Figure 22: Norwegian emissions of greenhouse gases from UNFCCC agriculture sector in 1999.



Sources: SFT, SN

3.5 Land Use Change and Forestry

According to the IPCC Guidelines, the reporting of emissions and uptake from land-use change and forestry should focus on three activities, namely changes in forest and other woody biomass stocks, forest and grassland conversion and abandonment of managed lands. In Norway it is difficult to separate the contributions from the three different categories, hence we have reported the uptake and emissions under changes in forest and other woody biomass stocks. This can be found in Table 5 of the reporting tables. To provide more detailed information, we have enclosed an additional table (See Appendix Table 5A on the last page of the Reporting Tables in Appendix 2 and 3 to this report). We calculate the emissions employing the IPCC default method, where harvested wood is counted as emissions the year the harvest takes place. Hence, uptake in harvested wood products is not included.

The Norwegian Institute of Land Inventory (NIJOS) performs a national forest inventory every year. Field observations are then collected from all counties in Norway. These observations are the basis for the calculations of the annual growth increment. Permanent observation fields have been established and all plots are visited within the course of a five-year cycle. From this survey, and from annual figures of felling and other depletion, the figures for uptake and emission of CO_2 are calculated. The figures include above and below ground biomass, which signify tops and branches, bark, stumps and coarse roots. The carbon content in forest soils is not included in the estimates here.

Changes in forests up to 1999

Until the beginning of 1900 the harvest was about the same as the regrowth. Since then the standing volume of Norwegian forests has increased, it has almost doubled from 1925 to 1990, while the harvest has been about the same (10 mill m^3 per year). The large increase in the standing volume is primarily due to active forest management. The result is a considerable net increment and hence accumulation of carbon in forests. The standing volume yields a carbon reservoir of 250 million tonnes (1995), including bark, stumps, branches and roots.

The gross increment of carbon in Norwegian forests is estimated to being equivalent to 34.1 million tonnes of CO_2 in 1999. A total of 16.4 million tonnes of CO_2 were harvested or depleted, which resulted in a net removal of 17.7 million tonnes of CO_2. The net sink increased by 0.1 million tonnes from 1998 to 1999. The net removal may be compared with the total emissions of greenhouse gases; as much as about 34% of the emissions are offset by CO_2 uptake due to forest regrowth. As stated earlier, the net changes in CO_2 emissions and removals from forest soils have not been estimated.

From Table 4 it can be seen that harvested wood resulted in emissions of 13.1 million tonnes of CO_2, while other depletion gave emissions of 3.3 million tonnes. According to the Revised IPCC Guidelines, felled wood is calculated as emissions the year of harvest. The figure for felling consists of emissions from commercial consumption, fuel wood consumption and other private wood consumption. “Other depletion” signifies emissions from logging and sivilcultural waste and natural losses.

Table 4: Emissions and removals in Norwegian forests 1999

	CO_2-removals (mill. tonnes CO_2) 1999
Gross increment	**34.1**
Felling - Commercial consumption - Fuel wood consumption - Other private wood consumption	**13.1** 10.6 2.2 0.3
Other depletion - Logging and sivilcultural waste - Natural losses	**3.3** 0.9 2.4
Total gross depletion	**16.4**
Net growth	**17.7**

Sources: SFT, SN

Methodology

The National Forest Inventory is carried out as a sample survey. In the period 1986-1993 permanent sample plots were established in forests in a 3 x 3 km grid. This includes most of the forest area in Norway, except the county of Finnmark and the mountain birch forests. Totally, approximately 10500 permanent sample plots are located on productive forest and other wooded land below the coniferous forest limit. On the average, each sampled area comprises about 3×10^{-5} of the surveyable area. The plots are re-measured every 5^{th} year. Measurements on trees are carried out on an area of 250 m^2. Stand parameters are based on a plot size of 0,1 ha.

An extensive number of attributes concerning forest conditions are being recorded at the plots. Some of these describe the area. Parameters which characterise the level of development and species composition of the vegetation, certain aspects on biodiversity, utilisation and yield capacity of the land, forest treatment, relations concerning forest operations etc., are being measured or estimated.

To include total above and below ground biomass (tops, branches, stumps, coarse roots and bark) the roundwood cut volume is multiplied with a factor of 1.9. Trees lower than 1.3 meters are not taken into account.

Norway follows the FAO definition where forest land is defined as an area with a minimum of 10 % crown coverage. The trees should be able to reach a minimum height of 5 meters at maturity. The area can be temporarily without crown coverage due to harvesting without following land use change. In Norway the category “Other wooded lands” defines areas with a minimum of 5 % crown coverage and tree heights over 5 meters at maturity, or a crown coverage of more than 10% and tree heights under 5 meters at maturity, which is the FAO definition.

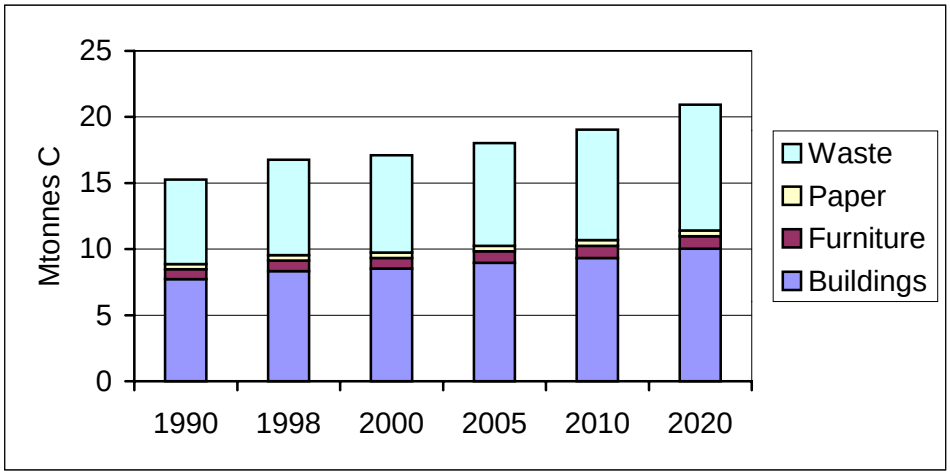
Carbon in products and waste

The stock of carbon in products and waste has been estimated by Gjesdal et al, Statistics Norway, and the storage sources included are paper and paper products, furniture, buildings, and wood and paper disposed of in landfills (SFT 1996**)**. This stock is not included in the tables on land-use change and forestry. A national estimation method has been used, which is based on the stock change approach (defined in Brown *et al* (1998)).

The study from 1996 is now being updated by Statistics Norway (SFT in prep.). According to the study, the total stock of carbon in wood products was estimated at 16.2 million tonnes of carbon (or 59.5 million tonnes of CO_2) in 1998. The stock has increased by about 11% since 1990, see figure 23. The main part of the stock was stored in buildings and waste; these two categories constituted 49% and 43% of the harvested wood stock respectively in 1998. The change in the reservoir from 1997 to 1998 has been estimated to 0.2 million tonnes of carbon (or 0.7 million tonnes of CO_2).

In the national method, carbon stored in paper is calculated from consumption of paper, lifetimes and carbon content in the paper products. Production data is obtained from Statistics Norway's annual industry survey, while the annual External trade statistics gives data on import and export. The amount of wood in buildings and furniture is calculated from i.a. the number of dwellings, the average utility of floor space, the fraction of dwellings built with wood, the amount of wood per m^2 in wood buildings and the C-content. The calculations of carbon stored in waste are based on background data used in estimation of methane emissions from landfills. Three categories of waste are considered: household and industrial waste included in municipal waste, and industrial waste treated outside the municipal refuse disposal service. The waste products included in this analysis are paper and wood.

Figure 23: Stock of carbon in wood products in Norway in 1990 and 1998, and projections for 2000-2020. (SFT in prep.)



3.6 Waste

Emissions of GHG from waste, mainly methane from landfills, accounted for 7.4% of the total GHG emissions in Norway in 1999 (see table 5). This is a slight decrease from 1990.

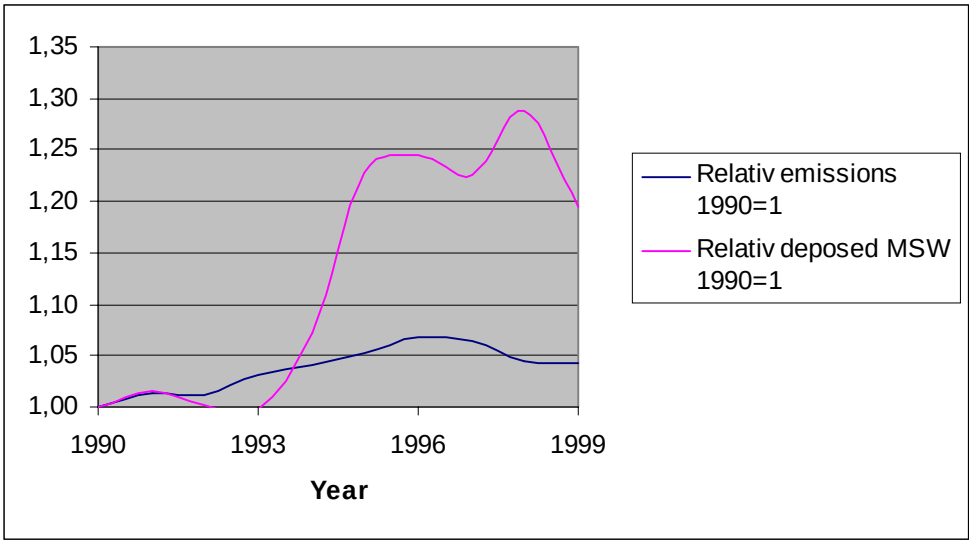
Emissions of methane have decreased due to reduction of the amount of waste disposed at disposal sites. The effects of several measures introduced in the waste sector explain this reduction. With a few exemptions, at all landfills in Norway it is prohibited to dispose easy degradable organic waste. In 1999 a tax was introduced on waste delivered to final disposal sites. This tax is today equal to 314 Nkr per tonne waste disposed at landfill sites. In addition, landfills receiving biodegradable waste (waste containing degradable organic carbon (DOC)) are required to collect and treat landfill gas. Today more than 40 landfills have installed a landfill gas extraction system, and approximately 22 ktonnes of methane were recovered in 1999 - 5% more than in 1998. In addition, the amounts of waste recycled have increased significantly since 1990.

Table 5: Emissions of greenhouse gases from waste (Ktonnes CO_2- equivalents)

	1990	1998	1999
Landfills	3853	4028	4016
Wastewater handling	135	164	164
Totals	3987	4192	4180
% of national totals	7.7	7.1	7.4

Sources: SFT, SN

Figure 24: Emissions of methane from landfills and produced waste. Index of total emission and total produced waste. 1990=1. MSW=Municipial Solid Waste.



Sources: SFT, SN

4. International aviation and marine bunker fuels

In accordance with the IPCC Guidelines, emissions from international aviation and marine bunker fuels are excluded from national totals. They are presented separately for informational purposes, see table 5 and table 6. The emissions in 1999 are also included in the Reporting Tables (Table 1s2) as required.

In 1999, CO_2 emissions from ships and aircraft in international traffic bunkered in Norway amounted to a total of 3.7 million tonnes, which corresponds to about 8 % of the total Norwegian CO_2 emissions. The sum of CO_2-emissions from marine and aviation bunkers remained almost constant from 1998 to 1999. Looking at emissions from international aviation separately, we see that they increased by ca. 19% from 1998 to 1999. Emissions of CO_2 from ships in international traffic decreased by about 6% in the same period.

The emissions of CO_2 from ships in international traffic have increased by as much as 80% from 1990 to 1999, while emissions of CO_2 from aircraft increased by 67% in this period. The reason for these increases is primarily growth in traffic. We know that the aircraft engines are more fuel-efficient now than they were some years ago, which means that the growth in international air-traffic has been even higher than the growth in emissions.

Table 5 and table 6: Emissions of CO_2, CH_4, N_2O, NO_X , CO, NMVOC and SO_2 from ships and aircraft in international traffic bunkered in Norway. 1990-1999. 1000 tonnes. CO_2 in Mtonnes

Marine	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	1.5	1.3	1.6	1.7	1.8	2.3	2.5	3.1	2.9	2.7
CH_4	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
N_2O	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
NO_X	30.3	25.6	32.1	34.3	37.8	46.2	50.7	63.0	59.4	56.0
CO	1.4	1.2	1.5	1.6	1.8	2.2	2.4	3.0	2.8	2.7
NMVOC	1.1	0.9	1.2	1.3	1.4	1.7	1.9	2.3	2.2	2.1
SO_2	9.9	9.7	12.3	13.5	-	13.7	15.4	19.9	17.0	12.9

Aviation	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	0.6	0.5	0.6	0.6	0.6	0.6	0.7	0.8	0.8	1.0
CH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NO_X	1.7	1.6	1.6	1.8	1.7	1.7	2.1	2.3	2.5	3.0
CO	1.7	1.6	1.6	1.8	1.7	0.9	1.0	1.2	1.3	1.5
NMVOC	0.5	0.5	0.5	0.5	0.5	0.1	0.2	0.2	0.2	0.3
SO_2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Sources: SFT, SN

Emissions of NO_X from ships were 56 ktonnes, or about 24 % of the total Norwegian NO_X emissions in 1999. During the period from 1990 to 1999, NO_X emissions from ships increased by 84%. NO_X-emissions resulting from international aviation increased by 76% from 1990 to 1999. As for the other gases in the table, emissions from international aviation and marine bunker fuels are small compared to the total Norwegian emissions of these gases.

The estimations of emissions resulting from marine bunkers are based on Norwegian sales statistics for liquid commercial fuels. The total sale of fuel to aircraft was also found from the sales statistics, thus subtracting the amount of fuel used in domestic air transport provided the emissions from international flights. Emissions from helicopters are included in the totals for aircraft.

5. Methods of estimation

The methods of estimation of all gases are harmonised with current IPCC Guidelines for National Greenhouse Gas Inventories and are to a large extent in accordance with IPCCs Good Practice Guideline. However, national specific estimation methodologies have been used when they better illustrate Norwegian conditions. The methodology, emission factors, activity data and measurements used in the Norwegian inventory model are described in the report The Norwegian Emission Inventory (SN/SFT 2000).

The emission figures for CO_2, CH_4, N_2O, HFCs and for the precursors CO, NO_X, NMVOC and SO_2 are estimated in collaboration between Statistics Norway (SN) and the Norwegian Pollution Control Authority (SFT). SFT contributes with emission factors from all sources and measured emission data from large industrial plants. SN is responsible for activity data (e.g. on energy use), emission models and calculations.

In the Norwegian emission inventory model all emissions are calculated in a four-dimensional cube model, with the axes components, technical emission sources, emission carriers (e.g. fuels) and economic sectors. This model includes the greenhouse gases CO_2, CH_4 and N_2O and in addition the precursors NO_X, SO_2, NMVOC, and CO. Thus, emissions can be listed by a multitude of combinations of fuels, sources and sectors. The combustion emissions are calculated by combining the fuel consumption distributed on emission sources and economic sectors with fuel-, source-, sector- and pollutant specific emission factors. If measured emission estimates are available, these are used instead of the calculated emissions. Aggregated emission factors are input to the main emission model. Emissions from road traffic, methane from landfills and emissions of HFC are calculated in a special model in a detailed manner. The non-combustion emissions are estimated by combining activity data with emission factors, by more complicated calculations. The emission factors are either estimated from measurements or taken from special investigations. The non-combustion emissions are fitted into the cube model by an appropriate emission carrier, emission source and economic sector.

The Norwegian national inventory model covers all the recognised important sources for the emissions of all the above mentioned components. The industrial emissions are fairly well covered by measurements or by use of national emission factors.

Emissions of SF_6, PFCs and HFCs are calculated separately, and are not included in the national inventory model.

The calculation of greenhouse gas emissions measured as CO_2 equivalents is based on data for global warming potential (GWP), calculated for a time horizon of 100 years, from IPCC Second Assessment in 1995.

6. Recalculations

According to UNFCCC Common Reporting Format parties are committed to report recalculation of emissions since last submission. In table 8(a) Recalculation - Recalculated data in the Common reporting format we have reported recalculated data for 1990 and 1998. We have explained recalculations due to methods, emissions factors and activity data in table 8(b) Recalculation - Explanatory information. The most important changes from previous year submission we are summing up in this chapter. Only minor changes in the emissions have occurred after recalculations.

6.1 Recalculation of Fugitive emissions from coal mining and -handling

Norway produces coal on the Arctic island of Spitsbergen. Emissions of methane from coal mining have till today been based on a Tier 1 methodology due to lack of relevant national data. In the calculation of methane emissions from underground mining Norway has used a default emission factor value of 14 kg CH_4 per tonne extracted (Tier 1). Based on measurements the methodology has been improved and we have changed the factor to 0.54 kg methane per tonne coal (Tier 2). The result is that Norwegian figure for fugitive emissions from coal mining and handling has decreased with 96% measured as CO_2-equivalents.

In year 2000 emissions of methane from coal mining has been measured in two ways. Firstly coal has been sampled and methane content has been analysed (IMC Technical Services Limited 2000). Samples yielded an estimate of seam gas content of 0.535-1.325 m^3 methane per tonne coal derived from an average content of 0.79 m^3 per tonne. This factor includes the total possible methane emissions from coal mining, loading and transport on shore and on sea. This factor also includes the possible emission from handling and crushing at the coal power plant. The sampling process started after a long period (a week) of continuo production. Small samples of coal were removed directly from the coalface as soon as possible after a cut has been taken This was to minimise degassing losses in the samples if the face or heading has been standing for a long time.

Secondly the methane content in ventilation air from the underground coal mines at Spitsbergen has been measured. From the Norwegian mines it was measured to 0.1-0.4 m3 methane per tonn coal (Bergfald & Co 2000). The low content of methane is explained with the mine's location 300-400 meter *above* sea level. The rock at Spitsbergen is porous and therefor methane has been aired through many years. Bergfald & Co has also measured methane in ventilation air from an underground mine at Spitsbergen that is located 500-700 meter *below* sea level. This Russian operated mine is not included in the Norwegian emission inventory. Methane was measured to 10 m^3 methane per tonne coal. The high emissions of methane compared with the Norwegian mines are explained with that the mountain covering the coal is deeper and more solid and methane has not been ventilated as much as in the Norwegian mines.

According to IPCC`s Good Practice Guideline the Norwegian mines at Spitsbergen are to be defined as underground mines but due to other characteristics they have emissions that is more like those from surface mines. Considering the above mentioned measurements we therefor conclude to use the 0.54 kg methane per tonne coal as emission factor when calculating methane emission from coal mining in Norway.

6.2 Recalculation of other sources

Historical National Energy Accounts are examined every year. Generally this lead to only minor changes in the historical emission inventories due to that amounts of energy are transferred form one source to another source. In this year submission there are a few minor changes in the emission inventory compared with latest submission because of amends in historical National Energy Accounts. The amendments are minor and are described in the Reporting tables Table 8(b) (Recalculation – Explanatory information).

Regarding UNFCCC sector 2.C (Metal Production): For ferro alloy the whole timeserie has been recalculated due to improved methodologies. The new data are based on reported data from each company. The emission data includes emissions from carbonatic ores, dolomite etc. Correction has been done for use of charcoal and water in the coal and coke. The percentage moisture varies from plant to plant and year to year, but averages to about 10 per cent. Due to this, emissions of CO_2 from Metal Production are reduced with 100 Gg (2%) in 1990 and 400 Gg (6%) in 1998.

Regarding UNFCCC sector 4.D (Agricultural soils): Formerly a fixed figure of 170 ktonnes of CO_2 was used annually based on an SFT calculation. Now the consumption of lime combined with an emission factor of 0.44 tonne/tonne is used. Therefor emissions of GHG from this source have been reduced by about 25%.

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Appendix 1: Comments to tables in appendix 2

The Common Reporting Format (CRF) is completed with emission and background data according to the UNFCCC reporting guideline on annual inventories adopted in November 1999 by decision 3/CP.5.

It has been resource demanding to fill in the CRF tables, but with a few adaptations we have managed to make use of the CRF. These adaptations and remarks to CRF tables are given below. Several comments have also been given in the electronic version of the CRF.

Explanations to the Norwegian emission inventory reported in the CRF tables:

- A full set of emission- and background data etc. has been given for 1990 and 1999 only, while emissions trends are given for 1990-99. The reason is that it is resource demanding to give full CRFs for all years.
- Table 8 Recalculation: Only 1998 is calculated. However, the explanations of the differences are also valid for previous years. It is a question of definition what is defined as recalculation. Is every minor change from the previous national report to UNFCCC recalculation? This should be clarified in the UNFCCC reporting guidelines.
- Cells (emission sources) are filled in with IE, NO, NE in Table 7 (Overview table for national greenhouse gas inventories (IPCC Table 8A)) only and not in every single table. Othervise empty cells indicate emission sources for which Norway has no data.
- We have given some explanations to the reported figures as cell remarks.

Adaptations of the CRF:

- Land-use change and forestry (LUCF), we have used our own reporting format for LUCF. See Appendix _Table 5.A. The reason is that the CRF does not reflect our calculation methodology. It is based on forest area, while the results from the Norwegian forest inventory are given directly in volume terms.
- Table 4.B(a) Sectoral background data for agriculture. In Table 4.B(a) additional background data are given.
- In some of the shaded cells, Norwegian emission calculations are filled in and in some cases cell formulas are amended. Explanations are given as cell remarks and put in documentation boxes in the associated table. (These remarks are only visible in the electronic version of the tables). These changes were necessary to make in order to report properly.

1. Table1s2: B35: formula changed. The original formula reads only the parts of national total, the number we have included is total CO_2 from biomass. CO_2 from biomass have not been reported in the sectorial tables to avoid confusion.
2. Table1.A(a)s1: H8, H20: includes biomass in formula. The CO_2 emissions reported are a small fraction of incinerated waste (fossil part).
3. Table1.A(a)s4: H8, H14: includes biomass in formula. The CO_2 emissions reported are a small fraction of incinerated waste (fossil part).
4. Table1.A(c): E12: includes biomass in formula. The CO_2 emissions included are a small fraction of incinerated waste (fossil part).
5. Table2(I)s1: K22: shaded cell. However, Norway considers carbide production to be a source of NO_x.

6. Table3: B10: shaded cell. However, this source may lead to emissions of CO_2, direct and indirect from NMVOC.
7. Table4s1: B25: Animals not included in this list have been added. The reporting does not allow reporting of emissions from all animals. (The module for enteric fermentation allows users to add animals.)

Preliminary remarks to the CRF:

- Level of detail: Countries with a well-established inventory system are able to fill in the CRF tables. But even these countries may face some difficulties delivering all the requested data. Consequently, one should evaluate which data are actually needed in for example a review of the reported national data to the UNFCCC. This comment is relevant to the background data as well as the emission data.
- Data format: Norway has a well-established inventory system that allows reporting at different levels of detail. The CRF, however, demands that all data are entered manually into individual cells. Norway would have preferred to report "flat files" (e.g. comma separated) according to a specified format. This would substantially reduce the time needed for preparing the CRF.
- Our general impression is that the workbook is rather big and somewhat cumbersome to use. It takes time to open and store it. It is also a problem that it is not possible for more than one person to enter data at the same time.
- The CRF does not allow reporting of data without some changes in cells and formulas (see above)
- Summary 3. Summary reports for methods and emission factors used. The countries should have the opportunity to inform whether they have used Tier 1, 2 or 3 emission factors when estimating the emissions.
- Table 8 Recalculation: Since all emissions are in CO_2-equivalents, it might be considered to also express the differences in Gg or difference scaled to total emissions This will highlight the recalculations that are most important.
- The data in Table 10s1 to 10s4 should be linked to the relevant cells in the reporting tables for the years where this is possible (at least the last year).
- Recalculations: This table could be made automatically with current and previously reported data (from Table 10 Summary).
- The level of comparison between the Reference approach and the Sectorial approach is unclear.

Appendix 2: http://www.sft.no/publikasjoner/luft/1801/ta1801-1999.xls

Reporting tables
1999

Appendix 3: http://www.sft.no/publikasjoner/luft/1801/ta1801-1990.xls

Reporting tables
1990

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Title
Greenhouse Gas Emissions in Norway 1990-1999. Reporting according to the UNFCCC guidelines.

Summary
The report presents an inventory of greenhouse gas emissions and sinks in Norway from 1990 to 1999. Emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), tetrafluoromethane (CF4), hexafluoroethane (C2F6), sulphur hexafluoride (SF6) and HFCs are described by gas and by UNFCCC source categories. Emissions are reported according to UNFCCC/IPCC common reporting format (CRF).

Subject words	
Climate changes,	Klimaendringer
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emission inventory	Utslippskartlegging
carbon dioxide	Karbondioksid
Climate convention	Klimakonvensjonen