January 2003

Emissions of greenhouse gases and long-range transboundary air pollutants in the Faroe Islands 1990-2001

Lena Lastein

Ministry of Petroleum
The Faroese Food-, Veterinary- and Environmental Agency.

CONTENT

1. Introduction

The Kingdom of Denmark (which includes Greenland and the Faroe Islands as geographical areas) together has signed the United Nations Climate Change Convention (UNFCCC). Emission information from the Faroe Islands must each year be submitted to Denmark. Until today the National Environmental Research Institute (NERI) in Denmark has calculated the emissions from the Faroe Islands as total CO_2 emissions based on total fuel sale information.

The aim of the present project is to construct an emission inventory for the Faroe Islands in 2001 according to the guidelines of the UNFCCC convention. The inventory should comprise estimates of the greenhouse gas emissions of CO_2, N_2O and CH_4 and the long-range transboundary pollutants of SO_2, NO_x, CO and NMVOC.

Another aim is to make inventories for the Faroe Islands in a consistent time series from the 1990 to 2000 using the 2001 inventory methodology. Also the project should include the evaluation of reporting model to submit the emissions.

Emissions of the greenhouse gases HFC, PFC and SF_6 have been omitted in the inventory covering the years 1990-2001, but is suggested to be included in future emission inventories.

This present report documents the activity data and emission factors used to estimate the emissions, and presents the emission results of greenhouse gases and long-range transboundary pollutants covering the years 1990-2001. The report also serves as a basis for future inventories.

The work in this project has been carried out in co-operation with NERI in Denmark who has provided council and information of emission factors for the years 1990-2001.

2. Summary

This report explains the first detailed inventory of emissions of greenhouse gases and long-range transboundary pollutants on the Faroe Islands. Emission estimates are carried out according to the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1997a. b). Special efforts have been made to collect and validate the data used in the inventory. Also it has been prioritised to evaluate a model for future emission inventories. The National Environmental Research Institute in Denmark (NERI) has mainly provided emission factors, but it is recommended that emission factors will be adjusted to Faroese circumstances in future inventories.

The emission inventory (1990-2001) can in the future be used for different purposes.

- Reporting to international protocols
- As input to air quality models for estimation and projection of local air pollution and evaluation of reduction methods
- As a basis for government evaluation of technical regulation and taxes
- As a basis for projections of emissions in the future

2.1 Activity data

Fuel combustion

The total energy use from fuel consumption 1990-2001 is presented in figure 2.1. The energy use has risen from 8.7 PJ in 1990 to 9.6 PJ in 2001 corresponding to an increase of 10%). From 1990-1993 the energy use decreased with 24%, caused by the economical fall off on the Faroe Islands in that time period. After that the energy use has increased with 45% until today (from 6.6 PJ in 1993 to 9.6 PJ in 2001).

Figure 2.2 shows the proportion of fuel use per fuel type for the time period 1990-2001 compared to the use of fuel in 1990. The figure shows that the heavy fuel amount in 2001 has increased with 33% compared to 1990 and the use of gas-diesel fuel have increased with 9%. In the opposite, the amount of gasoline fuel has decreased with 24% compared to 1990.

Figure 2.1 The total energy use from fuel combustion on the Faroe Islands. 1990-2001.

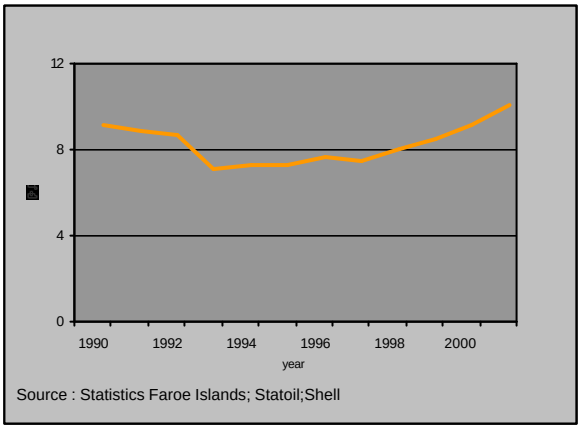
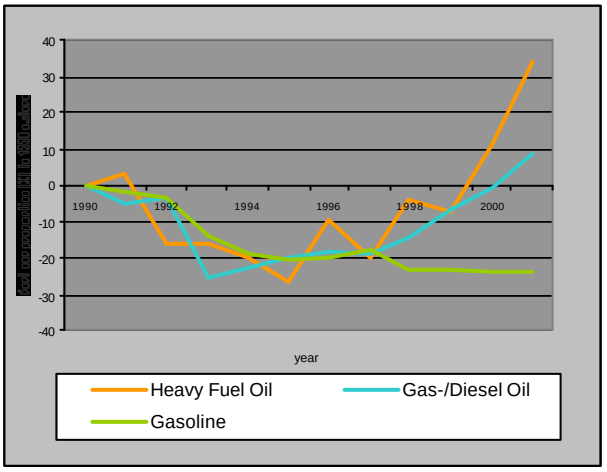


Figure 2.2 The proportion of fuel use compared to 1990 values divided by the type of fuel. 1990-2001.



Waste incineration

The total waste energy increased with 99% from 1990 to 2001 and is probably explained

by an increasing import of goods to the Faroe Islands in the same period (Figure 2.4).

Figure 2.3 Total waste energy on the Faroe Islands. 1990-2001.

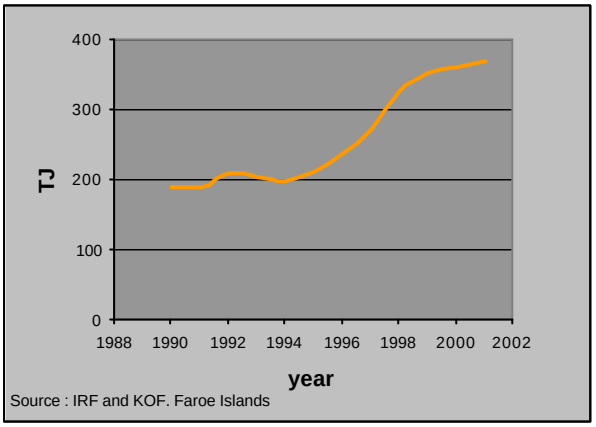
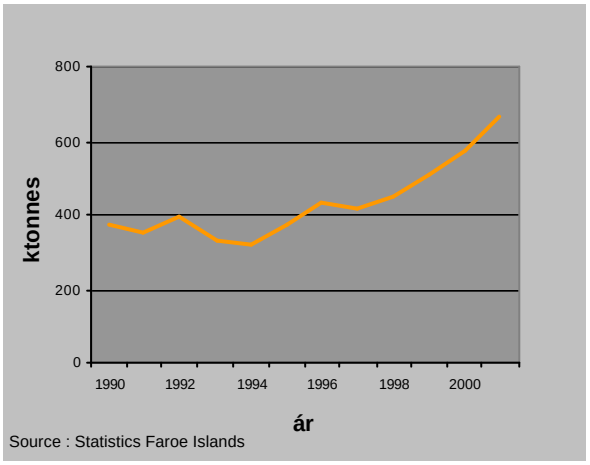


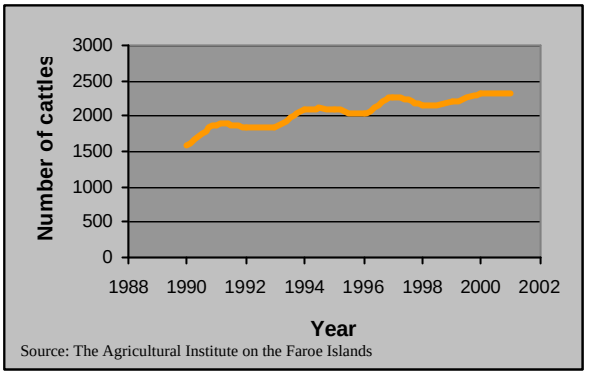
Figure 2.4 Import of goods to the Faroe Islands. 1990-2001.



Agriculture

Sheep's and cattle's are the two major animal species present in the agriculture on the Faroe Islands. The number of sheep's is assumed to be constant of 78940 in the period 1990-2001, while the number of cattle's has increased from 1582 in 1990 to 2332 in 2001 (figure 2.5).

Figure 2.5 Number of cattle's on the Faroe Islands. 1990-2001



2.2 Emission factors

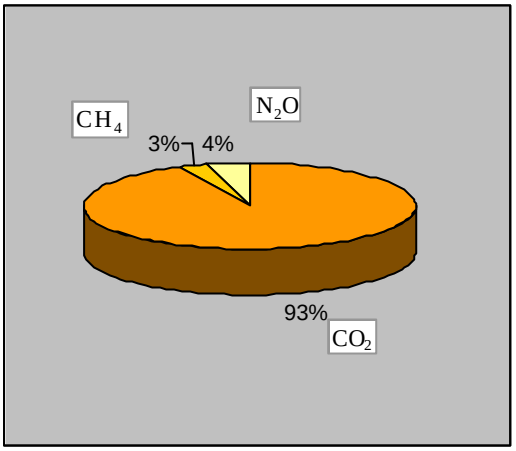
Emission factors connected to fuel combustion have been selected in co-operation with NERI. For road transport the emission factors have been calculated using results from the Danish emission inventory modified for Faroese traffic conditions. Emission factors for waste incineration are based on Danish waste composition. The emission factors for agriculture have been chosen based on information on Faroese animal stocks and are evaluated by the NP model in Denmark(J.M. Andersen.1999).

2.3 Emission results

Greenhouse gases

The composition of greenhouse gases (in CO_2 equivalents) on the Faroe Islands in 2001 is shown in Figure 2.6. CO_2 constitute 93% of the total emission of greenhouse gases, N_2O 4% and CH_4 3%.

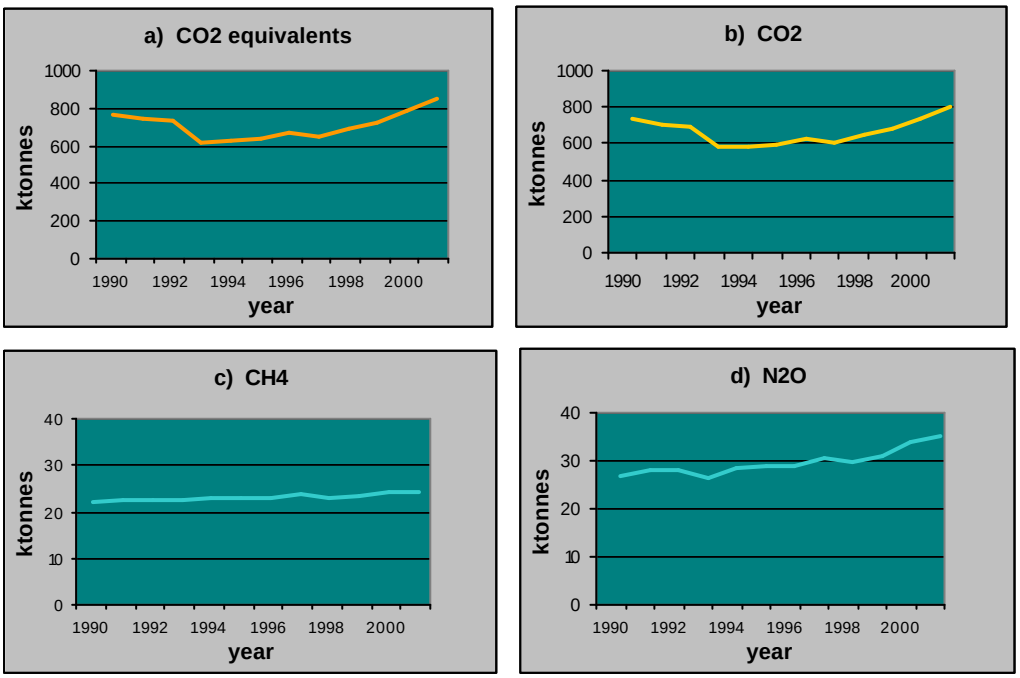
Figure 2.6 Composition of greenhouse gas emissions in the Faroe Islands weighted by GWP values. 2001



The emissions of greenhouse gases have increased with 12% from 1990 to 2001 (Figure 2.7). From 1990-1993 a decrease of 22% is observed, due to the economical decrease on the Faroe Islands in this time period. After 1993 the emissions have increased with 44 % until today (from 543 ktonnes in 1993 to 782 ktonnes in 2001).
For CO_2 alone the emissions from 1990 to 2001 follows the pattern observed for CO_2 equivalents, since CO_2 constitute of 93% of the total greenhouse gas emissions each year in the observed time period. In 2001 32% of the CO_2 emissions originated from fishery, 18% from public industry, 18% from residential, 12% from manufacturing industry and 10% from road transportation.

The total emissions of CH_4 have increased with 14% from 1990 to 2001. The increase is due to a larger number of cows on the Faroe Islands. In the same time period the emissions of N_2O have shown a 37% increase, mainly due to an emission increase from agricultural soils.

Figure 2.7 Emissions of greenhouse gases from 1990-2001 and derived CO_2 equivalents



Long-range transboundary pollutants

The emissions of NO_x have increased with 7% from 1990-2001 (figure 2.8). A minimum in the emissions is observed in 1993 (4.0 ktonnes) due to the economical decrease on the Faroe Islands. Since 1993 the emissions have increased with 46% due to an increase in fuel use in fishery, and test drills (manufacturing industry) in 2001. In 2001, 71% of the NO_x emissions originated from fishery, 8% from navigation, 7% road transportation, 6% from manufacturing industry and 6% from public electricity.

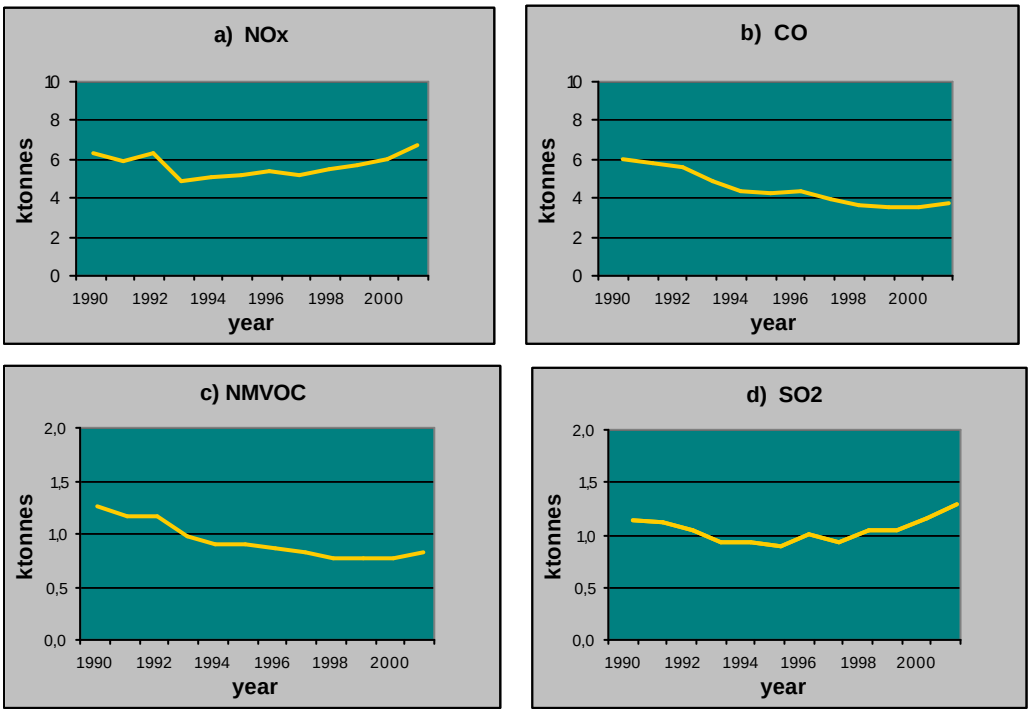
The emissions of CO and NMVOC decreased with 44% and 41%, respectively in the time period 1990-2001 (figure 2.8). For both emission species the decrease is mainly due to the introduction of gasoline catalyst private cars.

From 2000 to 2001 a CO emission increase of 6% is observed, which is mainly due to fuel use by test drills. For NMVOC an emission increase of 12% is observed from 1999 to 2001, explained by an increase in fuel use by the manufacturing industries (test drills), navigation and fishery.

In 2001 64% of the CO emissions originated from road transportation, 19% from fishery, 8% from navigation and 4% from manufacturing industry. In the same year 47% of the NMVOC emissions originated from road transportation, 26% from fishery, 17% from navigation and 7% from manufacturing industry.

The emissions of SO_2 increased with 18% in the 1990-2001 time period (figure 2.8). The increase is mainly due to increasing use of heavy fuel oil in the public industry and manufacturing industry sectors. In 2001, 54% of the SO_2 emissions originated from public industry, 26% from fishery and 15% from manufacturing industry.

Figure 2.8 Emissions of NO_x, CO , NMVOC and SO_2 from 1990-2001.



2.4 Conclusions

In the present project emission inventories was constructed for the Faroe Islands for the years 1990-2001 according to the guidelines of the UNFCCC convention. The inventory comprise estimates of the greenhouse gas emissions of CO_2, N_2O and CH_4 and the long-range transboundary pollutants of SO_2, NO_x, CO and NMVOC.

Suggestions for improvements of background data are made in the following areas in order to make the future annual inventories more precise:

The fuel data used in the emission inventory are at the present not grouped by IPCC categories, and moreover the reporting formats of the two oil companies are different. It is therefore suggested to evaluate a new common format.

The new format should also include more detailed information on fuel sale to fishing ships (according to gear) and distribution of oil sales to ships operating outside Faroese waters in more detail. Further it will be necessary to divide the group industry into sub-groups according to the UNFCCC reporting format.

In terms of transport more detailed Faroese vehicle fleet and mileage figures must be obtained for road transportation vehicles. For aviation and sea transport, specific data (aircraft/vessel type and destination airport/seaport) must be gathered in order to classify the emissions as being either domestic or international.

NERI has mainly provided the emission factors used for the emission inventory presented in this report. It is recommended that the Faroe Islands in the future adjust the emission factors on the basis on more detailed information of fuel types used on the Faroe Islands. This relates also to detailed emission information for sea vessels.

Resources must be set apart to continue the emission inventory work in the future. This implies continuous efforts to ensure a timely, consistent and accurate provision of activity data by relevant companies and institutions. Lastly it must be legally clarified where the responsibility should be placed for making the final report of the Faroese emission results.
.

3. Activity data

3.1. Fuel combustion

Statistics Faroe Islands provides the information of fuel sales divided into 8 main groups (fishing vessels, other ships, transportation, industry, trading and service, residential and communities, institutions and public electricity) as total fuel sale numbers. The fuel data from Statistics Faroe Islands originate from several sources. The main data sources are the two oil companies on the Faroe Islands. Fuel data not included in sales data from the companies are delivered directly from the consumer (Industry).

To evaluate emissions it was necessary to get information on fuel sale according to IPCC categories and by fuel type. Therefore fuel sales information was provided directly from the two oil companies on the Faroe Islands. From one of the oil companies information of fuel sales were available for all the years in the time period 1990-2001 (Føroya Shell), while information covering the years 1990-1991 were missing from the other oil company (Statoil Føroya). For these years the missing information were estimated by using fuel data from 1992 and the fuel sale proportion between the two companies, together with information of total fuel sales in 1990 and 1991.

Fuel accounts for the sector ”Manufacturing Industries and Construction” are calculated as a total fuel account for the sector, as data on disaggregated levels were not available. Fuel accounts for foreign ships and bunkering by fishing ships operating abroad Faroese waters are included under the sectors “International Bunkers”. Fuel accounts covering the years 1990-2001 are shown in appendix A and heating values for different fuel types are shown in Table 1.

Fuel type	Heating value GJ/ton
Gasolin	43.80
Gas-/Diesel Oil	42.70
Jet Fuel	43.50
Fuel Oil	40.65
Petroleum	43.50
Lubricants	41.90

Table 3.1. Heating values for different fuel types.

Figure 3.1 shows that the consumption of gas-diesel oil and heavy fuel oil have increased from 1993 to 2001, and gasoline from 1997 and onwards, while the consumption of other fuel types have been constant in the same time period The fuel consumption increased from 8.7 PJ in 1990 to 9.6 PJ in 2001, which corresponds with an increase of 10%. The gas-diesel oil share was 74% of the total fuel consumption, whilst the heavy fuel oil consumption accounted for 19% of the total fuel consumption in 2001 (figure 3.2).

Figure 3.1 Fuel use by fuel type on the Faroe Islands 1990-2001

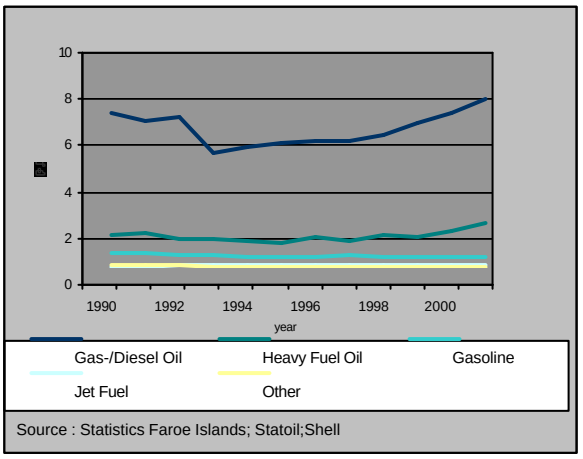
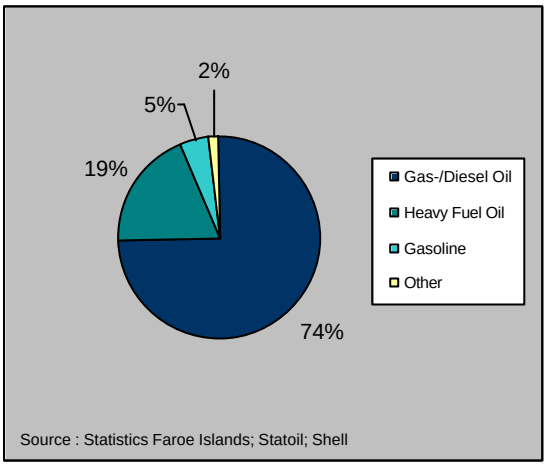


Figure 3.2 Composition of fuel types on the Faroe Islands. 2001.



The increase in the consumption of gas-diesel oil from 1993 is mainly due to the increasing fuel use in the fishery and road transport sectors as a result of an increasing fishery activity and more vehicle new sales. The increase in the heavy fuel oil consumption is mainly due to an increased fuel use in the public electricity and manufacturing industry sectors. This is a result of an increase in use of power (figure 3.5) and an increase in heavy fuel use in the fishing industry.

In 2001 the fishery sector accounted for 31% of the energy use, residential 18 %, public electricity 18%, manufacturing industry 12% and road transportation 11% (figure 3.3).

The energy consumption in the fishery sector increased with 4% from 1990-2001. A minimum is observed in 1993 (in connection with the economical decrease on the Faroe Islands by that time) and the fuel use has since that year increased 44% (from 2157 TJ in 1993 to 3108 TJ in 2001; see figure 3.4).

The energy use by fuel consumption in the residential sector decreased with 13% from 1990-2001. A minimum is observed in 1993 (connected to the economic crisis on the Faroe Islands at that time) and has since that year increased with 13% (from 1517 TJ in 1993 to 1715 TJ in 2001). The energy use in the Residential sector is closely linked to seasonal temperature variations and is relatively high because of the relatively low temperatures on the Faroe Islands.

The energy use by fuel consumption in the public electricity sector has increased by 46 % from 1990-2001. A minimum is observed in 1995 (connected to the economical decrease on the Faroe Islands by that time) and has since that year increased with 85% (from 920 TJ in 1995 to 1702 TJ in 2001). The energy increase is caused by heavy fuel use in connection with an increase in power use/capita (figure 3.5).

Figure 3.3 Composition of Energy use by consumer group.2001.

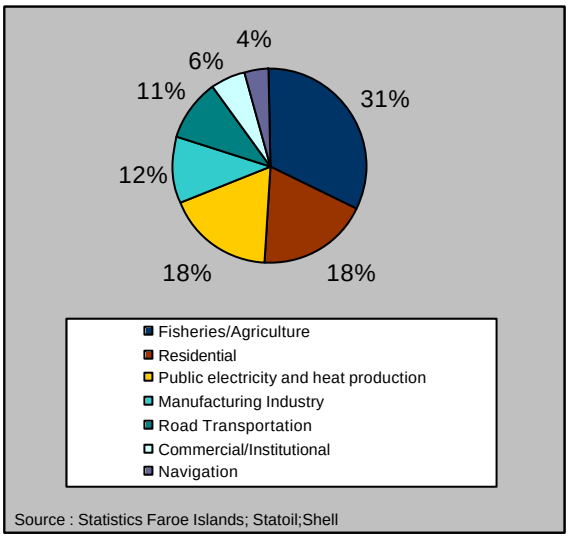


Figure 3.4 Energy use by consumer group in the Faroe Islands 1990-2001

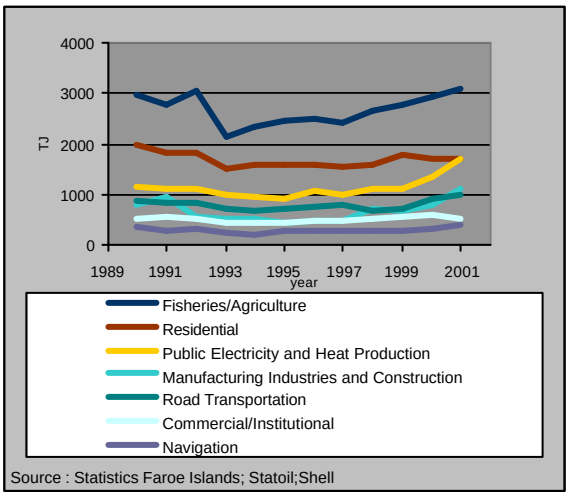
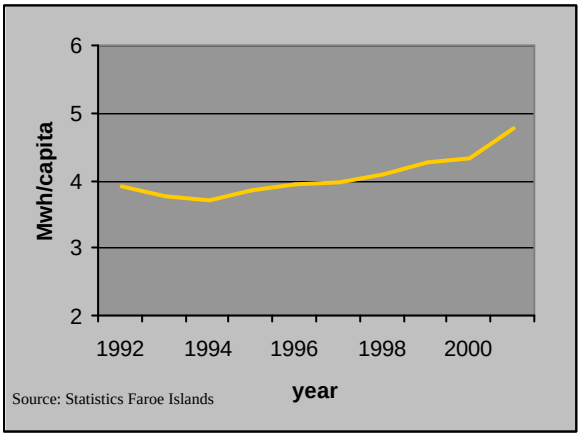


Figure 3.5 Power use (Mwh)/capita in the Faroe Islands. 1990-2001.



The energy consumption for manufacturing industries has increased with 37% from 1990-2001. A minimum is observed in 1995 (due to the economical decrease on the Faroe Islands by that time) and has since that year increased with 165% (from 422 TJ in 1995 to 1118 TJ in 2001). The pronounced increase is caused by fuel use in connection with test drillings in 2001 and an increase in use of heavy fuel in the fishing industry after 1995.

The energy consumption by road transport has increased with 17% from 1990 to 2001. A minimum is observed in 1998 and has since that increased with 52% (from 665 TJ in 1998 to 1008 TJ in 2001). Reasons for the increase are an increasing number of new sold private cars on the Faroe Islands (figure 3.6;Data Source: FVI) and an increase in mileage driven for all vehicle types in general. The consumption of diesel fuel has shown a significant increase after 1998 (figure 3.7).

Figure 3.6 Number of private cars/capita on the Faroe Islands. 1990-2001.

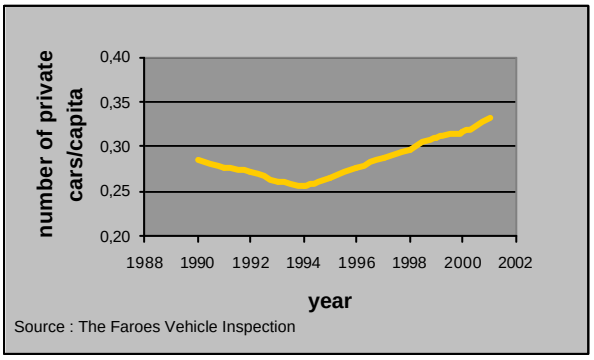
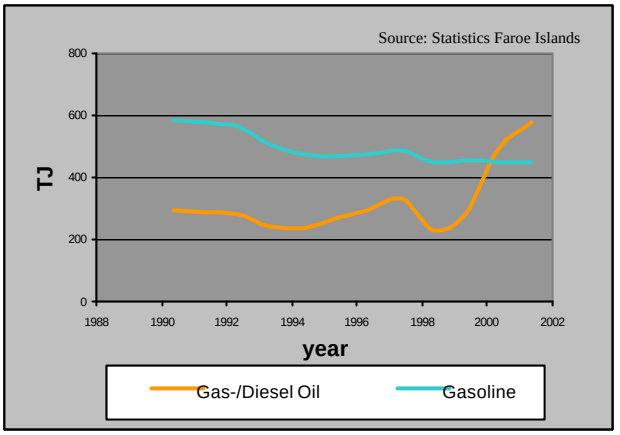


Figure 3.7 Fuel consumption by fuel type for road transportation . 1990-2001.

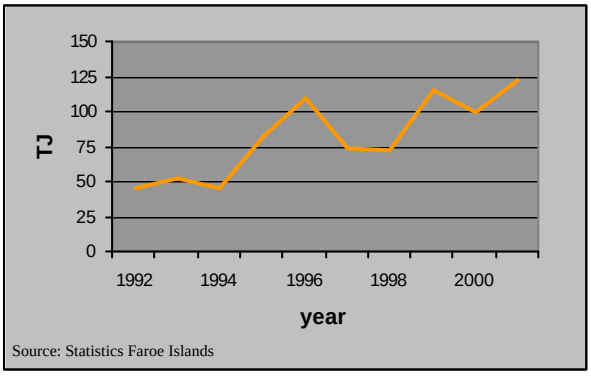


Aviation fuel use

Information on aviation fuel sales is provided by Statistics Faroe Islands for the time period 1992-2001. Information of fuel sold per destination country is not available today and efforts should be made to get more detailed information in the future. This will make it possible to separate aviation fuel use domestic and international figures and to make the subsequent emission calculations. As the Faroe Islands have accepted the United Nations Climate Convention as a part of the Kingdom Of Denmark, aviation between Denmark and the Faroe Islands is to be reported as domestic aviation. As almost all of the aviation on the Faroe Islands is between Denmark and the Faroe Islands the fuel used connected to aviation is added to the total consume of fuel oil.

Figure 3.8 shows the fuel use for aviation. The fuel use has increased by 174% from 1992 to 2001.

Figure 3.8 Energy use connected to fuel consumption from aviation on the Faroe Islands. 1992-2001.



Marine fuel use

4 fuels total are provided by the oil companies on the Faroe Islands 1990-2001:

1. Fuel sale to Faroese fishing ships bunkering in Faroese ports.
2. Fuel sale to other Faroese ships bunkering in Faroese ports.
3. Fuel sale to Faroese ships bunkering outside Faroese waters (fuel data are lacking for 1990-1991).
4. Fuel sale to foreign ships bunkering in and outside Faroese ports (fuel data are lacking for 1990-1991).

1. Fuel sale to faroese fishing ships bunkering in faroese ports

In the case of Faroese fishing vessels the fuel classification is in harmony with convention needs and fuel use and associated emissions are classified as fishery.

2. Fuel sale to other Faroese ships bunkering in Faroese ports

To satisfy the UNFCCC rules the fuel total for other faroese ships should be disaggregated into fuel sold to ships with destinations inside and outside the Kingdom of Denmark, as the Faroe Islands have accepted the United Nations Climate Convention as a part of the Kingdom Of Denmark. Destination information for other faroese ships are not available for this inventory, but it is assumed that almost all of the fuel use are used for destinations inside the Kingdom of Denmark. The fuel use connected to other faroese ships is therefore classified as navigation.

3. Fuel sale to faroese ships bunkering outside faroese waters

The fuel sale to faroese ships bunkering outside faroese waters is placed under "International Bunkers", as information on vessel type (fishing or other) and destination are missing.
The fuel sale should be split between fuel sale for fishing vessels and other vessels.

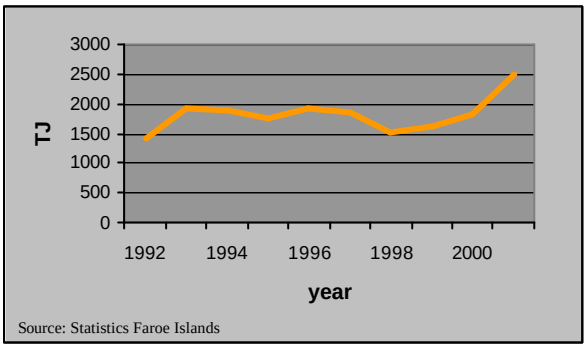
4. Fuel sale to foreign ships bunkering in and outside faroese waters

Fuel sale to foreign ships should be divided into fuel sale for ships with destinations inside and outside the Kingdom of Denmark, and classified as domestic and international, respectively. Also the fuel sale should be divided into sale to fishing vessels and other vessels.

As the fuel data lacks sufficient level of detail and is furthermore in contradiction to the general rule for fuel sale classification and subsequent emission calculations in the UNFCCC convention, all the fuel sale to foreign ships are classified under "International bunkers".

Figure 3.9 shows the total fuel sale connected to the sector International Bunkers (Marine).
The fuel use has increased 77% from 1992 to 2001.

Figure 3.9 Energy use connected to fuel consumption from marine (International bunkers) in the Faroe Islands. 1990-2001.



3.2. Waste incineration

Waste amounts and heating values covering the time period 1990-2001 are listed in Table 3.1 (Data source: IRF and KOB). The information of waste is provided by by the incineration plants on the Faroe Islands. Figure 3.10 shows the waste amounts for incineration in the time period 1990-2001. The figure shows that the energy connected to the waste amounts have significantly increased, from 183 TJ in 1990 to 364 TJ in 2001 corresponding to an increase of 99%. The increase of waste amounts seems to be correlated with the fluctuations in goods import to the Faroe Islands (Figure 3.11).

Year	Waste amount	Heating value
	tonnes	GJ/tonnes
1990	22369	8.20
1991	22392	8.20
1992	22668	9.00
1993	21030	9.40
1994	20287	9.40
1995	20526	10.00
1996	22090	10.50
1997	25374	10.50
1998	30755	10.40
1999	32974	10.50
2000	33715	10.50
2001	34681	10.50

Table 3.1 Emissions factors from waste incineration 1990-2001

Figure 3.10 Waste amounts for incineration in the Faroe Islands. 1990-2001.

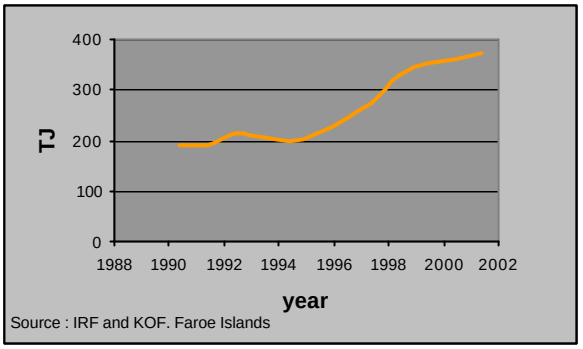
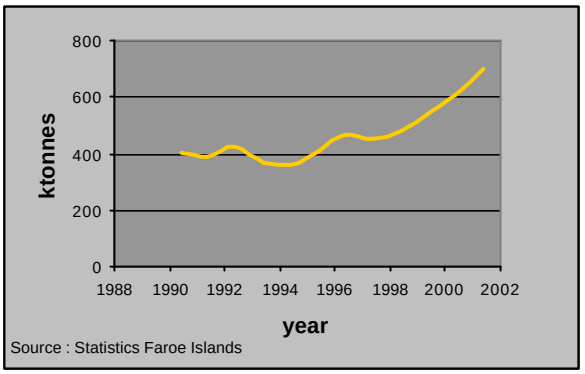


Figure 3.11 Total import to the Faroe Islands. 1990-2001



3.3 Agriculture

The activity data used to estimate the emissions of CH_4 from **e**nteric fermentation and the N_2O emissions from manure management and agricultural soils are shown in table 3.2. The number of diary cattle's has increased with 66% from 1990-2001 while the number of non-dairy cows has decreased with 49% in the same time period. The number of sheep's is assumed to be constant for the time period 1990-2001.

	Dairy cattle's	Non-dairy cattle's	Sheep's
Year	[No]	[No]	[No]
1990	1322	260	78940
1991	1567	308	78940
1992	1541	303	78940
1993	1544	303	78940
1994	1786	300	78940
1995	1797	302	78940
1996	1736	292	78940
1997	1981	290	78940
1998	1757	400	78940
1999	1843	349	78940
2000	2135	171	78940
2001	2200	132	78940

Table 3.2 Number of animals on the Faroe Islands. 1990-2001. (Source: The Agricultural Institute on the Faroe Islands)

4. Emission factors

4.1 Fuel combustion

Emissions from fuel combustion come from two main sources: stationary and mobile combustion. By stationary combustion means fuel combustion related to industrial processes, house heating and test drills. Mobile combustion includes the combustion in engines used for propulsion in the various modes of transport such as road transport, marine activities and aviation.

Emissions are calculated by multiplying energy data with an emission factor (e.g. in tonnes emission per GJ fuel). The emission factors used are mainly provided by NERI, or selected from the IPCC Guidelines (IPCC, 1997.a).

The emission factors for road traffic are calculated by NERI using background results from the Danish 1990-2001 emission inventories made with the European COPERT model (Ntziachristos et al., 2000). The Danish results are modified for Faroese traffical conditions such as other gross vehicle weights for heavy-duty vehicles and no highway driving conditions. For aviation NERI has aggregated emission factors for all flights leaving Vagar airport in 2001. The overall calculation principle is explained by Winther (2001). Due to lack of flight statistics the latter factors has been used for the years 1990-2000, but must be recalculated when better flight statistics become available.

The emission factors used to calculate emission of greenhouse gases and other gases from fuel combustion are listed in appendix B.

4.2 Waste Incineration

Emission factors concerning emissions of CO_2, N_2O and CH_4 from waste incineration in 1990-2001 are listed in Table 4.1. Emission factors for CH_4 and N_2O are selected from the IPCC Guidelines (IPCC, 1997a). CO_2 emission factors are provided by NERI and are based on a estimate of 6.4 w/w% of plastic in the municipality waste (see J.B. Illerup etc. 2000).

Table 4.1 Emission factors from waste incineration 1990-2001

Year	Emission factor CO_2 kg/GJ	Emission factor CH_4 g/GJ	Emission factor N_2O g/GJ
1990	24.44	6.00	4.00
1991	24.44	6.00	4.00
1992	22.27	6.00	4.00
1993	21.32	6.00	4.00
1994	21.32	6.00	4.00
1995	20.04	6.00	4.00
1996	19.09	6.00	4.00
1997	19.09	6.00	4.00
1998	19.41	6.00	4.00
1999	19.20	6.00	4.00
2000	19.20	6.00	4.00
2001	19.20	6.00	4.00

4.3 Agriculture

The emission factors for enteric fermentation are assumed constant for the time period 1990-2001. For sheep's the emission factors are selected from IPCC Guidelines and for cows the emission factors are provided by the National Environmental Research Institute in Denmark (J.M. Andersen 1999).

As regards manure management and agricultural soils N_2O emission factors come from NERI and are assumed constant during the time period of 1990-2001.

Table 4.2 Emission factors for Agriculture on the Faroe Islands 1990-2001

	Enteric fermentation	Manure management [kg/animal/yr]	Agricultural soils
	CH_4	N_2O	N_2O
Dairy cows	104	21.8	0.233
Non-dairy cows	37	1.6	0.285
Sheep's	8		0.192

The emission factors for all three sources should be recalculated in next years inventory, according to more detailed information on animals on the Faroe Islands.

5. Emissions of gases

In table 5.1 the total emissions of CO_2, N_2O, CH_4, SO_2, NO_x, NMVOC and CO are shown for the Faroe Islands in the time period from 1990 to 2001. More detailed emission numbers are listed in appendix C.

Table 5.1 Total emissions of CO_2, CH_4, N_2O, NO_x, NMVOC, CO and SO_2 on the Faroe Islands 1990-2001.

Year	CO_2 ktonnes	CH_4 tonnes	N_2O tonnes	NO_x tonnes	NMVOC tonnes	CO tonnes	SO_2 tonnes
1990	654.074	853	73	5497	1054	5174	925
1991	629.726	885	78	5068	966	4911	920
1992	618.997	881	78	5426	954	4696	838
1993	502.216	875	73	4040	781	4009	726
1994	510.170	906	79	4179	706	3539	721
1995	517.102	909	81	4371	690	3432	693
1996	546.756	904	81	4490	670	3464	793
1997	532.433	935	86	4361	629	3137	731
1998	572.097	908	83	4614	565	2778	835
1999	607.912	920	87	4839	559	2728	838
2000	658.089	959	97	5203	566	2706	952
2001	730.049	972	101	5884	626	2874	1092

5.1 Emissions of greenhouse gases

Figure 5.1 shows the composition of greenhouse gas emissions (CO_2, CH_4, N_2O) in 2001, calculated in GWP values. The GWP values used are 1 for CO_2, 21 for CH_4 and 310 for N_2O. CO_2 accounted for 94% of the total greenhouse gas emissions in 2001, N_2O 4% and CH_4 2%.

Figure 5.1 Combustion of the greenhouse gases CO_2, CH_4 and N_2O weighted by GWP values. 2001

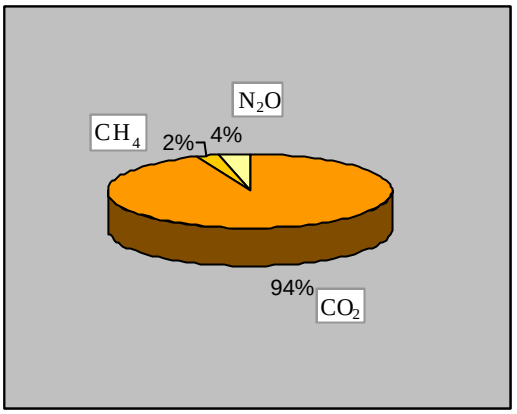
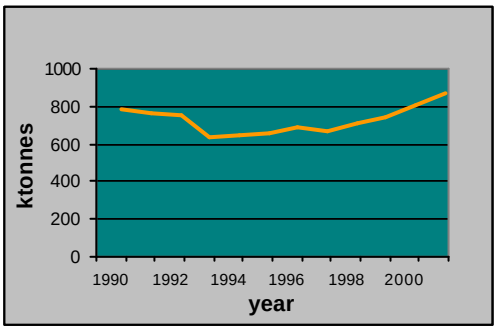


Figure 5.2 shows the total emissions of greenhouse gases (in CO_2 equivalents) in the time period 1990-2001. The total emission has increased with 12% from 1990-2001. From 1990 to 1993 a decrease of 22% is observed, due to the economical fall off on the Faroe Islands in the time period. After that the emissions have increased with 44% (from 543 ktonnes CO_2 in 1993 to 782 ktonnes CO_2 in 2001).

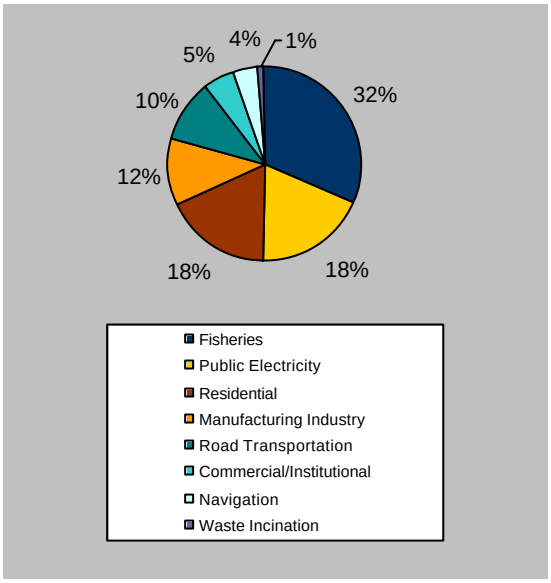
Figure 5.2 Emissions of greenhouse gases in CO_2 equivalents 1990-2001.



5.1.1 Carbon dioxide (CO_2)

Of the emissions of CO_2 in 2001 32% originated from fisheries, 18% from public electricity, 18% from residential, 12% from manufacturing industry and 10% from road transportation (figure 5.3).

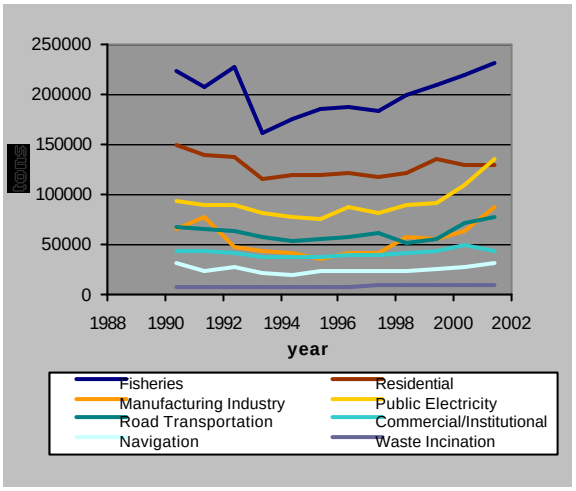
Figure 5.3. Composition of CO_2 emissions by IPCC sectors in the Faroe Islands. 2001.



The emissions from fisheries have increased with 44% from 1993-2001, and in the same period the emissions from residential increased with 13% (figure 5.4). The emissions from manufacturing industry increased with 164% from 1995-2001, which partly is due to increasing use of heavy fuel oil in the fishery industry and use of fuel oil in connection with test drillings in 2001. Test drillings accounted for 21% of the total CO_2 emissions in manufacturing industries.

The emissions from public industry increased with 85% in the time period 1995-2001 (figure 5.4). The increase is due to an increasing use of heavy fuel oil caused by a rise in power demand for all user groups in the Faroe Islands.

Figure 5.4. Emissions of CO_2 by IPCC sectors in the Faroe Islands. 1990-2001.



5.1.2 Methane (CH_4)

In 2001, 95% of the total CH_4 emissions originated from agriculture (enteric fermentation) and the remaining 5% from other sources (figure 5.5). The emissions from agriculture have increased with 13% from 1990-2001 (figure 5.6). The increase is due to a rise in the number of cows in the time period 1990-2001(table 3.2).

Figure 5.5. Composition of CH_4 emissions by IPCC sectors on the Faroe Islands . 2001

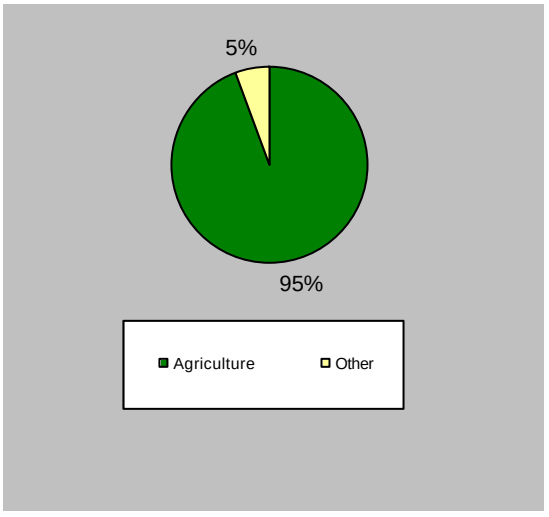


Figure 5.6 Emissions of CH_4 by IPCC sectors on the Faroe Islands. 1990-2001.

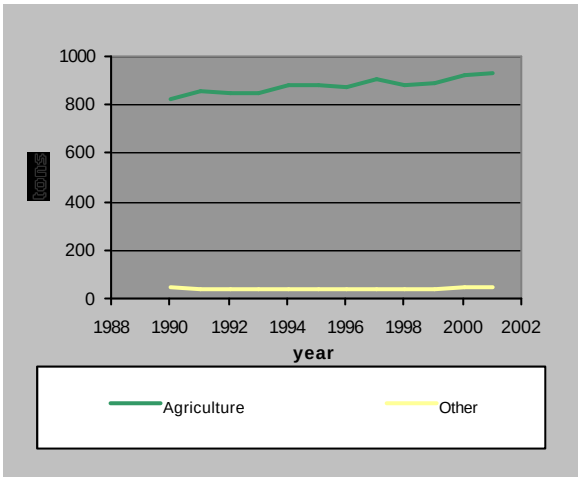
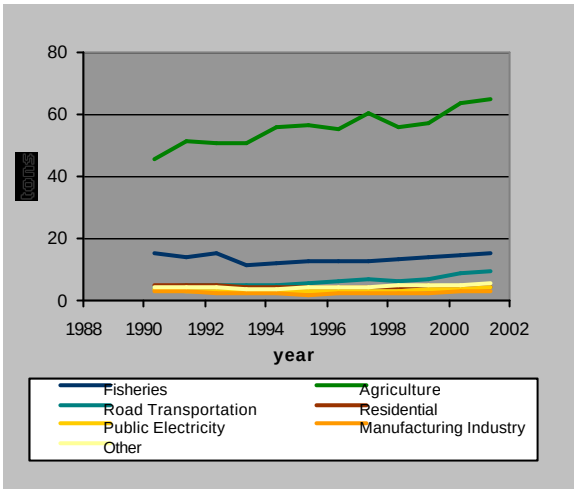


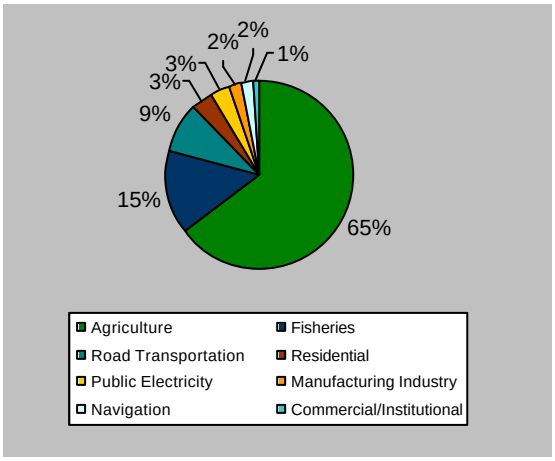
Figure 5.8 Emissions of N_2O by IPCC sectors on the Faroe Islands. 1990-2001.



5.1.3 Nitrous oxide (N_2O)

Of the emissions in 2001, 65% originated from agriculture (Manure Management and Agriculture Soils), 15% from Fisheries and 9% from Transportation (figure 5.7). The emissions from agriculture have increased with 43% from 1990-2001, while the emissions from fisheries increased with 4% in the same period (figure 5.8). The emissions from road transportation increased with 163% from 1990-2001, which is mainly due to the introduction of gasoline private cars equipped with catalytic converters in the beginning of the 1990s.

Figure 5.7. Composition of N_2O emissions by IPCC sectors on the Faroe Islands. 2001.



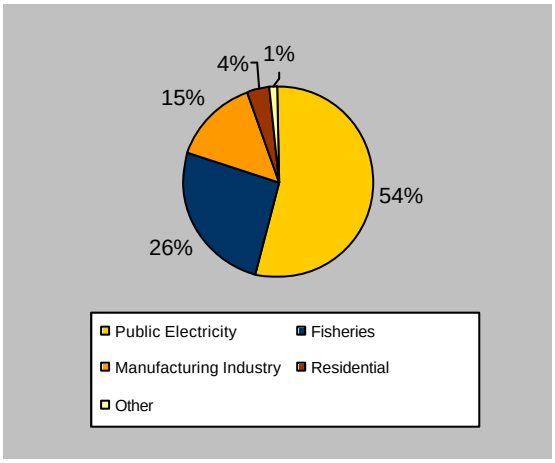
5.2 Emissions of other gases

5.2.1 Sulphur dioxide (SO_2)

The total emissions of SO_2 increased with 18% from 1990-2001 (table 5.1).

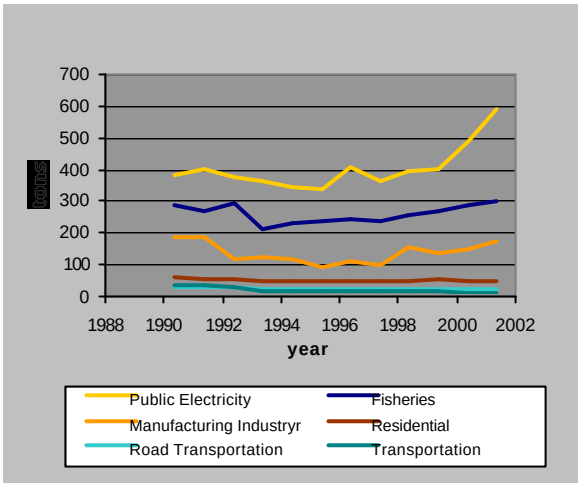
In 2001, 54% of the SO_2 emissions originated from public electricity, 26% from fisheries, 15% from manufacturing industry and 4% from residential (figure 5.9).

Figure 5.9. Composition of SO_2 emissions by IPCC sectors on the Faroe Islands. 2001



The emissions from public electricity have increased with 79% from 1995-2001, which is mainly due to an increase in the use of heavy fuel oil (figure 5.10). The emissions from fisheries increased with 44% from 1993 to 2001, while the emissions from manufacturing industry increased with 103% from 1995-2001. The latter increase is partly due to more heavy fuel oil being used in the fishery industry and the use of fuel oil for test drillings in 2001.

Figure 5.10 Emissions of SO_2 by IPCC sectors on the Faroe Islands. 1990-2001.



5.2.2 Nitrogen oxides (NO_x)

The total emissions of NO_x increased with 7% from 1990-2001 (table 5.1).

Of the emissions in 2001 71% originated from fisheries, 8% from navigation and 7% from transportation (figure 5.11). The emissions from fisheries have increased with 44% from 1993-2001. The emissions from road transportation have decreased with 48% from 1990 to 1999 (figure 5.12), due to the stepwise strengthening of emission standards for all vehicle types. From 1999 and onwards the emissions have increased with 28% (1999-2001) caused by a rising number of vehicles and an increase in traffic. The emissions from navigation increased with 87% from 1994 to 2001.

Figure 5.11. Composition of NO_x emissions by IPCC sectors on the Faroe Islands. 2001

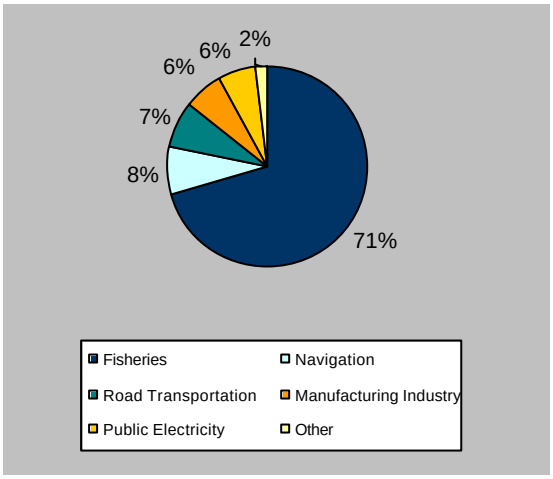
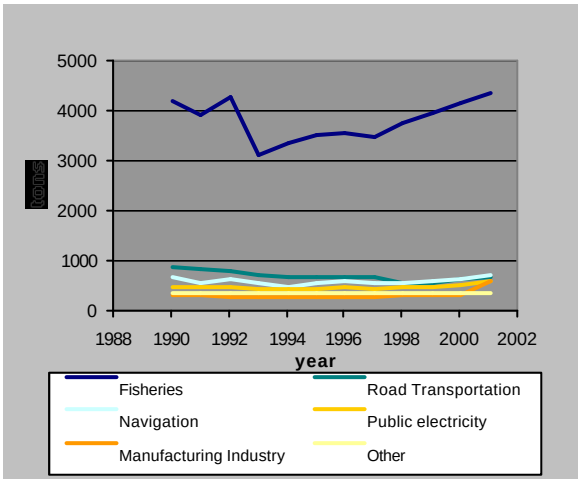


Figure 5.12 Emissions of NO_x by IPCC sectors on the Faroe Islands. 1990-2001.



5.2.3 Carbon monoxide (CO)

The total emissions of CO decreased with 44% from 1990-2001 (table 5.1).

In 2001, 64% of the CO emissions originated from transportation, 19% from fisheries and 8% from navigation (figure 5.13).

The emissions from transportation have decreased with 57% from 1990-2001(figure 5.18). The decrease observed is mainly due to use of catalytic converters for gasoline private cars.

The emissions from fisheries have increased with 34% from 1993 to 2001, while the emissions from navigation have increased with 86% from 1994-2001 (figure 5.14).

Figure 5.13. Composition of CO emissions by IPCC sectors on the Faroe Islands. 2001

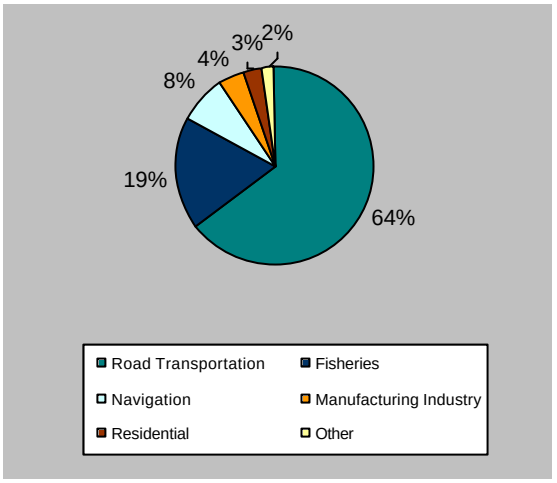
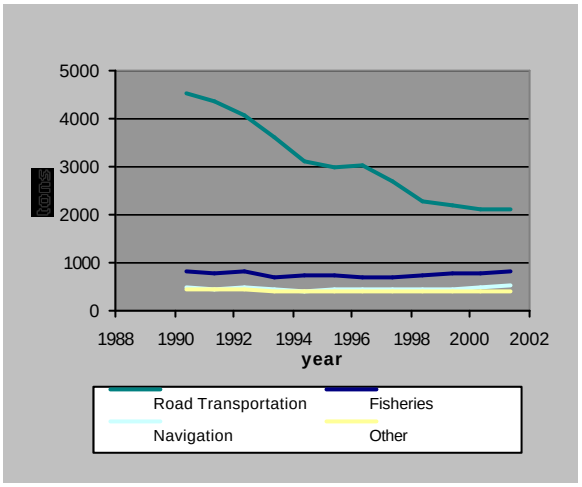


Figure 5.14 Emissions of CO by IPCC sectors on the Faroe Islands. 1990-2001.



5.2.4 Non-methane volatile organic compounds (NMVOC)

The total emissions of NMVOC decreased with 41% from 1990-2001 (table 5.1).

Of the emissions in 2001, 47% originated from road transportation, 27% from fisheries, 17% from navigation and 7% from manufacturing industry (figure 5.15). The emissions from transportation have decreased with 61% from 1990-2001 (figure 5.16). The emissions from fisheries have increased with

27% from 1993 to 2001, while the emissions from navigation have increased with 87% from 1994-2001 (figure 5.16).

Figure 5.15. Composition of NMVOC emissions by IPCC sectors on the Faroe Islands. 2001

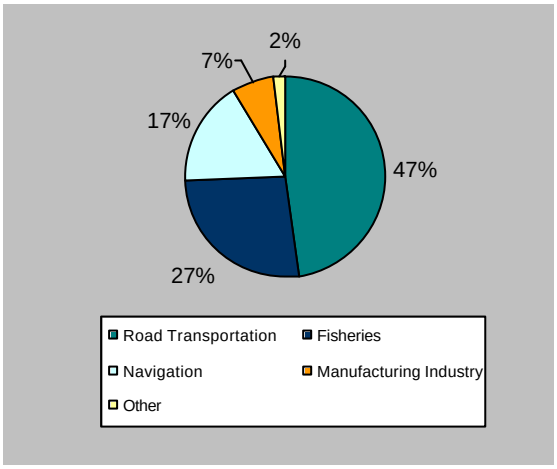
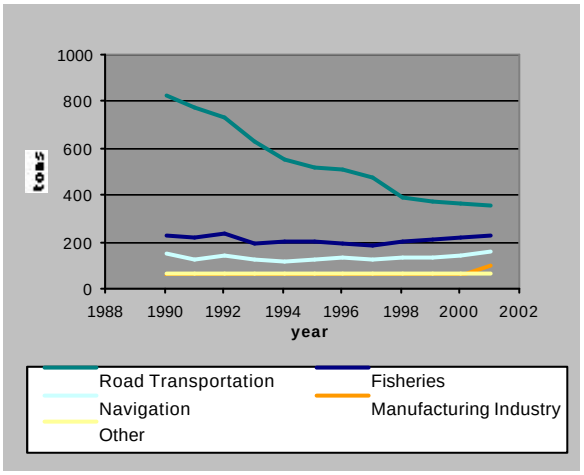


Figure 5.16 Emissions of NMVOC by IPCC sectors on the Faroe Islands. 1990-2001.



6. Conclusions

In the present project an emission inventory was constructed for the Faroe Islands in 2001 according to the guidelines of the UNFCCC convention. The inventory comprise estimates of the greenhouse gas emissions of CO_2, N_2O and CH_4 and the long-range transboundary pollutants of SO_2, NO_x, CO and NMVOC.

Inventories were also made for the Faroe Islands in a consistent time series from 1990 to 2000 using the 2001 inventory methodology. The inventory format is feasible to use in terms of 1) input activity data and emission factors, 2) the subsequent emission calculations and 3) the further submission of total emission results.

Suggestions for improvements in the following areas in order to make the future annual inventories more precise are:

- The fuel data used in the estimations of the emissions are at the present not available grouped by IPCC categories. It is therefore necessary to change the reporting of data from the oil companies. As the reporting format from the two oil companies is different it is suggested to develop a new common format.

- The new format should also include more detailed information on fuel sale to fishing ships (according to gear) and distribution of oil sales to ships operating outside Faroese waters in more detail. Further it will be necessary to divide the group industry into sub-groups according to the UNFCCC reporting format.

- In terms of transport more detailed Faroese vehicle fleet and mileage figures must be obtained for road transportation vehicles. For aviation and sea transport, specific data (aircraft/sea vessel type and destination airport/seaport) must be gathered in order to classify the emissions as domestic or international.

- NERI has mainly provided the emission factors used for the emission inventory presented in this report. It is recommended that the Faroe Islands in the future adjust the emission factors on the basis on more detailed information of fuel types on the Faroe Islands. This relates also to detailed emission information for sea vessels.

- Resources must be set apart to continue the emission inventory work in the future. This implies continuous efforts to ensure a timely, consistent and accurate provision of activity data by relevant companies and institutions. Lastly it must be legally clarified where the responsibility should be placed for making the final report of the Faroese emission results.

References

IPCC (1997a): Greenhouse Gas Inventory. Workbook. IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, London: Intergovernmental Panel on Climate Change.

IPCC (1997b): Greenhouse Gas Inventory. Reference Manual. Revised 1996. IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, London: Intergovernmental Panel on Climate Change.

Andersen, M.A. (1999): Estimering af emission af methan og lattergas fra landbruget. Miljø- og Energiministeriet. Danmarks Miljøundersøgelser.

Illerup, B. J., Winther, M. and E. Lyck (1999): Hvor kommer luftforureningen fra ?- fakta om kilder, stoffer og udvikling. Miljø- og Energiministeriet, Danmarks Miljøundersøgelser.

Illerup, B. J., Lyck, E., Winther, M. and E. Rasmussen (2000): Denmark's National Inventory Report Submitted under the United Nations Framework Convention on Climate Change.

Flugsrud, K., Gjerald, E., Haakonsen, G., Holtskog, S., Høie, H., Rypdal, K., Tornsjø, B. and F. Wiedeman (2000): The Norwegian Emission Inventory. Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants.

Ntziachristos, L., Samaras, Z. (2000): COPERT III Computer Programme to Calculate Emissions from Road Transport - Methodology and Emission Factors (Version 2.1). Tehnical report No 49. European Environment Agency, November 2000, Copenhagen.

Winther, M. (2001): 1998 Fuel Use and Emissions for Danish IFR Flights. Environmental Project no. 628, 2001. 112 p. Danish EPA. Prepared by the National Environmental Research Institute, Denmark. Electronic report at homepage of Danish EPA http://www.mst.dk/udgiv/Publications/2001/87-7944-661-2/html/.

Appendix A

Table A0. Fuel sources. 1990-2001.

IPCC code	Sector	Fuel source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
			tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1.A.1	Public electricity and heat production	Gas/Diesel	6066	3495	4958	3426	3498	2786	2603	2947	4066	3928	4247	6370
		Heavy Fuel Oil	22261	23715	21902	21362	20076	19716	24172	21562	23170	23689	29099	35192
		Lubricating Oil			1	3	2	2	1	2	1	1	1	1
1.A.2	Manufacturing Industries and construction	Gas/Diesel	7342	11467	6705	4848	4625	4637	5056	5875	7126	8286	9482	15736
		Heavy Fuel Oil	12284	11740	7033	7612	7541	5478	6971	6081	9996	8375	9324	10906
		Petroleum	3	3	2	2	3	2	1	2	2	2	2	57
		Lubricating Oil	80	126	68	27	23	31	36	41	49	59	59	3
1.A.3.a	Civil Aviation	Jet Fuel			1000	1161	991	1848	2460	1639	1607	2606	2228	2743
1.A.3.b	Road transportation	Gas/Diesel	6613	6485	6373	5470	5242	6014	6594	7504	5144	6381	11119	13227
		Gasoline	13177	12922	12698	11332	10639	10450	10564	10837	10089	10136	10010	10023
		Petroleum	16	17	25	15	16	10	10	19	11	10	4	2
		Lubricating Oil	64	62	61	47	49	62	70	80	69	40	87	92
1.A.3.d	Navigation	Gas/Diesel	8426	6242	7611	5730	4867	6098	6414	6191	6327	6855	7420	9105
		Petroleum	144	171	212	66	10	22	16	17	26	26		
		Lubricating Oil	121	143	179	128	30	32	42	58	51	130	162	84
1.A.4.a	Commercial/Institutional	Gas/Diesel	12130	12460	11795	10274	10583	10796	11043	11207	11872	12750	14390	12503
		Petroleum	193	198	187	157	174	15	114	12	10	10	6	9
		Lubricating Oil	25	26	25	20	18	15	21	16	28	33	56	66
1.A.4.b	Residential	Gas/Diesel	45978	42988	42552	35426	36824	36817	37097	35946	37543	41853	39767	40136
		Gasoline			2		2	2	1	1	1	1	1	
		Petroleum	2	2	116	78	70	58		42	34	30	28	22
		Lubricating Oil	125	117	18	14	15	9	8	9	9	9	10	8
1.A.4.c	Fisheries/Agriculture	Gas/Diesel	69338	64364	70822	50274	54657	57313	58218	56724	61814	65077	68581	72288
		Gasoline	24	23	25	33	42	29						
		Petroleum	3	2	2			2	1	1	1	1		1
		Lubricating Oil	324	218	239	213	270	413	445	248	282	318	546	496
	Total	**Gas/Diesel**	**155893**	**147501**	**150816**	**115448**	120296	124461	127025	126394	133892	145130	155006	169365
		Gasoline	**13201**	**12945**	**12725**	**11365**	10683	10481	10565	10838	10090	10137	10011	10023
		Heavy Fuel Oil	**34545**	**35455**	**28935**	**28974**	27617	25194	31143	27643	33166	32064	38423	46098
		Petroleum	**361**	**393**	**544**	**318**	273	109	142	93	84	79	40	91
		Lubricating Oil	**739**	**692**	**591**	**452**	407	564	623	454	489	590	921	750
		Jet Fuel			**1000**	**1161**	991	1848	2460	1639	1607	2606	2228	2743
	International bunkers : Marine	Gas/Diesel			26085	38172	37755	36659	40812	37628	31507	36313	41927	55791
		Heavy Fuel Oil			7187	6932	6532	4969	4121	6013	3943	2081	980	2743

Appendix B

Table B.1 Emission factors for CO_2 1990-2001.

IPCC code	Sector	Year	Gas /Diesel oil	Gasoline	Heavy fuel oil	Petroleum	Jet fuel
			kg/GJ	kg/GJ	kg/GJ	kg/GJ	kg/GJ
1.A.1	Public electricity and heat production	1990-2001	74		78		
1.A.2	Manufacturing Industries and construction	1990-2001	74		78	72	
1.A.3.b	Road transportation	Tab. B.9	74	73			
1.A.3.d	Navigation	1990-2001	74		78	72	
1.A.4.a	Commercial/Institutional	1990-2001	74			72	
1.A.4.b	Residential	1990-2001	74			72	
1.A.4.c	Fisheries/Agriculture	1990-2001	74	73			
	International bunkers : Aviation			73			72
	International bunkers : Marine		74		78		

Table B.2 Emission factors for CH_4 1990-2001

IPCC code	Sector	Year	Gas/Diesel oil	Gasoline	Heavy fuel oil	Petroleum	Jet fuel
			g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
1.A.1	Public electricity and heat production	1990-2001	1.50		3.00		
1.A.2	Manufacturing Industries and construction	1990-2001	1.50		3.00	1.50	
1.A.3.b	Road transportation	Tab. B.9					
1.A.3.d	Navigation	1990-2001	1.69			1.50	
1.A.4.a	Commercial/Institutional	1990-2001	7.00			1.50	
1.A.4.b	Residential	1990-2001	7.00			1.50	
1.A.4.c	Fisheries/Agriculture	1990-2001	1.69	108.10		1.50	
	International bunkers : Aviation		21.90				0,65
	International bunkers : Marine		1.69		1.76		

Table B.3 Emission factors for N_20 1990-2001.

IPCC code	Sector	Year	Gas/Diesel oil	Gasoline	Heavy fuel oil	Petroleum	Jet fuel
			g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
1.A.1	Public electricity and heat production	1990-2001	2.00		2.00		
1.A.2	Manufacturing Industries and construction	1990-2001	2.00		2.00	3.00	
1.A.3.b	Road transportation	Tab. B.9					
1.A.3.d	Navigation	1990-2001	4.70			3.00	
1.A.4.a	Commercial/Institutional	1990-2001	2.00			3.00	
1.A.4.b	Residential	1990-2001	2.00			3.00	
1.A.4.c	Fisheries/Agriculture	1990-2001	4.70	0.52		3.00	
	International bunkers : Aviation		2.00				2.68
	International bunkers : Marine		4.70		4.90		

Table B.4 Emission factors for SO_2 1990-2001.

IPCC code	Sector	Year	Gas/Diesel oil	Gasoline	Heavy fuel oil	Petroleum	Jet fuel
			g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
1.A.1	Public electricity and heat production	1990-2001	23.00		403.00		
1.A.2	Manufacturing Industries and construction	1990-2001	23.00		344.00	573.00	
1.A.3.b	Road transportation	Tab. B.9					
1.A.3.d	Navigation	1990-2001	93.68			573.00	
1.A.4.a	Commercial/Institutional	1990-2001	23.00			573.00	
1.A.4.b	Residential	1990-2001	23.00			573.00	
1.A.4.c	Fisheries/Agriculture	1990-2001	93.68	4.60		573.00	
	International bunkers : Aviation		4.59				2.30
	International bunkers : Marine		468.38		1641.94		

Table B.5 Emission factors for NO_x 1990-2001

IPCC code	Sector	Year	Gas/Diesel oil	Gasoline	Heavy fuel oil	Petroleum	Jet fuel
			g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
1.A.1	Public electricity and heat production	1990-2001	52.00		142.00		
1.A.2	Manufacturing Industries and construction	1990-2001	52.00		142.00	105.00	
1.A.3.b	Road transportation	Tab. B.9					
1.A.3.d	Navigation	1990-2001	1334.90			105.00	
1.A.4.a	Commercial/Institutional	1990-2001	52.00			105.00	
1.A.4.b	Residential	1990-2001	52.00			105.00	
1.A.4.c	Fisheries/Agriculture	1990-2001	1334.90	64.34		105.00	
	International bunkers : Aviation		859.00				205.14
	International bunkers : Marine		2037.50		2127.10		

Table B.6 Emission factors for NMVOC 1990-2001

IPCC code	Sector	Year	Gas/Diesel oil	Gasoline	Heavy fuel oil	Petroleum	Jet fuel
			g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
1.A.1	Public electricity and heat production	1990-2001	1.50		3.00		
1.A.2	Manufacturing Industries and construction	1990-2001	1.50		3.00	1.50	
1.A.3.b	Road transportation	Tab. B.9					
1.A.3.d	Navigation	1990-2001	54.50			1.50	
1.A.4.a	Commercial/Institutional	1990-2001	3.00			1.50	
1.A.4.b	Residential	1990-2001	3.00			1.50	
1.A.4.c	Fisheries/Agriculture	1990-2001	54.50	10809.60		1.50	
	International bunkers : Aviation		1242.60				6.14
	International bunkers : Marine		54.50		56.90		

Table B.7 Emission factors for CO 1990-2001.

IPCC code	Sector	Year	Gas/Diesel oil	Gasoline	Heavy fuel oil	Petroleum	Jet fuel
1.A.1	Public electricity and heat production	1990-2001	47.00		15.00		
1.A.2	Manufacturing Industries and construction	1990-2001	47.00		15.00	1000	
1.A.3.b	Road transportation	Tab. B.9					
1.A.3.d	Navigation	1990-2001	173.3			1000	
1.A.4.a	Commercial/Institutional	1990-2001	47.00			1000	
1.A.4.b	Residential	1990-2001	47.00			1000	
1.A.4.c	Fisheries/Agriculture	1990-2001	173.30	18485.10		1000	
	International bunkers : Aviation		173.30				49.76
	International bunkers : Marine		6972.00		180.9		

Table B.8 Emission factors for road traffic 1990-2001

	CO_2		CH_4		N_2O		SO_2		NO_x		NMVOC		CO	
	kg/GJ	kg/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline
1990	74.00	73.00	9.25	36.69	7.13	2.20	93.68	2.28	609.69	817.41	226.62	1225.80	529.72	7090.55
1991	74.00	73.00	9.26	38.59	7.20	2.95	93.68	2.28	607.58	776.65	230.81	1160.92	534.50	6933.91
1992	74.00	73.00	9.20	39.26	7.18	3.65	60.89	2.28	607.64	743.63	227.92	1107.62	529.93	6546.09
1993	74.00	73.00	9.40	41.97	7.14	4.31	23.42	2.28	609.94	708.41	227.09	1043.76	529.48	6447.99
1994	74.00	73.00	8.76	42.74	7.22	5.37	23.42	2.28	588.40	657.76	220.33	951.25	507.51	5843.64
1995	74.00	73.00	8.59	45.22	7.18	6.14	23.42	2.28	577.52	617.32	212.05	890.96	481.02	5625.73
1996	74.00	73.00	8.48	49.26	7.20	6.78	23.43	2.28	565.09	580.91	210.06	842.94	464.91	5624.61
1997	74.00	73.00	8.23	46.01	7.24	7.84	23.42	2.28	544.18	530.44	203.59	739.04	440.51	4816.18
1998	74.00	73.00	8.05	42.93	7.30	8.45	23.42	2.28	526.51	489.69	198.93	664.70	418.76	4350.56
1999	74.00	73.00	7.78	42.11	7.39	9.04	12.88	2.28	505.38	440.66	191.89	596.47	396.85	4069.99
2000	74.00	73.00	7.43	40.85	7.45	9.55	2.34	2.28	485.52	403.62	181.85	505.62	372.99	3812.17
2001	74.00	73.00	7.24	40.89	7.49	10.03	2.34	2.28	470.69	364.90	176.19	452.63	354.53	3746.72

Appendix C

Table C.1 Emissions of CO_2 1990-2001.

IPCC code	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		ktonnes	ktonnes	ktonnes	ktonnes	ktonnes	ktonnes	ktonnes	ktonnes	ktonnes	ktonnes	ktonnes	ktonnes
1.A.1	Public electricity and heat production	89.750	86.237	85.111	78.558	74.708	71.317	84.867	77.679	86.313	87.522	105.684	131.711
1.A.2	Manufacturing Industries and construction	62.162	73.470	43.495	39.463	38.538	32.030	38.083	37.854	54.220	52.746	59.534	84.555
1.A.3.a	Civil aviation	3.132 *	3.132 *	3.132	3.636	3.104	5.788	7.705	5.133	5.033	8.162	6.978	8.591
1.A.3.b	Road transportation	63.071	61.850	60.779	53.536	50.607	52.512	54.753	58.565	48.552	52.710	67.669	74.543
1.A.3.d	Navigation	27.264	20.481	24.989	18.402	15.424	19.365	20.337	19.639	20.106	21.775	23.446	28.770
1.A.4.a	Commercial/Institutional	39.185	40.250	38.100	33.160	34.212	34.180	35.399	35.465	37.558	40.332	45.496	39.547
1.A.4.b	Residential	145.843	136.360	134.977	112.285	116.674	116.598	117.223	113.772	118.783	132.384	125.784	126.920
1.A.4.c	Fisheries/Agriculture	219.183	203.459	223.871	158.960	172.838	181.198	183.962	179.241	195.324	205.635	216.702	228.420
6.C	Waste incineration	4.483	4.488	4.543	4.215	4.066	4.113	4.428	5.086	6.208	6.648	6.797	6.992
	Total	**654.074**	**629.725**	**618.998**	**502.215**	**510.171**	**517.102**	**546.756**	**532.434**	**572.097**	**607.912**	**658.089**	**730.048**
	International bunkers : Marine			105.211	142.595	140.009	131.590	142.024	137.962	112.058	121.340	135.588	176.288

the emissions listed for civil aviation in 1990 and 1991 are set equal to the values in 1992 while data were missing for these years.

Table C.2 Emissions of CH_4 1990-2001.

IPCC code	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		tonnes	tonnes	tonnes	tonnes	tonnes	Tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1.A.1	Public electricity and heat production	3.10	3.12	2.99	2.82	2.67	2.58	3.11	2.82	3.09	3.14	3.82	4.70
1.A.2	Manufacturing Industries and construction	1.97	2.17	1.29	1.24	1.22	0.97	1.17	1.12	1.68	1.55	1.74	3.05
1.A.3.a	Civil Aviation	0.03 *	0.03 *	0.03 *	0.03 *	0.03 *	0.05 *	0.07 *	0.05 *	0.05 '	0.07 *	0.06 *	0.08 *
1.A.3.b	Road transportation	15.83	16.07	15.95	14.61	13.79	15.75	18.05	18.93	13.14	15.14	23.07	26.79
1.A.3.d	Navigation	0.62	0.46	0.56	0.42	0.35	0.44	0.46	0.45	0.46	0.50	0.54	0.66
1.A.4.a	Commercial/Institutional	3.64	3.74	3.54	3.08	3.17	3.23	3.31	3.35	3.55	3.81	4.30	3.74
1.A.4.b	Residential	13.76	12.87	12.74	10.59	11.28	11.02	11.09	10.75	11.23	12.52	11.89	12.00
1.A.4.c	Fisheries/Agriculture	5.12	4.76	5.23	3.79	4.15	4.28	4.20	4.09	4.46	4.70	4.95	5.22
4.A	Enteric Fermentation	778.63	805.88	803.00	803.31	828.36	829.58	822.87	848.27	829.05	836.11	859.89	865.20
4.B	Manure Management	29.30	34.73	34.16	34.22	39.50	39.75	38.40	43.75	39.04	40.83	46.91	48.27
6.C	Waste Incineration	1.10	1.10	1.22	1.19	1.14	1.23	1.39	1.60	1.92	2.08	2.12	2.18
	Total	**853.10**	**884.93**	**880.71**	**875.30**	**905.66**	**908.88**	**904.12**	**935.18**	**907.67**	**920.45**	**959.29**	**971.89**
	International bunkers : Marine			2.40	3.25	3.19	3.00	3.24	3.15	2.56	2.77	3.10	4.03

the emissions listed for civil aviation in 1990 and 1991 are set equal to the values in 1992 while data were missing for these years

Table C.3 Emissions of N_2O 1990-2001.

IPCC code	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		tonnes	tonnes	tonnes	tonnes	tonnes	Tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1.A.1	Public electricity and heat production	2.33	2.23	2.20	2.03	1.93	1.84	2.19	2.00	2.23	2.26	2.73	3.41
1.A.2	Manufacturing Industries and construction	1.63	1.93	1.14	1.03	1.01	0.84	1.00	1.00	1.42	1.39	2.03	2.24
1.A.3.a	Civil Aviation	0.12 *	0.12 *	0.12	0.14	0.12	0.22	0.29	0.19	0.19	0.31	0.26	0.32
1.A.3.b	Road transportation	3.28	3.69	4.01	3.81	4.12	4.66	5.16	6.04	5.34	6.03	7.72	8.63
1.A.3.d	Navigation	1.71	1.27	1.56	1.16	0.98	1.23	1.29	1.24	1.27	1.38	1.49	1.83
1.A.4.a	Commercial/Institutional	1.06	1.09	1.03	0.90	0.93	0.92	0.96	0.96	1.02	1.09	1.23	1.07
1.A.4.b	Residential	3.94	3.69	3.65	3.04	3.15	3.15	3.17	3.08	3.21	3.58	3.40	3.43
1.A.4.c	Fisheries/Agriculture	13.92	12.92	14.21	10.09	10.97	11.50	11.68	11.38	12.41	13.06	13.76	14.51
4.D	Agricultural Soils	44.77	50.26	49.68	49.75	55.07	55.32	53.96	59.35	54.62	56.42	62.52	63.88
6.C	Waste Incineration	0.73	0.73	0.82	0.79	0.76	0.82	0.93	1.07	1.28	1.38	1.42	1.46
	Total	**73.49**	**77.93**	**78.42**	**72.74**	**79.04**	**80.50**	**80.63**	**86.31**	**82.99**	**86.90**	**96.56**	**100.78**
	International bunkers : Marine			6.67	9.04	8.88	8.35	9.01	8.75	7.11	7.70	8.61	11.20

the emissions listed for civil aviation in 1990 and 1991 are set equal to the values in 1992 while data were missing for these years.

Table C.4 Emissions of SO_2 1990-2001.

IPCC code	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1.A.1	Public electricity and heat production	370.64	391.93	363.67	353.32	332.32	325.72	398.54	356.12	383.56	391.93	480.87	582.77
1.A.2	Manufacturing Industries and construction	179.06	175.50	104.98	111.25	110.07	81.21	102.47	90.85	146.83	125.30	139.75	164.48
1.A.3.a	Civil Aviation	0.10 *	0.10 *	0.10	0.12	0.10	0.19	0.25	0.17	0.16	0.26	0.22	0.28
1.A.3.b	Road transportation	27.77	27.24	17.84	6.60	6.30	7.05	7.64	8.58	6.15	4.53	2.09	2.30
1.A.3.d	Navigation	5.10	5.68	7.03	2.53	0.78	1.26	1.11	1.12	1.40	1.45	0.74	0.91
1.A.4.a	Commercial/Institutional	16.72	17.17	16.24	14.00	14.73	10.98	13.69	11.31	11.91	12.77	14.28	12.50
1.A.4.b	Residential	48.27	45.14	44.68	36.74	37.91	37.61	36.43	36.35	37.72	41.85	39.75	39.97
1.A.4.c	Fisheries/Agriculture	277.46	257.53	283.36	201.11	218.64	229.32	232.91	226.93	247.29	260.35	274.33	289.19
	Total	**925.12**	**920.29**	**837.90**	**725.67**	**720.85**	**693.34**	**793.04**	**731.43**	**835.02**	**838.44**	**952.03**	**1092.40**
	International bunkers : Marine			1001.39	1226.11	1191.07	1064.83	1091.29	1153.89	893.31	865.15	903.94	1115.81

the emissions listed for civil aviation in 1990 and 1991 are set equal to the values in 1992 while data were missing for these years.

Table C.5 Emissions of NO_x 1990-2001.

IPCC code	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1.A.1	Public electricity and heat production	234.01	241.06	227.44	217.92	205.57	200.08	243.05	218.54	237.33	242.01	295.68	361.01
1.A.2	Manufacturing Industries and construction	87.24	93.25	55.50	54.72	53.82	41.93	51.47	48.16	73.54	66.76	74.89	373.71
1.A.3.a	Civil Aviation	8.98 *	8.98 *	8.98	10.42	8.90	16.59	22.09	14.72	14.43	23.40	20.01	24.63
1.A.3.b	Road transportation	643.93	607.85	578.91	494.06	438.23	430.85	427.90	426.13	332.04	333.36	407.46	426.05
1.A.3.d	Navigation	449.53	332.99	406.03	305.68	259.65	325.28	342.14	330.29	337.50	365.67	395.83	485.71
1.A.4.a	Commercial/Institutional	27.35	28.10	26.60	23.15	23.88	24.00	24.77	24.91	26.38	28.33	31.96	27.78
1.A.4.b	Residential	102.37	95.71	94.74	78.83	81.92	81.88	82.37	79.91	83.44	93.00	88.36	89.17
1.A.4.c	Fisheries/Agriculture	3952.36	3668.83	4036.95	2865.72	3115.58	3266.94	3318.44	3233.28	3523.41	3709.41	3909.13	4120.43
	Total	**5505.77**	**5076.77**	**5435.15**	**4050.50**	**4187.55**	**4387.55**	**4512.23**	**4375.94**	**4628.07**	**4861.94**	**5223.32**	**6113.18**
	International bunkers : Marine			2890.86	3920.40	3849.53	3619.03	3907.02	3793.61	3082.09	3339.21	3732.44	5908.49

the emissions listed for civil aviation in 1990 and 1991 are set equal to the values in 1992 while data were missing for these years.

Table C.6 Emissions of NMVOC 1990-2001.

IPCC code	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1.A.1	Public electricity and heat production	3.10	3.12	2.99	2.82	2.67	2.58	3.11	2.82	3.09	3.14	3.82	4.70
1.A.2	Manufacturing Industries and construction	1.97	2.17	1.29	1.24	1.22	0.97	1.17	1.12	1.68	1.55	1.74	42.96
1.A.3.a	Civil Aviation	0.27 *	0.27 *	0.27	0.31	0.27	0.50	0.66	0.44	0.43	0.70	0.60	0.74
1.A.3.b	Road transportation	771.46	720.96	678.03	571.12	492.61	462.26	449.17	416.01	337.42	317.11	308.04	298.22
1.A.3.d	Navigation	97.19	72.00	87.79	66.57	56.14	70.33	73.97	71.41	72.97	79.06	85.58	105.01
1.A.4.a	Commercial/Institutional	1.57	1.61	1.52	1.33	1.37	1.38	1.42	1.44	1.52	1.63	1.84	1.60
1.A.4.b	Residential	5.95	5.57	5.52	4.54	4.78	4.78	4.78	4.64	4.84	5.39	5.12	5.14
1.A.4.c	Fisheries/Agriculture	172.98	160.92	176.92	132.98	147.53	147.42	135.48	132.01	143.85	151.44	159.60	168.23
	Total	**1054.49**	**966.62**	**954.33**	**780.91**	**706.59**	**690.22**	**669.76**	**629.89**	**565.80**	**560.02**	**566.34**	**626.60**
	International bunkers : Marine			77.33	104.87	102.97	96.80	104.51	101.47	82.44	89.32	99.84	129.83

the emissions listed for civil aviation in 1990 and 1991 are set equal to the values in 1992 while data were missing for these years.

Table C.7 Emissions of CO 1990-2001.

IPCC code	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
		tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1.A.1	Public electricity and heat production	25.75	21.47	23.30	19.90	19.26	17.61	19.96	19.06	22.29	22.33	26.27	34.24
1.A.2	Manufacturing Industries and construction	22.26	30.21	17.77	14.40	13.92	12.67	14.41	15.52	20.42	21.76	24.74	121.47
1.A.3.a	Civil Aviation	2.18 *	2.18 *	2.18	2.53	2.16	4.03	5.36	3.57	3.50	5.68	4.86	5.98
1.A.3.b	Road transportation	4241.93	4072.54	3784.90	3324.09	2836.64	2698.46	2733.42	2427.21	2014.25	1915.02	1848.51	1845.11
1.A.3.d	Navigation	220.42	166.07	202.65	149.33	124.14	155.93	163.70	158.09	161.92	175.34	188.58	231.40
1.A.4.a	Commercial/Institutional	32.74	33.62	31.81	27.45	28.81	22.32	27.12	23.01	24.26	26.02	29.14	25.48
1.A.4.b	Residential	98.05	91.70	90.78	74.49	77.28	76.75	74.62	74.13	76.99	85.47	81.19	81.51
1.A.4.c	Fisheries/Agriculture	533.10	495.42	544.87	399.35	439.24	448.21	430.85	419.80	457.46	481.61	507.49	534.97
	Total	**5176.43**	**4913.21**	**4698.26**	**4011.54**	**3541.45**	**3435.98**	**3469.44**	**3140.39**	**2781.09**	**2733.23**	**2710.78**	**2880.16**
	International bunkers : Marine			7818.47	11414.95	11287.86	10950.09	12180.22	11246.24	9408.77	10825.84	12489.06	16609.23

the emissions listed for civil aviation in 1990 and 1991 are set equal to the values in 1992 while data were missing for these years.

Appendix D

Abbreviations

Pollutants

CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
N_2O	Nitrous oxide
NMVOC	Non-methane volatile organic compound
NO_x	Nitrogen oxides
SO_2	Sulphur dioxide

Other

GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
LTO	Landing and take off
UNFCCC	United Nations Framework Convention on Climate Change