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REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY OF NORWAY SUBMITTED IN THE YEAR 2002[1]

(In-country review)

I. OVERVIEW

A. Introduction

1. The Conference of the Parties (COP), by its decisions 6/CP.5 and 34/CP.7, requested the secretariat to conduct individual reviews of greenhouse gas (GHG) inventories submitted by Parties included in Annex I to the Convention (Annex I Parties), according to the UNFCCC reporting guidelines for the technical review of GHG inventories from Annex I Parties, hereinafter referred to as the review guidelines.[2] The principle objectives[3] of the review of the GHG inventories are to ensure that the COP has adequate information on GHG inventories and GHG emission trends, and to examine the information submitted by Annex I Parties in accordance with the UNFCCC reporting guidelines[4] for consistency with those guidelines.

2. Norway volunteered for an individual, in-country review of its 2002 inventory submission, which took place from 7 to 11 October 2002 in Oslo, Norway. The in-country review was carried out by a team of nominated experts from the roster of experts and coordinated by the secretariat. Experts participating in the review were as follows: generalist – Mr. Art Jaques (Canada), energy – Mr. Krzysztof Olendrzynski (Poland), industrial processes – Mr. William Kojo Agyemang-Bonsu (Ghana), agriculture – Ms. Lilian Portillo (Paraguay) and Mr. Haruo Tsuruta (Japan), land-use change and forestry – Mr. Sergio Gonzalez (Chile) and waste – Dr. Charles Russell (New Zealand). Mr. Jaques and Mr. Gonzalez were the lead reviewers of this review. The review was coordinated by Ms. Clare Breidenich (UNFCCC secretariat).

3. At the beginning of the review, the host country officials and experts provided a general overview of inventory preparation, including institutional arrangements. Thereafter, sectoral sessions were conducted in parallel. During those sessions, national experts responsible for the respective sectors clarified key issues related to inventory preparation, followed by a question and answer session. Where answers could not be provided immediately they were submitted to the team in the course of the week.

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1 In the symbol for this document, 2002 refers to the year in which the inventory was submitted, and not to the year of publication. The number (2) indicates that this is an in-country review report.

2 For the UNFCCC review guidelines and decision 6/CP.5 see document FCCC/CP/1999/7, pages 109 to 114 and 121 to 122, respectively.

3 For the objectives of the review of GHG inventories see document FCCC/CP/1999/7, page 109, paragraph 2.

4 The guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (FCCC/P/1999/7) are referred to in this report as the UNFCCC reporting guidelines.

B. Inventory submission and other sources of information

1. National inventory report (NIR) and common reporting format (CRF)

4. Norway submitted an NIR on 12 April 2002 in both electronic and printed form. Revised versions of the CRF and a final version of the NIR were subsequently submitted, and available to the review team. In addition, as part of its inventory submission the Party provided additional documentation on methodologies in an associated report *The Norwegian Emission Inventory* (SN/SFT) 2000, which describes in detail the methodologies used to calculate the emissions in the National Inventory. Additional reports, in English and some only in Norwegian, that provide additional documentation on methods, emission factors and activity data were provided to the review team and were considered by the expert review team (ERT). These reports are listed in each section of this report.

5. In its 2002 submission, Norway submitted inventory data for all the requested gases for the years 1990, 1998, 1999 and 2000, using the CRF, and included data in all tables, except for tables 4.B(b), 4.C, 4.E, 5.B, 5.C and 5.D. The CRF was accompanied by an NIR, which included summary information on the Norwegian inventory model, institutional arrangements and other methodologies used, quality assurance/quality control (QA/QC), uncertainties, future improvements, key sources and GHG emission trends and recalculations. Energy balances and the CRF for the years 1990 and 2000 were included in the NIR as appendices. A complete set of CRFs for all years was not provided, although summary data for all years were provided by Norway to the review team. Norway noted that the data for the years 1992–1997 were available on the Web in a format other than that of the CRF tables. However, national experts pointed out that all information included in the CRF tables for those years can become available in the form of flat files at any stage in the future. Norway also noted that it found the production of the CRFs for all years, both time, and labour intensive, and was looking forward to the development of newer streamlined reporting software by the UNFCCC secretariat. Where needed, the ERT also used previous years' submissions, including the CRF tables for the years 1990–2000.

2. Other sources of information

6. The ERT used the 2002 status report, the draft 2002 synthesis and assessment (S&A) report, together with the Party's response to the S&A analysis, and the key source analysis[5] prepared by the secretariat to focus their review. The status and S&A reports for previous years were provided for information purposes, as well as a recently completed (September 2002) desk review of the 1999 inventory submitted in 2001, and previous NIRs.

7. Other sources of information used during the review were the UNFCCC reporting[6] and review guidelines and the draft review handbook, which provides additional guidance to ERTs in conducting the review activities.

8. During the review the host country provided the ERT with additional information sources. These documents are not part of the inventory submission, but are in many cases referenced in the NIR and an accompanying report (SN 2000). The full list of materials used during the review is provided in annex I to this report.

[5] The UNFCCC had identified, for each individual Party, those source categories which are key sources in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC good practice guidance. Key sources according to the tier 1 trend assessment were also identified for those Parties providing a full CRF for the year 1990. The key sources presented in this report are based on the secretariat's preliminary key sources assessment. They may differ from the key sources identified by the Party itself.

[6] See note 4.

C. Emission profile, trends and key sources

1. Emission profile

9. In the year 2000, the most important GHG in Norway was carbon dioxide (CO_2), contributing 75 per cent to total[7] national GHG emissions expressed in CO_2 equivalent, followed by methane (CH_4), 13 per cent and nitrous oxide (N_2O), 9 per cent, perfluorocarbons (PFCs), 2 per cent, sulphur hexafluoride (SF_6), about 1 per cent, and hydrofluorocarbons (HFCs), less than 1 per cent. The energy sector accounted for 64 per cent of the total GHG emissions followed by the industrial processes sector, 18 per cent, agriculture, about 9 per cent, and waste, 7 per cent.

2. Emission trends

10. Total GHG emissions (excluding land-use change and forestry (LUCF)) amounted to 55,263 Gg CO_2 equivalent and increased by 6 per cent from 1990 to 2000. Tables 1 and 2 provide data on emissions by gas and by sector from 1990 to 2000. Over the period 1990–2000, CO_2 emissions increased by 17 per cent, mainly because of higher activity in the oil and gas extraction sector and in the transport sector. From 1999 to 2000 emissions from the energy sector declined by about 2 per cent, primarily because of a mild winter and concomitant reduction in the use of fuel for heating purposes. Preliminary data for 2001 indicate that emissions rose once again, reflecting the general trend in increasing emissions over the last decade. CH_4 emissions increased during the same period by 6 per cent, from 6,454 Gg to 6814 Gg of CO_2 equivalent, mainly due to growth in the energy sector, while N_2O emissions increased about 0.5 per cent over the same period, largely because of emission reductions from nitric acid production offsetting emission increases from ageing three-way catalyst-equipped motor vehicles. Emissions of PFCs have declined by about 70 per cent, primarily from emission reduction initiatives undertaken in the production of primary aluminum, while SF_6 decreased by 59 per cent. The major source of SF_6 emissions is magnesium production, where the gas is used to cover the surface of liquid magnesium to prevent oxidizing. Emissions were 66 per cent lower in 2000 than 1990 due to improvements in technology and process management. Emissions of HFCs have increased dramatically, as would be expected, as they are replacing ozone-depleting substances controlled under the Montreal Protocol.

Table 1. GHG emissions by gas, 1990–2000 (Gg CO_2 equivalent)

GHGs	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Net CO_2 emissions/ removals	25,573	21,799	21,039	22,312	21,979	24,116	23,329	24,694	23,726	23,975	22,530
CO_2 emissions (without LUCF)[(a)]	35,163	33,499	34,289	35,822	37,659	37,756	40,940	41,193	41,314	41,743	41,273
CH_4	6,454	6,484	6,597	6,723	6,836	6,888	6,965	7,022	6,913	6,850	6,814
N_2O	5,130	4,966	4,290	4,650	4,752	4,826	4,828	4,771	5,023	5,268	5,154
HFCs[(b)]	0	0	0	2	9	26	53	88	133	179	232
PFCs	3,032	2,523	2,017	1,980	1,710	1,562	1,440	1,377	1,267	1,122	899
SF_6	2,186	2,066	688	719	854	578	543	548	695	841	891
Total (with net CO_2 emissions/ removals)	42,375	37,838	34,630	36,386	36,141	37,997	37,158	38,499	37,757	38,235	36,520
Total (without CO_2 from LUCF)	51,965	49,538	47,880	49,896	51,821	51,637	54,769	54,998	55,345	56,002	55,263

(a) LUCF = land-use change and forestry.
(b) The figures in Gg for the years 1990, 1991 and 1992 have been rounded up for this table; being: 1990, 0.02; 1991, 0.11; and 1992, 0.34

7 In this report, the term 'total emissions' refers to the aggregated national GHG emissions expressed in terms of CO_2 equivalent excluding land-use change and forestry (LUCF) unless otherwise specified.

Table 2. GHG emissions by sector, 1990–2000 (Gg CO_2 equivalent)

GHG SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy	29,414	28,325	29,185	30,410	32,003	31,882	34,891	35,365	35,314	36,028	35,211
2. Industrial processes	13,523	12,222	9,808	10,471	10,801	10,615	10,727	10,464	10,872	10,893	11,024
3. Solvent and other product use	180	161	165	165	174	171	179	174	173	171	164
4. Agriculture	4,896	4,828	4,722	4,788	4,751	4,843	4,795	4,817	4,850	4,772	4,705
5. LUCF[(a)]	–9,590	–11,700	–13,250	–13,510	–15,680	–13,640	–17,611	–16,499	–17,588	–17,767	–18,743
6. Waste	3,952	4,003	4,000	4,062	4,092	4,126	4,177	4,178	4,136	4,140	4,159
7. Other	0	0	0	0	0	0	0	0	0	0	0

[(a)] LUCF = land-use change and forestry.

3. Key sources

11. Norway reported a tier 2 analysis to determine key sources to both level and trend as part of its 2002 submission. The key sources analysis performed by the Party and the secretariat produced different results. The reason for the differences can be explained by the differences between a tier 1 and a tier 2 approach to identifying key sources. As noted in the International Panel on Climate Change (IPCC) good practice guidance, use of national inventory uncertainty allows Parties to adjust the key source threshold, if necessary, to explicitly reflect 90 per cent of the uncertainty in the inventory. Norway has performed the key source analysis at the level of IPCC source categories and each GHG from each source category is considered separately with respect to total global warming potential (GWP)-weighted emissions. Correlations are taken into account in the analysis. As noted in the IPCC good practice guidance, the advantage in using a tier 2 rather than the tier 1 methodology is that uncertainties are taken into account so the ranking shows where uncertainties can be reduced. Furthermore, emission factors and activity data can be assessed separately, whereas a tier 1 method could lead to the identification of sources that are not actually key, according to tier 2. The steps taken to find key sources to level and trend are described in the NIR and a separate report on uncertainties in the Norwegian Greenhouse Gas Inventory (Statistics Norway 2000).

12. Norway indicated that it uses this key source analysis to prioritise work for improving the accuracy of its national inventory. The lead agencies for the national inventory, the SFT and SN, have a formal process that involves prioritising work plans for improving the inventory.

Table 3. Key sources, Norway: Level and trend assessment (UNFCCC secretariat)[(a)]

Key Source	Gas	Level assessment %	Cumulative total %	Trend assessment %
Mobile combustion: road vehicles	CO_2	16.3	16	5.0
Stationary combustion: oil	CO_2	15.5	32	10.0
Stationary combustion: gas	CO_2	14.8	47	19.5
Solid waste disposal sites	CH_4	7.1	54	1.1
Ferroalloys production	CO_2	5.5	59	2.9
Fugitive emissions: oil and gas operations	CO_2	4.9	64	4.3
Mobile combustion: waterborne navigation	CO_2	4.3	68	2.6
Direct N_2O emissions from agricultural soils	N_2O	3.3	72	1.9
Aluminium production	CO_2	3.3	75	1.3
Enteric fermentation in domestic livestock	CH_4	3.1	78	
Nitric acid production	N_2O	3.1	81	3.5
Mobile combustion: aircraft	CO_2	1.9	83	2.6
Stationary combustion: coal	CO_2	1.6	85	0.9
Cement production	CO_2	1.6	87	1.4
PFCs from aluminium production	$CH_4+C_2F_6$	1.6	88	17.8
Magnesium production	SF_6	1.4	90	11.5
Other transport	CO_2	1.2	91	
Ammonia production	CO_2	1.1	92	
Indirect N_2O from nitrogen used in agriculture	N_2O	0.9	93	
Fugitive emissions: oil and gas operations	CH_4	0.9	94	1.6
Mobile combustion: road vehicles	N_2O	0.9	95	3.2
Carbide production	CO_2		95	1.1
Ozone depleting substances (ODS) substitutes	HFCs+ PFCs		97	1.8
Agricultural soils	CO_2		98	0.9

(a) See footnote 5 in this report.

D. General assessment of the inventory

13. The national inventory submitted by Norway is generally in conformity with the UNFCCC reporting guidelines. Norway's submission for 2002 consisted of an NIR containing a complete set of CRF tables for 1990 and 2000. CRF tables for 1998 and 1999, as well as 1990 and 2000, were submitted in electronic format. A full CRF time series was not submitted, but summary tables for the intervening years were provided to the ERT. For these years, all information given in the CRF tables can be provided in the form of flat files, if the UNFCCC secretariat allows for it in future submissions.

14. A more detailed assessment is provided in sections II–VI of this report. In general, Norway has an excellent inventory programme that systematically reviews and targets areas for improvement utilizing key source identification. As noted in the NIR, a formal QA/QC plan has not been written, but many of the elements of such a plan are already being implemented. Of note is the fact that the emissions estimation methodologies are being developed continuously. Statistics Norway and the Norwegian Pollution Control Authority have initiated several studies of emissions, including emissions from road, sea, and air transport, emissions from landfills as well as emissions of HFCs and SF_6. Usually, such studies are connected to an evaluation of emission reduction measures. Statistics Norway is also working to increase the environmental relevance of the statistical system. In addition, Norway indicated to the ERT and noted in the NIR that improvements to its emission model are planned to better facilitate QA/QC and international reporting.

1. Completeness

15. Norway submitted inventory data for the years 1990, 1998, 1999 and 2000 using the CRF and summary data for 1990–2000 inclusive. The NIR provides a general assessment of completeness and notes a few sources for which estimates of emissions are not included, such as N_2O from manure handling and CO_2 emissions and removals from soil. These sources have been omitted simply because of lack of data or because they were not prioritised in the national inventorying work due to their insignificant contribution to the national GHG emission total. Norway indicated to the ERT and in the NIR that the 2003 year submission would include estimates for N_2O from manure management, in line with the IPCC Guidelines for National Greenhouse Gas Inventories, hereinafter referred to as the IPCC Guidelines. With these exceptions, the inventory covered all major sources and sinks, as well as all direct and indirect gases, included in the Revised 1996 IPCC Guidelines. Norway did note some difficulties in completing the CRF for crude oil, natural gas venting and flaring. The national sector split for activities and matching emissions in these subsectors is country-specific and difficult to apply in CRF. Under the waste, several of the cells are left blank where notation keys should be used and the additional information tables were not entirely complete (the sub-section on waste water was not completed).

2. Transparency

16. A number of changes to the 2002 NIR from previous reports have been made in such a way that the NIR, taken together with the CRF and methodology report, provides a relatively transparent inventory. The NIR contains a general description of institutional arrangements, quality assurance and quality control procedures, uncertainty estimation methods, key source analysis, reference to key source estimation methods, a summary of trends in emissions by gas, recalculations and explanations within the CRF on the differences between the reference and the sectoral approaches. 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*). Since that report was printed methodologies and data to estimate emissions from shipping and aviation have been further elaborated. See documentation in the report 'Utslipp til Luft fra Innenriks Sjøfart, Fiske og Annen Sjøtrafikk mellom Norske Havner' (SN 2001a) and for aviation in 'Utslipp til Luft fra Norsk Luftfart' (SN 2002). In addition, smaller refinements have been made also for other sources.

17. The NIR documents the methods and model employed in developing the emission estimates and describes the model as carrying out calculations in "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 nitrogen oxides (NO_X), SO_2, non-methane volatile organics (NMVOC), carbon monoxide (CO) and some other gases such as heavy metals and particles. Thus, emissions can be listed by a multitude of combinations of fuels, sources and sectors. Combustion emissions are calculated by combining the fuel consumption distributed by 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. 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. Non-combustion emissions are added to the model by an appropriate emission carrier, emission source and economic sector. Emissions from road traffic, CH_4 from landfills and emissions of HFC, PFC and SF_6 from products are calculated in sub-models to the main model, along with emissions from point sources collected by SFT.

18. However, the NIR and CRFs are not stand-alone documents and must be accompanied by other published reports in order to provide full transparency on emission factors used, choice of method, model details and activity data. A key document submitted with the NIR provides a detailed description of most methods and emission factors used in developing the emission estimates. This document, "*The*

Norwegian Emission Inventory (SN/SFT) 2000, references most of the sources of information and used in conjunction with the NIR and CRF is key to understanding the methods and data used in developing the national inventory. An updated summary of this document would be extremely useful if incorporated into the NIR. Additional materials and reports on methods, emission factors and activity data were provided to the ERT during the review and are listed in annex I to this report. The numerous background materials make it possible and fairly easy to track down activity data and emission factors applied in the inventory and enable reconstruction of the inventory, although it is not a simple exercise, especially for as complex a sector as energy. It is worthwhile to note that the same institution - SN - compiles both the emission inventories and energy balance data, and sends the latter to the International Energy Agency (IEA). This institutional arrangement facilitates consistency in reporting.

19. Generally the information provided by the Party was detailed enough, and comprehensive data and methodologies were included in accompanying reports, particularly for the first-order decay (FOD) model for solid waste deposited to land. Where information was not sufficient, the Party experts provided additional information. Several of the background reports were in Norwegian, which made clear comprehension difficult. A clear description of the incineration process and further description in the NIR of the waste water handling methodology would facilitate transparency in future submissions. The ERT believes that it is important to include supporting information on choices for and sources of emission factors and data to aid in explaining information gaps. It was also noted by the ERT that some reporting tables in the CRF did not contain notation keys.

20. The GHG inventory of the LUCF sector is not fully transparent for several reasons, namely:

(a) Only global estimates are reported with no information on the underlying processes;

(b) There are no notation keys in the CRF tables;

(c) There is no information on values assigned to different parameters used to estimate emissions/removals; and

(d) No back up documentation on the decision-taking process.

21. The ERT noted that the NIR submitted in 2002 lacks:

(a) Full CRF time series;

(b) Calculation sheets;[8]

(c) A clear indication of the methods used in some sectors (for example, agriculture, waste);

(d) A clear indication of the rationale and complexity of the methodologies used (IPCC default, tier 1, tier 2 and so on).

22. With the exception of (b), the ERT recommends that Norway add these elements to future NIRs.

23. The ERT noted that the CRF submitted in 2002 lacks:

(a) A complete set of tables for the years 1991–1997;

(b) Tables 4.B(b), 4.C, 4.E, 5.B, 5.C and 5.D.

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[8] According to the UNFCCC reporting guidelines, the NIR should include calculation sheets or equivalent database information on detailed inventory calculations in each sector, for all years from the base year to the year of the current annual inventory submission, containing, *inter ali*a, disaggregated national emission factors and activity data underlying the estimates (FCCC/CP/1999/7, paragraph 33(b)). This reporting requirement was, however, dropped from the revised UNFCCC reporting guidelines, which were agreed upon by the Subsidiary Body for Scientific and Technological Advice (SBSTA) at its sixteenth session.

3. Recalculations and time-series consistency

24. Chapter 3 of the NIR summarizes the recalculations that have been made since the last inventory submission and the reasons for them. Most of the recalculations of the time series 1990 to 2000 had been undertaken to take into account better knowledge, that is, new data or emission factors, or to correct previous errors. The following changes have taken place.

Energy – fuel combustion

25. Compared to the 2001 submission, the following recalculations have been made and noted in CRF and NIR:

(a) A decrease in reported activity data for use of wood, wood waste and black liquor in the pulp and paper manufacturing industries has led to a reduction in CH_4 and N_2O emissions;

(b) An error in the basic N_2O emission factor for heavy-duty diesel vehicles has been corrected. The previously used emission factor was only 20 per cent of the correct value; fuel consumption data for 1999 have been marginally revised; in addition, vehicle mileage data have been revised for some vehicle classes;

(c) Emission figures for national air traffic are recalculated as a result of the introduction of new emission factors for CH_4 based on recent studies (EEA 2001, SN 2002);

(d) Emissions from small-scale fuelwood combustion have been recalculated based on new emission factors for CH_4, N_2O and precursors; Statistics Norway has collected new national and international emission factor data, compared them and recommended new factors for Norwegian stoves and fireplaces; fuelwood consumption figures have been corrected for the approximate moisture content of 18 per cent, and emissions to air from combustion of wood in Norway (SN 2001).

Industrial processes and other solvent use sector

26. Norway recalculated emissions of CO_2 for cement, ammonia and ferroalloys production for the years 1990, 1998 and 1999. CO_2 emission from the mineral production increased on average by 4.16 per cent for all the years because of recalculations performed for emissions from cement production. There was a decrease in CO_2 emissions by an average of 5.75 per cent for the metal production sub-category as a result of the recalculations performed on the CO_2 emissions from ferroalloy production.

27. Recalculations done for ammonia production resulted in no changes in reported CO_2 emissions for the chemical industry sub-category for 1990 and 1998. However, there was a decrease of 15.69 per cent in CO_2 emissions for 1999.

Agriculture sector

28. The recalculation was made including new figures for animal populations, including shorter than one-year lifespans for lambs. In addition, Norway has included field burning of agricultural wastes and reported a full-time series of emissions of CH_4 and N_2O from this source.

LUCF sector

29. In the 2002 submission, no recalculation was performed for the years 1990, 1998 and 2000 and only a minor increment in the net CO_2 capture (+0.14 per cent) was reported for the 1999.

Waste sector

30. There were no recalculations made in the waste sector. The S&A report prepared by the secretariat indicated that CH_4 emissions per capita from solid waste disposal sites (SWDS) did not change between 1990 and 1997. However, from 1997 to 2000 there were changes. On closer inspection,

it appears that the values for years between 1990 and 1997 were not available to the secretariat at the time of the S&A report compilation.

31. The result of all of these recalculations is a minor change to the overall trend for the three main GHGs – CO_2, CH_4 and N_2O – such that the trend from 1990 to 1999 shows an increase of 15.2 per cent instead of 15.5 per cent.

4. Uncertainties

32. Norway has provided information within the NIR on the quantitative estimation of uncertainties undertaken to perform a tier 2 key source analysis and the results of that analysis. Additional details on this are provided in two reports entitled 'Evaluation of Uncertainty in the Norwegian Emission Inventory' (SFT/SN 1999a) and a subsequent study 'Uncertainties in the Norwegian Greenhouse Gas Emission Inventory' both of which were provided to the ERT. These two reports provide a systematic investigation of uncertainties in level and trend using a simulation model analysis as described in the IPCC good practice guidance.

33. Detailed uncertainty estimates were quantified for Norway's GHG emissions in 2000 and provided in the NIR. The overall level uncertainty (tier 2 Monte Carlo method) for the 2000 data was found to be about +/– 20 per cent. The respective figure for the overall trend uncertainty was +/– 4 per cent.

34. PFC emissions from aluminium production were found to be one of the sources with the highest levels of uncertainty. In the agriculture sector uncertainties were found to be influenced most by uncertain emission factors which had a range of 2 orders of magnitude, particularly from agricultural soils, rather than by activity data. Norway noted that a knowledge of the uncertainty of N_2O emitted from agricultural soils is crucial for the determination of the overall uncertainty, and that this uncertainty is not well known. Norway indicated that N_2O from agriculture is the main source contributing to overall uncertainty.

35. For LUCF, a qualitative uncertainty estimate (low) is provided in CRF table 7 for 5.A. with no reference in the NIR. The ERT received the information that no specific uncertainty assessment has been performed for this sector. The national team recognizes that major uncertainties are related to biomass expansion ratio, and delimitation between reference and expanded biomass. Some additional sources of uncertainties are: inaccurate estimates of annual harvest; inaccurate estimates of fuelwood production and forest biomass in low-productivity areas; and net growth as the difference between uncertain values (gross increment, wood harvest, fuelwood production).

36. Uncertainties in the waste sector are reported in the document on uncertainties in the Norwegian GHG Inventory and the assumptions used for the uncertainties are contained in separate sections for the background reports (C707 for 6.B and SFT 99:16). Given the fact that uncertainties are important as a good practice component of the inventory, the inclusion of the basic assumptions in the NIR would enhance the transparency of the reporting for this sector.

5. Verification and QA/QC approaches

37. As noted in the NIR, Norway has not yet implemented a formally written verification or QA/QC plan for the national inventory. However, the ERT noted that Norway has formally implemented many of activities described in the IPCC good practice guidance for QA/QC. For example, the emissions figures are compared to last year figures and outliers are detected for extended QA/QC. The first inventory is produced 2–3 months after the end of the year on the basis of preliminary and aggregated data. These figures are updated one year later on the basis of final and preliminary data, and two years later based on final data. This process, with several updates based on partly different datasets, is also used as QA/QC as all differences in data are recorded and are verified by the SFT before publication.

38. Methods for most key sources are reviewed regularly, including a comparison of different emission factors and if possible also comparisons of top-down and bottom-up estimates of emission factors. Most often these projects involve collaboration between source experts, Statistics Norway and the SFT. The goal is to get a detailed technology assessment and at the same time ensure consistency with estimates for other sources and ensure that the FCCC reporting guidelines and the IPCC good practice guidance are followed. For the most part, IPCC good practice guidance is being applied although a formal QA/QC plan is in development. A formal archiving procedure is still required. However, Norway informed the ERT that all input data used in the model runs, the versions of the models used and the model output are stored at SN. Relevant information including dates and procedures followed are also recorded.

39. A total quality management project was carried out in 2001 with the overall goal of improving all aspects of the inventory system, such as data flow, identifications of obstacles, involvement of data providers and so on. Final inventory data provided by SN are checked and verified by the SFT.

40. Consistent with other sectors, no formal QA/QC plan has been implemented in the waste sector in the 2002 submission. QA/QC and verification procedures are being used, however, informally in some: for example, in the case of the SWDS, government and industrial experts were used to review input parameters of the first order decay model as it applied to the Norwegian specific national circumstances. Elements of QA/QC were also present in the waste water and incineration reporting; however, they are not clearly identified as such in these reports, and further explanation and description of the measures used would support the overall transparency and further assessment in future submissions.

6. Institutional arrangements

41. During the in-country visit, Norway presented the institutional arrangements for preparation of the inventory. The SFT has overall responsibility for the national inventory. The institutional arrangements function well, with Statistics Norway (SN) collaborating with the SFT to produce the annual inventory for greenhouse gases and in addition the precursors NO_X, SO_2, NMVOC, CO and some other gases such as heavy metals and particulates. The SFT is also responsible for the choice of emission data, models and emission factors as well as the preparation of the NIR. SN has responsibility for the activity data, emission models and the production of the CRF tables. In addition, other agencies, such as the Agricultural Ministry, universities, the Norwegian Institute of Agricultural Economics, and the Norwegian Institute of Land Inventory, are involved in providing information upon which to base emissions and removals estimates. While a formal QA/QC plan has yet to be written, much of what might be in that plan already exists. The SFT has written agreements with SN setting out procedures, specific deliverables and timelines for cooperative work between the two agencies for the preparation of each year's inventory. Final decisions on what is contained in the NIR and CRF reside with SFT. Since SFT is involved in discussions concerning changes to calculation methods and models, but does not necessarily have access to the some of the data in the models, the only weakness to this system is the ability of the Inventory Agency (SFT) to undertake adequate and timely QA/QC on the data generated, since the deadline for providing emission estimates to SFT is 1 March.

7. Record keeping and archiving

42. Norway does not yet have a centralised archiving system. During the in-country review (ICR) the ERT was able to trace the sources of data and was provided with a 'paper trail' documenting methods, activity data and emission factors for most sources.

8. Issues related to previous reviews

43. The ERT notes that Norway:

(a) Has responded appropriately to previous comments on differences in estimates of emissions using the reference approach resulting from different sets of activity data. After undertaking a special study (Rypdal 2001), Norway reports using the same data in its calculations of the reference approach as it reports to the IEA. However, inconsistencies still remain between the energy data used by the IEA (heating values) to apply the reference approach and those used by Norway. The ERT notes that this is an issue to be resolved by the IEA with support from Norway;

(b) Has provided more complete documentation on methods, in particular the reporting of fugitive emissions, although it also notes that additional information will be forthcoming in future NIRs;

(c) Stated that work to facilitate data checking, documentation and archiving began in 2002 and will be reported on further in future NIRs.

E. Areas for further improvement

1. Areas identified by the Party

44. In response to previous reviews and comments provided in S&A reports, Norway in its NIR has indicated, that for those sources identified as key, improvements are made regularly. In addition, some sectors will be prioritised in future years for elaboration of methods, activity data and emission factors, that is, N_2O emissions from road motor vehicles, N_2O from agricultural soils and manure storage. In addition, Norway is developing a new emission model that will improve reporting, including full time series, and probably lead to some methodological refinements.

2. Areas identified by the ERT

45. The ERT notes that the NIR submitted in 2002 has addressed most of the issues raised in the S&A reports and previous reviews. While the NIR has attempted to document the methods and sources of information, the ERT has identified the following major areas for improvement related to cross-cutting issues in the Norwegian inventory:

(a) The ERT has been provided with (see annex I) a number of publications, studies and reports that provide detailed information on the choice of methods, derivation of emission factors, sources of activity data, quantitative uncertainty analysis and verification procedures. The Party is encouraged, however to synthesize this information in a more transparent fashion and provide it as part of the NIR;

(b) The ERT encourages Norway to implement fully the IPCC good practice guidance, specifically the development and implementation of a QA/QC plan;

(c) *Emission factor*s: More information is needed with respect to the various country-specific emission factors and how they have been derived;

(d) *Reporting:* Norway may wish to consider including in the NIR a more detailed description of the methods used in some source categories (for example, agriculture, waste and LUCF), the background to the various country-specific emission factors, and information on uncertainty and QA/QC. Norway may also wish to provide some additional relevant information requested in the CRF.

46. Recommended improvements relating to specific source categories are presented in the relevant sector sections of this report.

II. ENERGY

A. Sector overview

47. The energy sector, including fugitive emissions, contributed about 29.4 Mt CO_2 equivalent or 56.6 per cent of total emissions in 1990. In the latest period covered by CRF reporting (1998–2000), this

sector was responsible for about 64 per cent of total emissions. Energy sector emissions dominate the overall growth in emissions, increasing by 19.7 per cent between 1990 and the year 2000, while total emissions increased by only 6.3 per cent in the same period.

48. The major sources of emissions in the energy sector are road transport and the oil and gas industries (especially extraction and distribution). In Norway electricity is almost entirely produced at hydropower plants and fossil fuels are not burned for power generation, which is quite unique. Compared to other countries there is a relatively large share of fugitive emissions (venting and flaring). The majority of Norway's key sources are in the energy sector.

1. Overall assessment of the inventory in the energy sector

49. Norway has developed a very high-quality GHG emission inventory with extensive documentation on methodologies, activity data and emission factors. Higher tier methods are widely used with country-specific methods derived through dedicated studies (e.g., surveys of activity data and direct measurements of emissions or emission factors). Extensive uncertainty analysis is carried out for both activity data and emission factors each year and the results are published in NIRs and separate publications.

2. Energy balance data

50. Before the visit, the ERT found it difficult to check the energy-related activity data in the CRF for the following reasons:

(a) Energy balance data for the year 2000 given in annex II of the NIR are aggregated with respect to fuel type and sector, and therefore unsuitable for checking individual entries in the CRF;

(b) Energy data in the annex turned out to be inconsistent with corresponding data in the CRF; a simple error while editing the annex significantly distorted the data, with the result that they could not be used for comparison purposes;

51. During the visit, detailed energy data for the year 2000 published by Statistics Norway and used in the CRF were provided to the ERT (*Energistatistik 2000*), as well as a copy of the data that were actually reported by Norway to the IEA. The differences between the CRF and IEA data for Norway and inconsistencies in the latter would benefit from additional elaboration, but major differences (combustion of gas offshore and bunker fuels) were satisfactorily explained by the Party (see below for more details). It is recommended that the NIR 2000 is supplemented by more detailed energy balance data with a required level of disaggregation with respect to fuel types and sectors. In addition, Norway will be contacting the IEA to resolve differences in heating values and other conversions applied by the IEA to Norway's data.

52. Implied emission factors (IEFs) that seemed to lie outside the ranges set by the respective values provided by other countries and identified by the ERT during the recent desk review, or in the 2002 S&A report compiled by the UNFCCC secretariat, were all considered by Norwegian experts and discussed in the document 'Comments to the draft report for Norway 2002'. In almost all cases the explanations given by Norway are satisfactory and point to either specific Norwegian conditions or national aggregation method (e.g., inclusion of medical waste and recovered CH_4 from landfills into other fuels in the commercial/institutional sector).

3. Recommendations for minor corrections in CRF

53. A few minor flaws in the CRF that require corrections have been identified by ERT. The recommended corrections are discussed in the following.

4. Methodologies, emission factors and activity data

54. Norway generally uses the tier 2 methods for fuel combustion and fugitive emissions. The methodologies are harmonised with the IPCC Guidelines and in line with the IPCC good practice guidance. The country-specific methodologies are not described in the NIR but are presented in a separate publication (SN/SFT 2000) and a number of background papers (some in English). Since the year 2000, methodologies for estimation emissions from aviation and shipping have been updated and described in two separate reports (SN 2001 – 'Emissions to Air from Fishing Fleet and Sea Traffic between Norwegian Harbour, and SN 2002 – 'Emissions to Air from Norwegian Air Traffic').

55. Norway generally uses country-specific emission factors (for CO_2 and CH_4 in fuel combustion and for CO_2 and CH_4 in fugitive emissions). Emission factors for N_2O are mainly IPCC default (except road traffic).

56. Energy balance data used in the CRF come from a disaggregated energy dataset. Other sources of activity data are national statistics and dedicated surveys (e.g., on domestic vs international use of fuels for shipping and aviation). Data reported to support the information needs of a CO_2 tax (mainly oil and gas industries) are another important source of both activity data and emission estimates. SFT collects activity data and emission data from individual plants within the framework of a national Pollution Release and Transfer Register (PRTR) system. This information is used for selection of some emission factors and activity data. Some specific data related to the oil and gas industry are provided by the Norwegian Petroleum Directorate. The data sets used in the inventory are in line with the IPCC good practice guidance.

B. <u>Reference and sectoral approaches</u>

1. Comparison of the reference approach with the sectoral approach and international statistics

57. Norway has provided an explanation of the fairly large difference between the sectoral and the reference approach by noting that, because of its national conditions, the reference approach is inappropriate for it. The national conditions are characterised by large non-energy use of coal, coke, natural gas and liquefied petroleum gas (LPG), large oil and gas production and exports (domestic supply is the difference between the two large numbers in each case) and relatively large statistical errors. End-user statistics from sales by energy commodity, sector and source are considered to be more reliable. Consumption figures are based on annual (industry, households) and occasional (agriculture, services, construction, transport) surveys. Gas production figures are applied differently by SN and IEA as a result of differences in definitions (offshore installations are included in the former while excluded from the latter). Norwegian experts expressed scepticism about the usefulness of the reference approach to Norway's particular conditions.

58. The ERT noted differences between the energy balance data for the year 2000 used in the CRF and those published by the IEA. Norway explained the difference by pointing to a fairly complex system of updating the energy data: monthly reports first, then preliminary annual data, updated annual data and so on. The energy balance data used in the latest version of the CRF (version 2) are the most recent and most reliable data for 2000, while IEA relied on an earlier set when compiling its publications. Moreover, different definitions of domestic and international fuel use are applied by the IEA and Norway with respect to shipping, aviation and offshore gas combustion and flaring. The latter has been described in detail in recent report by K. Rypdal (Rypdal 2001).

2. International bunker fuels

59. Differences between the IEA data and the CRF in sectoral data for marine shipping and aviation are due to the fact that different definitions of domestic use are used. In the Norwegian inventory, domestic consumption is based on a census in accordance with the IPCC good practice guidance. Annual questionnaires are sent to all authorised airline companies with questions on their domestic consumption.

On the other hand, the IEA makes its own assessment with respect to the split between the domestic and the international market. Norway informed the ERT that the IEA reports on aviation energy consumption from 2003 will be consistent with the CRF data.

3. Feedstocks and non-energy use of fuels

60. Because it uses relatively large amounts of gas, coal and coke as feedstock for industrial processes, Norway enters the non-energy use directly into table 1A(d) using a carbon storage factor of 1. The respective default IPCC values are generally much lower. Norway maintains that the use of the IPCC default values would lead to non-comparable results with respect to the sectoral approach. The use of default carbon storage factors gives misleading results for Norway. This is documented in more detail in a recent report (Rypdal 2001).

C. Key sources

61. The ERT noted that the list of key sources as indicated by the UNFCCC secretariat (table 3 above) differs from the list identified by Norway (NIR 2000). The differences arise because the secretariat applied a tier 1 method while Norway used exclusively a tier 2 method. In the case of the energy sector, Norway identified eight key sources and described them in detail during a presentation for ERT and in NIR 2000 and SN/SFT 2000. Below only the most important aspects of the key sources are briefly discussed.

62. For level uncertainty, importance has been assessed separately for activity data and for emission factors for the years 1990 and 2010. Most important sectors within energy include: for activity data, oil shipping (1A3d), gas-oil and gas extraction (1A1c), oil aviation, services and households (1A3a, 1A4a, 1A4b respectively). For emission factors the main parameters include CO_2 from oil combustion (1A1–1A4), CO_2 from gas-oil and gas extraction (1A1c), CO_2 and CH_4 from oil loading (1B2a-b), and N_20 from road traffic (1A3b).

63. For trend uncertainty (2010–1990), the sectors include: for activity data: oil shipping (1A3d), gas-oil and gas extraction (1A1c); for emission factors: N_2O from road traffic (1A3b), CO_2 from natural gas and oil combustion (1A1c,1A), and CH_4 and CO_2 from oil loading (1B2a) and from venting and flaring (1B2c). It should be stressed that the emission factors for CH_4 venting and flaring developed by Norway are among very few estimates available internationally.

64. All key sources identified by the Party are covered by country-specific methodologies and parameters (emission factors). The quality and accuracy of activity data for these sources is considered to be high with a few exceptions, namely, separation of domestic from international fuel consumption data in air and marine transport.

1. Fuel combustion

65. Emissions of CO_2 from fuel combustion made up about 80 per cent of the national total for CO_2. They increased by 17 per cent in the period 1990–2000. The total oil consumption used in the energy balance is based on monthly and annual sales statistics (the top-down approach), while other energy data are obtained through surveys. CO_2 emission factors are based on estimated average carbon content of extracted oil and gas (domestic studies), while emission factors for CH_4 and N_2O are mainly default IPCC values.

CO_2 from manufacture of solid fuels and other energy industries

66. Consumption of gaseous fuels is reported by the Norwegian Petroleum Directorate and the data are considered to be of high quality because of the obligations stemming from the CO_2 tax system. There are both private and state owned oil companies operating and all the Norwegian companies have private shareholders and studies have shown that the CO_2 tax has given a reduction of 2.6 Mtonnes CO_2 per year.

Civil aviation

67. Fuel consumption data are obtained by means of annual surveys of airlines (jet fuel) and sales statistics (aviation petrol). It is very difficult to distinguish between domestic and international travel (bunker fuels). Emission factors for CO_2 are provided by the Norwegian Petroleum Industry Association. IPCC default values for jet fuel are used for CH_4 and N_2O. Norway followed the IPCC Tier 2b methodology for calculation of civil aviation emissions.

N_2O from road transport

68. This source contributes significantly to trend uncertainty as a result of the rapid emission increase caused by the introduction of catalytic converters. On the other hand, uncertain emission factors contribute to level uncertainty. Norway uses a fairly sophisticated traffic model that gives as output aggregated emission factors. Specific features like cold start, fuel evaporation and ageing of vehicles (and catalytic converters) are accounted for factors not always included in traffic models. Top-down (sales statistics) and bottom-up (vehicle, and road condition-specific) fuel consumption data differ by merely a few per cent for gasoline and 30–40 per cent for diesel oil. The reason for the latter difference is the probable use of diesel oil for purposes other than road traffic.

Navigation

69. As with air traffic, there is an inherent difficulty in distinguishing between domestic and international sea traffic. This is one of the reasons for the differences between data reported in the CRF and those published by the IEA. Sales statistics (applied in the inventory) give about 15 per cent more fuel consumption than bottom-up estimates. Emission factors for CO_2 are based on domestic studies while emission factors for CH_4 and N_2O emissions are IPPC default values. The methodology of emission estimation for both sea and air traffic has recently been updated and described in two separate reports (SN 2001/6 and SN 97/20), copies of which were made available to the ERT. It should be noted that a country specific approach usually gives more accurate division between domestic and international bunkers than estimates made by IEA.

Commercial/institutional

70. For the commercial/institutional sector it is sometimes difficult to obtain disaggregated activity data. For some sectors (e.g., manufacturing plants) surveys are carried out regularly, while for others often only limited information is available. For liquid and solid fuels (mainly coal and coke), CO_2 emission factors account for carbon content specific for Norwegian conditions. Moreover, because of a lack of detailed disaggregated data, for simplicity some emission factors are used for sector/source combinations other than those for which they were estimated.

2. Fugitive emissions

Crude oil loading, venting and flaring

71. Norway finds it difficult to fully apply the CRF format for reporting emissions in this sector as there is basically a lack of correspondence between the sector split for activity and emissions used domestically. On the other hand, for safety reasons, flaring is the preferred way of getting rid of excess extracted gas, while venting is avoided as far as possible. This is not normally the case for other oil-producing countries. Therefore, country-specific emission factors are quite unique. There are also very few measurements available outside the Norwegian continental shelf.

72. Carbon emitted in compounds other than CO_2, that is, CO, NMVOC and CH_4, is included in CO_2 estimates in accordance with the IPCC guidelines.

Coal mining and handling

73. CH_4 emissions from coal extraction are expected to rise from 339 tonnes in 2000 to about 900 tonnes in 2001. The only Norwegian coal mine is unique as it is situated 300–400 metres above sea level and the rock above the coal bed is quite porous and therefore methane has been aired through many years before mining. As a result the measured emission factor for CH_4 venting – 0.54 kg/tonne – of coal is much lower than the respective default IPCC value of 14kg/tonne. Another unique feature for Norway is that almost all the coal extracted is exported, while domestic use is based on imports.

D. Non-key sources

1. Energy industries

74. The emission factor for CH_4 emissions in subsector other fuels is relatively high (21.9kg/TJ) because here only waste used as fuel is considered. On the other hand, emission factors for CH_4, and N_2O for liquid fuels are relatively low (0.3 kg/TJ and 0.66 kg/TJ, respectively) as most of the liquid fuels is marine gas-oil combusted at oil platforms with a rather high calorific value.

75. The ERT fully accepts all the responses and explanations provided by Norway to the questions/issues raised in the S&A report concerning both key and non-key sources.

E. Areas for further improvement

1. Areas identified by the Party

76. The activity figure for other fuels in 1.A4.b should be corrected to 187.974 TJ, thus changing the respective CO_2 IEF from 149 to 5.66 t/TJ. The inclusion here of incineration of medical waste and CH_4 recovered from landfills accounts for this relatively low value of IEF for CO_2.

2. Areas identified by the ERT

77. The following minor additions/modifications are recommended by the ERT:

(a) Extend the presentation of the national energy balance in the NIR by applying fuel/sector disaggregation as in *Energy Statistics of OECD Countries, 1999–2000*, pp. II 163–165 with both physical and energy units provided for solid and liquid fuels add energy data; also for preceding years (1998–1999 and base year);

(b) Introduce minor corrections into CRF 2000:

(i) CO_2 from biomass combustion (correct formulae and remove waste combustion);

(ii) Add missing notation keys and descriptions (feedstocks);

(iii) Use IPCC default carbon oxidation factors in the reference approach;

(iv) Account for carbon stored in residual fuel oil, kerosene used as feedstock/non-energy use;

(v) Split mobile and stationary emissions from the military.

III. INDUSTRIAL PROCESSES AND OTHER SOLVENT USE

A. Sector overview

78. The industrial process sector contributes about 20 per cent of the total national emissions. Three major key sources that are readily identifiable, either because of their contribution to national absolute level and/or trend in emissions or because they have high associated uncertainties, are:

(a) Ferroalloy production;

(b) Aluminium production;

(c) Consumption of halocarbons and SF_6.

79. Emissions data from industrial processes are collected from annual reports sent to the SFT. SFT has developed the comprehensive Internet-based PRTR (pollutant release and transfer registries to the Aarhus Convention) where all pollutant releases from industries are stored. Follow-up audits are also performed and records kept of dates when the audits are given to the PRTR. Data from this database are partly used in the emission inventory. SFT provides SN with a file containing emission data for the about 60 plants.

80. The key sources analysis performed by the secretariat and that of Norway were different. Norway used a tier 2 methodology, which considers uncertainties in both activity data and emission factors. A threshold for the key sources analysed was set to 90 per cent. The secretariat, however, used a tier 1 methodology with a threshold of 95 per cent.

1. Completeness

81. The CRF includes estimates of most gases and sources of emissions from the industrial process sector, as recommended by the IPCC Guidelines. CO_2 emissions from the manufacturing of silicon manganese using biomass carbon as reducing agent are not included, in keeping with the treatment of imports and exports of harvested wood products, which are excluded under the IPCC Guidelines. Carbon dioxide emissions from domestically produced charcoal are accounted for a part of the total harvest volume within the LUCF sector. Norway may consider using notation keys, as appropriate, in all CRF tables.

2. Methodologies, emission factors and activity data

82. Norway used country-specific methodologies and emission factors in most of the emission estimates from industrial processes. For non-industrial HFCs and PFCs consumption, activity data from HFC and PFC importers were used since no national statistics exist.

B. Key sources

1. Ferroalloys – CO_2

83. Norway used the IPCC-recommended methodology and national emission factors for the estimation of CO_2 emissions. The emission of CO_2 increased by 21.56 per cent from 1990 to 2000.

2. Consumption of halocarbons and SF_6 – HFCs, PFCs

84. There is no production of HFCs and PFCs in Norway. Norway used the tier 2 methodology and a bottom-up approach to estimate emissions. The ERT recognised that the activity data collected covered up to 80 per cent of the total imports of HFCs and PFCs. The activity data were collected through surveys conducted on behalf of SFT by Hans T. Haukås AS and SN. These surveys were done in 1995, 1996 and 1998, and activity data for 1999 and 2000 were then extrapolated from these previous surveys. The ERT considers the use of a linear extrapolation to obtain the activity data for the years 1999 and

2000 as inappropriate, as it could lead to potential underestimation of the emissions. Moreover, the reported data for the years 1995, 1996 and 1998 do show an exponential growth.

85. The ERT team observed that importers of mixtures of HFCs and PFCs do not conduct any check to ascertain that the right specifications are delivered, and this could have implications for the HFC and PFC emission estimates. The team also noted that HFCs and PFCs in fishing vessels, a major consumer of HFCs and PFCs, were classified as stationary air conditioners.

86. The ERT noted the conflicting statements between pages 17 (line 2 paragraph 3) and 29 (last paragraph) of the NIR about the use or otherwise of Soederberg technology in Norway, especially in relation to SF_6 use in the aluminium industry. Norway agreed to this observation and is expected to delete the statement on page 29 of the NIR.

3. Aluminium production – PFCs

87. Norway indicated that the high ratio of CF_4 to C_2F_6 (25.87), identified in the 2002 S&A report, and raised again by the ERT team, is due to a combination of a large percentage (40%) of production from the higher emitting Soederberg technology. Reports show that Soederberg plants in Canada, USA and Norway have a higher ratio of CF_4/CF_6 than Prebake plants. Current published data from measurements from aluminium industries in Norway (Kvande et al 2001) made available to the ERT indicate that C_2F_6 emissions constitute 6 per cent of the total perfluorocarbon emissions during anode effects, which gives a ratio of CF_4 to C_2F_6 of about 15.67 compared to 25.87. Norway indicated that owing to large uncertainties in the measurements of PFCs, coupled with the fact that the estimation methods are specified in their agreements with the aluminium industry, no decision to change the current estimation methodology has been made. However, the methodologies are likely to change in 2005, when the voluntary agreement between the aluminium industry and the Ministry of Environment will be reviewed and the Soederberg technology may have been completely phased out.

88. The annual variation of IEF was also again explained by Norway as due to the installation of point feeders. However, the ERT did not consider this explanation as satisfactory and raised questions as to when and how often these point feeders are installed.

C. Non-key sources

1. Nitric acid production – N_2O

89. The 2002 S&A report identified N_2O as a key source. Norway did not provide activity data or use notation keys in the CRF tables. The activity data were considered confidential, because there are only two plants. These data were made available to the ERT. The ERT did cross-check the activity data with the reported emissions and recommended that notation keys be used in all CRF tables, especially for such cases where data are considered confidential.

2. Carbide production – CO_2

90. Activity data for silicon carbide (use of petrol coke) were reported in the CRF for all years. However, no activity data were reported for calcium carbide due to confidentiality (only one plant). This is indicated by a notation key (C) for all years except 1990. However, Norway provided production data for this single calcium carbide plant to the ERT during the review

D. Areas for further improvement

1. Areas identified by the Party

91. Implementation of formal procedures for QA/QC.

92. Plans to carry out an inventory of HFC and PFC systems to ensure good-quality activity data.

2. Areas identified by the ERT

93. The data gathered from the importers on HFCs and PFCs represent potential emissions (Tier 1), while the SN data (calculated on the basis of the potential data) indicate actual emissions. This is in accordance with the Tier 2 methodology. The ratio between potential and actual emissions is rather high (about 4), because of the growing consumption of halocarbons as CFCs and HCFCs are being phased out.

94. Norway may reconsider the classification of the use of HFCs and PFCs in fishing vessels as being a stationary source.

IV. AGRICULTURE

A. Sector overview

95. In Norway, the agricultural sector contributed almost 4.7 Mt of CO_2 equivalent and accounted for almost 9 percent of overall GHG emissions in 2000. Two sources, enteric fermentation from livestock and agricultural soils, were identified as key sources, with CH_4 and N_2O, respectively, the primary gases emitted.

96. Norway has provided the information according to the UNFCCC reporting guidelines and the IPCC Guidelines.

1. Methodologies, emission factors and activity data

97. The agriculture sector inventory is based on the IPCC Guidelines and uses country-specific emission factors and parameters, where available, or default emission factors and other parameters according to the IPCC Guidelines.

98. A clear description of the methodology used in developing the agricultural inventory was provided, although no clear explanation or reference documentation was given in relation to data sources and emission factors, especially country-specific methods and models such as NH_3 volatilization.

B. Key sources

99. The UNFCCC secretariat identified three key sources in the agricultural sector by using the tier 1 method in the IPCC good practice guidance – direct N_2O emissions from agricultural soils, CH_4 emission from enteric fermentation, and indirect N_2O from nitrogen used in agriculture – while Norway identified only the first two of these by using the tier 2 method.

1. Livestock population characterization

100. Norway reported that numbers of livestock were taken from SN's livestock statistics, based on sample surveys, while some of them were very different from the United Nations Food and Agricultural Organization (FAO) data.

2. Enteric fermentation – CH_4 emissions

101. The tier 1 method and IPCC default emissions factors are used for this key source. However, Norway reported that the tier 2 method will be used next year, because the data on daily feed intake are now being collected.

3. Agricultural soils: direct emissions – N_2O

Synthetic fertilizers

102. Norway reported that, for the implied emission factor in the CRF, the IPCC default emission factor was corrected for NH_3 volatilization during application, with no clear explanation. Norway replied to the ERT that the emission factor was corrected by using the one referred to in the ECETOC (1994).

The ERT recommends that in the future a clearer explanation of the methodology for correcting the emission factor be provided in line with IPCC good practice guidance.

Animal wastes applied to soils

103. The ERT noted that Norway is using country-specific factors (25 per cent) from SN's manure balance, which are very different from the IPCC default method (40 per cent), mainly because all animals are kept indoors in the winter due to the cold climate. In addition, Norway indicated that new data will be forthcoming on both the application of manures and N_2O emission rates.

104. The ERT noted that the amounts of N in excreta from each animal were different in tables 3.35 and 3.39 in the National Emission Inventory and recommends that Norway use only one data source of N in excreta for animal manure estimation. Norway informed the ERT that this will be improved in the future.

N-fixing crops

105. The ERT noted that there was no explanation of the methodology on how the amount of biological N-fixation (8 Gg N y^{-1}) was estimated, and recommends that Norway provide a clearer reference than that contained in (SN/SFT 2000) on the source of this activity data, reported in (AMBIO, 26, 134-142,1997) which the ERT also received from Norway at the ICR

Crop residues

106. The ERT noted that a clearer explanation of the methodology used to estimate total N in crop residues listed in the CRF could be provided in the NIR that would allow a comparison to be made with the IPCC default values in table 4.16 in the IPCC good practice guidance.

Cultivation of histosols

107. The ERT noted that there is no explanation of the methodology used to estimate the cultivated area of histosols, even in the reference (Aakra and Bleken 1997). The ERT noted that the explanation provided to it would be in line with the IPCC good practice guidance if Norway could provide more detail as to the area of cultivated organic soil is estimated, including information on soil types and areas cultivated. Norway informed the ERT that a new emission factor listed in the IPCC good practice guidance will be used next year, replacing the old one which is currently used in the NIR.

4. N_2O from agricultural soils – indirect emissions

Atmospheric deposition

108. The ERT noted that Norway reported in the CRF the amount of volatilized NH_3 from fertilizers and animal wastes with no clear explanation of the methodology. Norway replied to the ERT that it was calculated by using the Norwegian ammonia model with national ammonia emission factors.

Nitrogen leaching and run-off

109. The ERT noted that Norway used a run-off model with no clear explanation in the NIR. Norway replied to the ERT that a national factor (18 per cent) was used for the fraction of the fertilizer and manure nitrogen lost to leaching and surface run-off.

110. The ERT strongly recommends that Norway explains clearly in the NIR the methodology used for N_2O emission from atmospheric deposition and nitrogen leaching and run-off (the Norwegian ammonia model with a volatilization fraction and the run-off model, respectively).

C. Non-key sources

1. Manure management – CH_4 emissions

111. Norway calculated CH_4 emission from manure management by the IPCC tier 2 method. The ERT noted that the country-specific emission factors for most farm animals were used without explanation and while Norway did provide further information during the ICR, the ERT recommends that additional documentation be provided in the NIR to clearly indicate how emission factors were chosen and applied.

2. Field burning of agricultural residues – CH_4 and N_2O emissions

112. Norway reported that this source is newly included in recalculations. The ERT noted that the emission of CH_4 and N_2O from cereals is only reported in table 4.F in the CRF, with no explanation of the total amount of crop residues, the fraction that is due to biomass burning, nor the methodology by which the emissions were estimated. Norway replied that the CH_4 and N_2O emissions were estimated according to the IPCC Reference Manual (IPCC 1997b), with the activity data estimated by SN and the Norwegian Crop Research Institute. The ERT recommends that Norway reports in the NIR the methodology for estimating CH_4 and N_2O emissions with references to the relevant activity data.

3. Liming of agricultural soils – CO_2 emissions

113. Norway reported that this source category will be moved to the LUCF section and in table 5.D in the CRF next year, according to the IPCC good practice guidance.

D. Areas for further improvement

1. Areas identified by the Party

114. During the review, Norway recognised the need to involve more agriculture sector expertise in the investigation of the agriculture inventory.

2. Areas identified by the ERT

115. The following areas were identified as a result of the review:

(a) Further improvement should be made in transparency. It was noted that additional information is available and it may be adequate to take account of it as reference documentation;

(b) QA/QC is very important in the implementation of a formal system, not only for agriculture, but also for the other reporting sectors, according to the IPCC good practice guidance. An expert peer review outside from SFT and SN should also be undertaken;

(c) The methodology, emission factors, and estimated values for activity data are expected to be reported clearly with the data source. There should be a clear description of how the correction for NH_3 volatilization was made by using the Norwegian model;

(d) The emission estimate of N_2O from manure management is expected to be reported next year using consistent activity data on animal population N amount in excreta, and allocation of manure management. The data should be also used for improving other GHG emission estimations from manure management;

(e) The estimation of CO_2 emission uptake from agricultural soils is expected in the near future;

(f) Regional cooperation between the Scandinavian countries on calculating emission factors by field measurements and activity data is expected to be developed to produce better estimates of GHG emissions from agricultural soils and manure management.

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

116. For the year 2000, the LUCF sector accounted for 27.9 per cent of national CO_2 emissions and 22.4 per cent of national CO_2 equivalent emissions. Removal of CO_2 exceeded the LUCF sectoral CO_2 emissions by 117 per cent; removal is 16 per cent lower than the total national CO_2 emissions. The net removal of CO_2 by this sector has increased by 95.5 per cent from 1990.

117. According to information received during the review, land-use changes are relatively insignificant –2 kha/year as deforested land and 30 kha/year as afforested land, in 2000. National forest law obliges the farmer to regenerate the forest on harvested land by planting or enhancing natural regrowth. At the present time, Norway is an importer of timber products.

1. 2002 S&A report

118. During the review process, the ERT received information to support the sustained increase shown by the CO_2 net removal, which explained some rather large annual changes. These changes result from the difference between two factors:

(a) Gross increments, reported annually, based on figures from the permanent field plots which are updated every 5 years (thus, each year 20 per cent of the plots are measured again); and

(b) Annual wood and fuelwood harvests which are uncertain values. This information explains the finding in the 2002 S&A report.

2. Methodologies, emission factors and activity data

119. Norway is following a country-specific methodology, which was explained in the NIR in a general way. The information received during the review allowed the ERT to have a better understanding of the NIR and it would have been helpful if Norway had added some of the information given to the ERT both in the NIR and in the documentation boxes of the CRF tables.

120. The LUCF inventory is based on a forest balance that requires:

(a) Annual gross increment of forests (in m^3/year), which is estimated by the Norwegian Institute of Land Inventory (NIJOS); and

(b) Felling data, which come from different sources (The Ministry of Agriculture´s database containing data from timber scaling associations and others; data from regional forestry administrations, 1989 Census of Agriculture and Forestry).

121. The difference between net increment (which equals gross increment minus natural losses) and felling is called net growth and represents the annual CO_2 net removal by the Norwegian forests. Natural losses (including natural decay, biomass lost by insect and/or wind attacks, and forest fires) are currently calculated as a fixed percentage of the gross increment. To produce the estimates of CO_2, the following parameters are applied:

(a) The IPCC default value for the expansion ratio (1.9) and C content in biomass (0.50);

(b) Expansion factor of fellings applied to logging residues;

(c) National conversion rates by species (range from 0,38 to 0,50 ton/m^3).

122. The rationale for the selection of the respective parameters should be better documented and reported.

123. Required activity data are:

(a) Gross increment of forest mass, estimated by the Norwegian Institute of Land Inventory, except for Finnmark County (Agricultural Census, Statistics Norway);

(b) Annual wood harvest and fuelwood consumption, compiled by Statistics Norway.

124. The annual gross increment is released by the Forest Inventory, which is produced in a five-year cycle by field measurements from 10,500 permanent plots, which are in turn based on increment boring. These activity data can be classified as appropriate and accurate, although some improvements are planned.

125. Annual timber harvest is collected by SN from different sources, the most important being the timber scaling associations and the 1989 Census of Agriculture and Forestry. These activity data can be classified as appropriate but need to be more accurate.

126. Fuelwood consumption data are taken from the 1989 Census of Agriculture and Forestry and estimates made by regional forestry administrations and consumer surveys. These activity data can be classified as appropriate but inaccurate, as Norway has some indications that fuelwood removals may be higher than estimated.

B. Sink and source categories

1. Source category

127. The LUCF sector is reported as a net sink of CO_2 because the forest biomass is being expanded (not the surface area devoted to forests) as a result of planting and natural regrowth at the beginning of the 20th century. The inventory recognises the following sources of CO_2:

(a) Removals due to biomass expansion;

(b) Emissions due to felling (timber and fuelwood harvests).

128. Inclusion of non-CO_2 gas emissions/removals from forest soils and forest residues is dependent upon the publication of the IPCC good practice guidance on LUCF.

C. Areas for further improvement

1. Areas identified by the Party

129. During the review, Norway recognised the next areas for further improvement:

(a) National values for biomass expansion;

(b) Fuelwood production data;

(c) More accurate estimates for gross increment, changing from increment boring to measured diameter increment of trees in permanent plots;

(d) Clarity in the definitions of forest area and biomass types included;

(e) Better estimates of natural losses from re-measured sample plots.

2. Areas identified by the ERT

130. The following areas for improvement were identified as a result of the review:

(a) A national system to register and archive GHG inventories;

(b) A national system to register and archive supporting information;

(c) More accurate country-specific definitions for managed and unmanaged forests, and productive and non-productive forests;

(d) Improved matching between the outputs of the LUCF inventory and the CRF tables.

131. The ERT encourages Norway to make an effort to report the results of the forest balance (LUCF inventory) in the format of the CRF tables. It was understood that Norway produces almost all, if not all, the information required for that.

VI. WASTE

A. Sector overview

132. The waste sector represented 7.5 per cent of the total GHG emissions in 2000, which was fractionally lower than the proportion in 1990 (7.6 per cent). Emissions in this sector have, however, increased by 5.25 per cent since 1990.

133. Emissions increased at an annual rate of 32 Gg from 1990 to 1996, became stable between 1996 and 1997, then decreased by 42.5 Gg between 1997 and 1998; however, emissions started to increase again from 1998 at a rate of 11.6 Gg year.

134. The sector is dominated by CH_4 emissions from solid waste disposal on land which has decreased as a proportion from 97.5 per cent to 95 per cent. This decrease is mostly due to the introduction of incineration plants in Norway from 1997. Incineration plants represented approximately 2 per cent of the sector's emissions in 2000.

135. The greenhouse gas profile changed between 1990 and 2000 as follows: CH_4, 96.8 per cent to 94.4 per cent; CO_2, 0.9 per cent to 3 per cent; N_2O, 2.3 per cent to 2.6 per cent.

B. Methodologies, emission factors and activity data

136. The methodologies used were a range of country-specific and IPCC default approaches, and generally methodologies were consistent with the IPCC good practice guidance.

137. The emissions factors used were a mixture of country-specific, conjectured by a range of officials and Norwegian waste experts, and IPCC defaults values applied where country-specific information was not available. This was consistent with the IPCC good practice guidance.

138. The activity data for the waste sector come from a number of sources. Municipal waste is assessed by annual survey carried out by Statistics Norway. Data on commercial waste are taken from surveys conducted every three years. Additionally, information on SWDS and incineration is provided to SFT from the county governors, who are responsible for issuing permits and are required to record waste information, which is held on a national database called INKOSYS. Plant-specific information and assumptions are contained in an SFT document of 1996 (in Norwegian) – Rapport 96:16. In consultation with Norwegian experts, the collection and detail of the activity data were found to be consistent with the IPCC good practice guidance.

1. Solid waste disposal on land – CH_4

139. Norway uses a Norwegian-specific FOD model to assess CH_4 emissions from SWDS. The methodology was developed at the same time as the IPCC methodology and is very similar to the IPCC default.

140. Detailed reports SFT 99:16 and SFT 96:16 give background information and assumptions for the model. Norwegian officials provided the minutes of the meetings held in designing the model and constructing the tier 2 approach, and the documented decisions about emission factor and other factors such as half-life values.

141. The additional information from the UNFCCC secretariat noted that the CH_4 emissions per capita were the highest among reporting Parties. This is due to the combined approach of the model and the specific conditions in Norway.

142. Norway did not report emissions from unmanaged SWDS sites. The explanation was that emissions from these sites are minimal and that currently no survey statistics are available.

143. It would assist future reviews if total population and waste generation rate were included in the additional information table.

144. Some further explanation of the model and the basic assumptions could be included in the background information linked to the NIR.

C. Non-key sources

1. Solid waste disposal on land – CO_2

145. A documentation box should be used to explain "indirect CO_2 emissions". A note of this could also be included in the methodology in future submissions.

2. Waste water handling – N_2O and CH_4

146. This subsector was predominantly reported using IPCC good practice guidance.

147. There was a substantial amount of information on the surveys and in the background report (Statistics Norway, 'Discharges and Treatment in the Municipal Waste Water Sector in 2000'); the report is comprehensive and is written in English.

148. Further information about the methodology and assumptions in the NIR would be useful for transparency.

149. Industrial waste water is not reported: it is considered insignificant as most industrial waste water systems are aerobic treatment plants and gas is collected from the anaerobic sites. It would enhance clarity if this could be indicated in the background reports to the NIR.

150. The CRF was incomplete in this sector; there was also a minor inconsistency between the CRF and NIR data values – 0.41Gg (CRF), 401 tonnes (NIR) for CH_4; and 0.35 Gg (CRF) 362 tonnes (NIR) for N_2O.

151. The additional information boxes were not completed in the CRF for waste water, nor were notation keys used for blank cells. This could be completed in future submissions.

3. Incineration – CO_2

152. The background methodology and approach are comprehensive in the report *Emissions from treatment of municipal solid waste* (SFT 96:16); however, there is only a brief description in the NIR on the methodology.

153. Further description and explanation of the methodology and the compilation of the survey data used (i.e., the sources – SN and local county data from INKOSYS) could be included in the NIR or methodology documentation.

D. Areas for further improvement

1. Areas identified by the Party

154. Norway identified that it had not implemented its QA/QC plan and verification processes in the submission reviewed. It plans to have this component of its inventory installed for subsequent submissions.

2. Areas identified by the ERT

155. The reporting and information about collection of data are comprehensive, as is the methodology for the waste sector. In order to enhance transparency, the ERT recommends further compilation and the inclusion of more of this background information in the Norwegian NIR. This could be done by condensing the information into one report. The use of flow diagrams explaining source information and processes would also enhance transparency and help comprehension in future reviews.

156. It would be helpful to include decision trees in the NIR to show why specific approaches were taken, particularly in the SWDS, where a number of country-specific factors are used in the model. Support materials and reports on these decisions should also be clearly documented and archived.

Annex I

DOCUMENTS RECEIVED DURING THE REVIEW

1. Energy

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Rypdal,K (1993):*Anthropogenic Emissions of the Greenhouse Gases CO_2 ,CH_4 and N_2O in Norway*, Report 93/24, Statistics Norway.

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2. Industrial Process

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Bodil Mosen og Sverre E. Olsen. *Omregningsfaktorer for CO_2–utslipp fra metallurgisk industri og sementproduksjon. Delpro jekt 3. Produksjon av ferromangan, silikonmangan og ferrokrom i Norge.* STF 24 A98548, Mai 1998

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Hans T. Haukås, Sigurd Holtskog, og Marit Viktoria Pettersen. *Calculations of emissions of HFCs and PFCs in Norway. tier 2 Method.* SFT Report 99:03, 1999

Guy Bouchard, Jens Kallmeyer, Alton Tabereaux and Jerry Marks. *PFC Emissions Measurement from Canadian Primary Aluminium Production, Light Metals 2001.*

Halvor Kvande, Helge Nes and Lars Vik, *Measurements of perfluorocarbon emissions from Norwegian aluminium smelters, Light Metals 2001.*

3. Agriculture

Laegreid, M. And Aastveit, A.H. 2002. *N_2O emission from fertilizer use. In Non-CO_2 Greenhouse Geses,*
Van Ham, Baede, Guicherit and Williams-Jacobse (eds.). ISBN 90-77017-70-4, 233-238.

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N-cycle, and its Role in Present and Future N_2O Emissions to the Atmosphere" Oslo, 22-25 May 1997.
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Norwegian Institute of Land Inventory (NIJOS). Printings from web pages of , English and Norwegian versions.
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