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# REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY OF NORWAY SUBMITTED IN THE YEAR 2001[1]

**(Desk review)**

## I. OVERVIEW

### A. Introduction

1. The Conference of the Parties (COP), at its fifth session, by its decision 6/CP.5, requested the secretariat to conduct, during the trial period, individual reviews of greenhouse gas (GHG) inventories for a limited number of Parties included in Annex I to the Convention (Annex I Parties), according to the UNFCCC guidelines for the technical review of GHG inventories from Annex I Parties, hereinafter referred to as the review guidelines.[2] The secretariat was requested to coordinate the technical reviews and to use different approaches to individual reviews, including desk reviews, centralized reviews and in-country reviews.

2. The review of Norway's 2001 inventory submission took place from 8 October to 27 October 2001. The desk review was carried out by a team of nominated experts from the roster of experts, working in their own countries. Experts participating in the review were Mr. Klaus Radunsky (Generalist, Austria), Mr. Michael McGettigan (Energy, Ireland), Mr. John Sarafidis (Energy, Greece), Mr. Mauro Meirelles de Oliveira Santos (Industrial processes, Brazil), Mr. Alexander Nakhutin (Industrial processes, Russian Federation), Mr. Ayite-Lo Ajavon (Agriculture, Togo), Mr. Pascal Boeckx (Agriculture, Belgium), Mr. Tomás Hernández-Tejeda (Land-use change and forestry, Mexico), Mr. James Barton (Land-use change and forestry, New Zealand), Ms. Sirintornthep Towprayoon (Waste, Thailand) and Mr. Heinrich Widmer (Waste, Switzerland). The review was coordinated by Ms. Rocio Lichte (UNFCCC secretariat). Mr. Klaus Radunsky and Mr. Ayite-Lo Ajavon were lead authors of this report.

3. In accordance with the UNFCCC review guidelines, a draft version of this report was communicated to the Government of Norway, which provided comments that were considered and incorporated, as appropriate, in this final version of the report.

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[1] In the symbol for this document, 2001 refers to the year in which the inventory was submitted, and not to the year of publication. The number (1) indicates that for Norway this is a desk 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.

## B. Inventory submission and other sources of information

4. The expert review team (ERT) reviewed the 2001 inventory submission of Norway, which consists of the national inventory report (NIR) and the common reporting format (CRF) tables for the years 1990 and 1999, submitted on 15 April 2001. Inventory reports from previous years' were not considered during this desk review. The NIR referenced a report entitled "The Norwegian Emission Inventory – Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants" (SN/SFT 2000), which was submitted at a later stage, in June 2001. This documentation report on methodologies contains inventory information up to the year 1997. According to comments provided by the Party during the 2001 review process, the information in that documentation report is generally also valid for subsequent years. Norway also explained in its response to the draft of this review report that the above-referenced documentation report was, together with the 2001 NIR, part of its 2001 inventory submission. The NIR focuses only on major changes in methodologies since the previous submission and provides information on emission trends. That documentation report was, however, not part of this desk review and therefore many of the comments made by the ERT do not reflect the status of Norway's emission inventory at the time the review was made. Unfortunately, that report has not been made available to the ERT by the secretariat, nor did the ERT request it from the secretariat. The ERT proposes to use this experience from the trial period to try to improve information and data management between the Parties, the secretariat and the ERTs.[3]

5. The ERT also used for the review the 2001 status report, the draft synthesis and assessment (S&A) report of the 2001 inventory submissions, the final S&A report of the 2000 inventory submission (FCCC/WEB/SAI/2000) and the preliminary key source analysis prepared by the UNFCCC secretariat.[4] The ERT noted that Norway addressed the preliminary findings raised in the draft S&A report.

6. Other sources of information used during the review include: the preliminary guidance for experts participating in the individual review of GHG inventories, the UNFCCC reporting guidelines[5] and the review guidelines (FCCC/CP/1999/7).

7. During the review the Party was not contacted to request additional information.

## C. Emission profile, trends, key sources

8. Norway has a GHG emission profile broadly typical of Annex I Parties. The most important GHG is carbon dioxide ($CO_2$), which in 1999 accounted for 74% of total emissions,[6]

[3] This case also indicates the need to establish direct contact between the ERT and the Party under review during desk and centralized reviews so that there is a common understanding of what information forms the basis of the review. The revised guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention, which were agreed upon by the SBSTA at its sixteenth session, address this problem identified during the trial period.

[4] The UNFCCC secretariat 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 which provided a full CRF for the year 1990. The key sources presented in this report are based on the secretariat's preliminary key source assessment. They might differ from the key sources identified by the Party itself.

[5] 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/CP/1999/7), are referred to in this report as the UNFCCC reporting guidelines.

[6] In this report the term "total emissions" refers to the aggregate national GHG emissions expressed in terms of $CO_2$ equivalents excluding land-use change and forestry, unless otherwise specified.

followed by methane ($CH_4$), 13%, and nitrous oxide ($N_2O$), 9%. By source, energy accounted for 63% of total emissions, agriculture 9%, industrial processes 20% and waste 7%. The contribution of public electricity and heat production is very small in Norway (0.6% of total emissions) but that of other energy industries is quite large (approximately 17%).

9. Tables 1 and 2 provide data on emission trends, by gas and by sector. Emissions of $CO_2$, excluding land-use change and forestry (LUCF), grew by 19% between 1990 and 1999 driven mainly by the growth of emissions from the oil and gas industries and transport. $N_2O$ emissions did not show a significant trend between 1990 and 1999, the only sector with a significant trend being transport. $CH_4$ emissions increased by 8%, the increase being driven by fugitive emissions from fuels. Hydrofluorocarbons (HFCs) experienced significant growth from 1990 to 1999, whereas perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$) showed a decrease. Total GHG emissions (without $CO_2$ from LUCF) increased by 8% between 1990 and 1999.

**Table 1. GHG emissions by gas, 1990–1999 (Gg $CO_2$ equivalent)**

| GHGs | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ equivalent (Gg) | | | | | | | | | |
| Net $CO_2$ emissions/ removals | 25,489 | 21,764 | 21,057 | 22,300 | 21,996 | 24,154 | 23,260 | 24,677 | 23,809 | 23,908 |
| $CO_2$ emissions (without LUCF)[(a)] | 35,079 | 33,464 | 34,307 | 35,810 | 37,676 | 37,794 | 40,871 | 41,176 | 41,396 | 41,650 |
| $CH_4$ | 6,547 | 6,628 | 6,759 | 6,879 | 7,027 | 7,079 | 7,151 | 7,204 | 7,096 | 7,082 |
| $N_2O$ | 5,179 | 5,018 | 4,343 | 4,701 | 4,810 | 4,881 | 4,881 | 4,827 | 5,101 | 5,324 |
| HFCs | 0 | 0 | 0 | 2 | 9 | 26 | 53 | 88 | 133 | 179 |
| PFCs | 3,032 | 2,524 | 2,016 | 1,980 | 1,710 | 1,562 | 1,440 | 1,377 | 1,267 | 1,122 |
| $SF_6$ | 2,190 | 2,067 | 693 | 720 | 854 | 575 | 582 | 544 | 690 | 834 |
| Total (with net $CO_2$ emissions/removals) | 42,437 | 38,001 | 34,868 | 36,582 | 36,406 | 38,278 | 37,368 | 38,717 | 38,095 | 38,448 |
| Total (without $CO_2$ from LUCF)[(a)] | 52,027 | 49,701 | 48,118 | 50,092 | 52,086 | 51,918 | 54,979 | 55,216 | 55,683 | 56,190 |

[(a)] In the CRF, the information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report $CO_2$ emissions and removals from LUCF.

**Table 2. GHG emissions by sector, 1990–1999 (Gg $CO_2$ equivalent)**

| SOURCE AND SINK CATEGORIES | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ equivalent (Gg) | | | | | | | | | |
| 1. Energy | 29,132 | 28,112 | 28,995 | 30,214 | 31,792 | 31,643 | 34,720 | 35,067 | 35,150 | 35,633 |
| 2. Industrial processes | 13,749 | 12,425 | 10,045 | 10,679 | 11,059 | 10,916 | 10,895 | 10,787 | 11,213 | 11,248 |
| 3. Solvent and other product use | 180 | 161 | 165 | 165 | 174 | 171 | 179 | 174 | 173 | 174 |
| 4. Agriculture | 5,014 | 5,000 | 4,913 | 4,972 | 4,969 | 5,061 | 5,007 | 5,027 | 5,063 | 5,019 |
| 5. LUCF (net emissions) | -9,590 | -11,700 | -13,250 | -13,510 | -15,680 | -13,640 | -17,611 | -16,499 | -17,588 | -17,742 |
| 6. Waste | 3,952 | 4,003 | 4,000 | 4,062 | 4,092 | 4,126 | 4,176 | 4,161 | 4,083 | 4,116 |
| 7. Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

10. Norway did not provide a list of its key sources in its 2001 inventory submission.[7] According to the preliminary level and trend assessment undertaken by the secretariat, the key sources shown in table 3 below have been identified for Norway. In its response to the draft of this report, Norway informed the ERT that a tier 2 key source identification would be provided in the 2002 inventory submission.

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

| Key source | Gas | Level assessment for 1999 % | Cumulative total % | Contribution to trend % |
|---|---|---|---|---|
| Stationary combustion – oil | $CO_2$ | 17.4 | 17 | 15.0 |
| Mobile combustion – road vehicles | $CO_2$ | 16.6 | 34 | 2.7 |
| Stationary combustion – gas | $CO_2$ | 13.0 | 47 | 15.6 |
| Solid waste disposal sites | $CH_4$ | 7.0 | 54 | 6.5 |
| Ferro-alloys production | $CO_2$ | 6.0 | 60 | 2.4 |
| Mobile combustion – waterborne navigation | $CO_2$ | 5.0 | 65 | 8.3 |
| Fugitive emissions: oil and gas operations | $CO_2$ | 4.3 | 69 | 3.2 |
| Enteric fermentation in domestic livestock | $CH_4$ | 3.5 | 73 | 1.8 |
| Nitric acid production | $N_2O$ | 3.3 | 76 | 7.0 |
| Direct $N_2O$ emissions from agricultural soils | $N_2O$ | 3.3 | 79 | 6.0 |
| Aluminium production | $CO_2$ | 3.2 | 83 | |
| PFCs from aluminium production | $CF_4$+$C_2F_6$ | 2.0 | 85 | |
| Mobile combustion – aircraft | $CO_2$ | 2.0 | 87 | 4.5 |
| Cement production | $CO_2$ | 1.6 | 88 | 1.6 |
| $SF_6$ from magnesium production | $SF_6$ | 1.3 | 89 | |
| Other transportation | $CO_2$ | 1.2 | 91 | |
| Stationary combustion – coal | $CO_2$ | 1.0 | 92 | |
| Indirect $N_2O$ from nitrogen used in agriculture | $N_2O$ | 0.9 | 93 | |
| Fugitive emissions: oil and gas operations | $CH_4$ | 0.9 | 93 | 2.2 |
| Mobile combustion – road vehicles | $N_2O$ | 0.8 | 94 | 4.8 |
| Ammonia production | $CO_2$ | 0.6 | 95 | 5.3 |
| Carbide production | $CO_2$ | | | 2.6 |
| ODS substitutes | all HFCs and PFCs | | | 2.5 |
| Agricultural soils | $CO_2$ | | | 1.7 |
| Railways | $CO_2$ | | | 0.8 |

[(a)] See footnote 4 to this report.

## D. General assessment of the inventory[8]

### 1. Completeness and transparency of reporting

Completeness

11. Norway submitted inventory data for the years 1990 and 1999 using the CRF. The ERT identified a few omissions in the national inventory relating to $N_2O$ emissions from manure management. No explanations were provided regarding these omissions in neither the CRF nor the NIR. For some sources (for example agriculture residue burning, $CO_2$ emissions and

[7] According to Norway's response to the draft S&A report 2001, Norway has performed a tier 2 key source identification, which was, however, not described in the NIR.

[8] The assessment and conclusions resulting from this desk review are based on information available in the 1990 and 1999 CRFs and the 2001 NIR (see also paragraph 4).

removals from soil) no emission data are included due to a lack of data. 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 for National Greenhouse Gas Inventories, hereinafter referred to as the IPCC Guidelines. With regard to $N_2O$ emissions from manure management, Norway informed the ERT in its response to the draft of this report that these emissions would be included in the inventory in the submission due by 2003.

Transparency

12. The ERT noted that the NIR included:

(a) a general description of the methods and data;

(b) reference to detailed methodologies;

(c) a detailed explanation of differences between the reference approach and the sectoral approach;

(d) a qualitative explanation of trends in emissions;

(e) an explanation for Norway's not submitting a CRF for the years 1991 to 1998.

13. The ERT noted, however, that the NIR lacks:

(a) full CRF time series;

(b) calculation sheets;[9]

(c) uncertainty estimates (although major studies to quantify uncertainty have been completed), including uncertainty estimates relating to individual sectors (subsectors);

(d) indication of the rationale for the selection of the emission factors used;

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

(f) a clear indication of the rationale and complexity of the methodologies used (IPCC default, tier 1, tier 2, and so on);

(g) indication of sectors (subsectors) and GHGs with emission data coming directly from measurements;[10]

(h) a description of data management and software.[11]

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[9] 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 alia*, 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 SBSTA at its sixteenth session.

[10] Norway informed the ERT that this information was included in the documentation report (SN/SFT 2000). See also paragraph 4.

[11] Norway informed the ERT that part of this information was included in the documentation report (SN/SFT 2000). See also paragraph 4.

14. The ERT recommends that Norway add these elements to future NIRs. In its response to the draft of this report, Norway informed the ERT that the reporting of methods used in some sectors (paragraph 13 (e) above) has been improved in the 2002 submission and would be further improved in the inventory submission due in 2003.

15. The ERT noted that the CRF submitted in 2001 lacks:

(a) tables 4.B(b), 4.F and LUCF tables 5.A-5.D.[12] In its response to the draft of this report Norway informed the ERT that information corresponding to table 4.B(b) would be provided in the submission due by 2003. Norway also explained that field burning of agricultural residues (4.F) is not common in Norway, but that straw burning has been reported in the 2002 inventory submission. With regard to LUCF tables 5.A-D, Norway confirmed the use of country-specific methods for estimating emissions and removals from LUCF and informed the ERT that a change in methodology will be under consideration once the IPCC completes its work on good practice guidance on land use, land-use change and forestry;

(b) the use of notation keys in some tables (for example no notation keys are used in the energy sector or in the tables relating to HFCs, PFCs and $SF_6$);[13]

(c) some sectoral background data (for example table 1.A(d)).

16. The ERT recommends that Norway provide more comprehensive information in the future, as specified in the UNFCCC reporting guidelines, with a focus on areas with "no information" according to table 9 completeness. The ERT also recommends the use of tier 1 methods in the future for sources which have been qualified as probably insignificant. In its response to the draft of this report, Norway confirmed that these sources are insignificant and that there is a lack in activity data for these sources; however, efforts would be made to improve reporting of these sources in future.

## 2. Cross-cutting issues

Institutional arrangements

17. Institutional arrangements were not addressed by the desk review. Some information is included in the chapters on agriculture and LUCF.

Record keeping

18. No assessment of record keeping was made during this desk review.

Verification and quality assurance/quality control (QA/QC) approaches

19. Norway provided no information in its 2001 NIR on verification or QA/QC activities. Norway's response to the draft S&A report states that a project aiming to improve these processes is being carried out in 2001 and further work is planned. In its response to the draft of this report, Norway informed the ERT that information on verification has been included in the 2000 NIR as well as in a report entitled "Verification of the Norwegian emission inventory –

[12] According to the reporting guidelines, sectoral background data tables 5.A-D should be used by Parties using IPCC default methods to estimate emissions and removals from the LUCF sector. Norway used a country specific method to estimate emissions and removals from this sector.

[13] In its response to the draft of this report, Norway noted that notation keys had been used in table 7 (overview) of the CRF and stated that this information was also valid for all sectoral tables. According to the UNFCCC reporting guidelines, notation keys should be used to fill in the blanks in all the tables of an inventory (see FCCC/CP/1999/7, paragraph 21).

Comparing emission intensity values with similar countries". Norway also informed the ERT that some QA/QC activities were already explained in the 2002 submission and that it was planned to formalise and document QA/QC procedures further.

Recalculations

20. Norway reports recalculated data for 1990 and 1998 in table 8(a) of the CRF for 1990 and 1999, and detailed explanations in table 8(b) and in the NIR. For the year 1990, $CO_2$ and $CH_4$ emissions decreased by 0.26% and 0.95% respectively, and $N_2O$ emissions increased by 0.36%.

Uncertainties

21. No specific information is provided in the 2001 NIR in relation to quantitative estimates of uncertainty. However, major studies to quantify uncertainty, which take account of the IPCC good practice guidance, have been completed and several reports on the subject have been published.[14] Some qualitative information has been provided via table 7 of the CRF.

## 3. Areas for further improvement

Planned or ongoing work by the Party

22. The ERT notes that Norway:

(a) plans to use the data reported to the International Energy Agency (IEA) for the application of the reference approach relating to emissions in 2000;

(b) intends to improve completeness and transparency relating to the reporting of fugitive emissions for its next submission;

(c) states that work to facilitate data checking, documentation and archiving will begin in 2002.

23. The ERT encourages Norway to report on these matters in future submissions. In its response to the draft of this report, Norway informed the ERT that the plans indicated in paragraph 22 (a) have already been addressed in the 2002 NIR. With regard to reporting of fugitive emissions (paragraph 22 (b)), Norway informed the ERT that, in principle, the reporting of these emissions is complete; however, some activities have not been reported in the 2002 NIR either. In response to paragraph 22 (c), Norway explained that this work had started and that information would be provided in the 2003 NIR.

[14] According to information provided by the Party during the 2001 review process, the information on uncertainty in its previous report (SFT-report 1742/2000) also applies for the 2001 NIR. In addition, Norway references a report entitled "Uncertainties in the Norwegian Greenhouse Gas Emission Inventory", in which a detailed description on uncertainties can be found. These reports were, however, not subject to this desk review. All remarks related to uncertainties in the sectoral sections of this report are based on the information available in Norway's 2001 inventory submission, that is, the CRFs for 1990 and 1999, and the 2001 NIR entitled "Greenhouse gas emissions in Norway, 1990–1999". In its response to the draft of this report, Norway informed the ERT that information on uncertainties had been included in the 2002 NIR, and referred to the following web site from Statistic Norway, where one of the published reports on uncertainties could be found: http://www.ssb.no/emner/01/04/10/rapp 200013/.

Issues identified by the ERT

24. The ERT found that the inventory from Norway needs some further improvement in addition to the improvements relating to transparency already indicated in paragraphs 13-16 above. The ERT is aware of several publications, which describe the great amount of work already carried out on uncertainty analysis and verification procedures. The Party is encouraged to provide the salient findings of this work in a future submission.

25. The ERT encourages Norway to implement fully the IPCC good practice guidance, which Annex I Parties should apply as far as possible for their inventory submissions in the year 2001.[15]

26. *QA/QC:* The ERT encourages Norway to consider implementing and reporting the corresponding QA/QC procedures for the whole national inventory, consistent with the IPCC good practice guidance. This will help to overcome some existing inconsistencies and gaps in the current inventory. In its response to the draft of this report, Norway explained that it planned to improve its reporting on formal QA/QC procedures (see also paragraph 19 above).

27. *Emission factors*: More information is needed with respect to the various country-specific emission factors and how they have been derived.

28. *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), 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 (for example activity data in table 6.B).

29. *Completeness:* Norway may wish to consider in its future inventories some sources not covered in the current inventory. These sources include, for example, $N_2O$ emissions from manure management as well as some minor sources relating to industrial processes (see paragraph 65) and LUCF. Regarding $N_2O$ emissions from manure management, see also paragraph 11 above for information provided by Norway in its response to the draft of this report.

30. *Consistency*: Norway may wish to provide full coverage of the time series starting from 1990.

## 4. Consistency with the UNFCCC reporting guidelines and the IPCC Guidelines

31. The NIR and CRF were mostly consistent with the IPCC Guidelines and the UNFCCC reporting guidelines for estimating emissions. Both the IPCC Guidelines and country-specific methodologies were used for estimating emissions. Reporting in accordance with the UNFCCC reporting guidelines is at an advanced stage through well-completed CRF submissions for the years 1990 and 1999, supported by an NIR in 2001. However, important other items not yet reported in the NIR include calculation sheets[16] and information on uncertainties and QA/QC activities, as well as a full time series of CRF tables.

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[15] There are opportunities for closer adherence to the IPCC good practice guidance, for example with regard to reporting and documentation, taking into consideration the observations in paragraph 4 above. Good practice requires the reporting of summaries of methods used and references to source data such that the reported emission estimates are transparent and the steps in their calculation may be retraced. See also observations made in paragraphs 60, 76 and 159.

[16] See footnote 9.

### 5. Conclusion

32. The ERT recognizes that Norway's preparation and reporting of its national GHG inventory is at an advanced stage. The ERT considers that Norway should further improve information on its GHG inventory and GHG emission trends, in particular by providing inventory information in the CRF for all years from the base year to the year of the current annual inventory submission.[17]

## II. ENERGY

## A. Sector overview

33. Total emissions of GHGs in Norway increased by 8% from 1990 to 1999, from 52,027 kt to 56,190 kt. The increase in emissions of $CO_2$ was much greater, at approximately 19%. The energy sector accounted for 82% of $CO_2$ emissions and for 63% of all GHGs in 1999. The combustion of oil contributed three quarters of the $CO_2$ emissions from combustion sources, of which almost 60% emanated from transport sources.

34. Very little electricity is produced by thermal power plants in Norway. As a result, the contribution of the energy sector to total GHG emissions is much smaller than that of many Parties. Nevertheless, three key source categories in this sector accounted for almost half of all GHG emissions in 1999. These key source categories are the stationary combustion of oil and gas and road transportation.

### 1. Completeness

35. The energy sector of the Norwegian inventory is thoroughly covered with respect to the IPCC source categories, and emissions for all gases relevant to the sector are reported in the CRF.

### 2. Consistency

36. The same methods and data sources have been applied for estimating GHG emissions from the energy sector for all years from 1990.

### 3. Transparency

37. The reasons for the differences in $CO_2$ estimates between the reference approach and the sectoral approach are explained in detail. Notation keys are not used in the CRF tables for the energy sector.

### 4. Methodologies, activity data and emission factors

38. A national model taking into account technologies, emission sector and fuels is used in Norway to estimate a wide range of emissions to air from all recognised sources in the country. Emissions from stationary combustion sources are calculated by combining detailed sectoral fuel consumption figures with country-specific emission factors which take account of fuel, source, sector and gas. Measured emissions are used where available. A supplementary Norwegian

[17] The ERT takes note of the communication by Norway in which the Party states that the report entitled "The Norwegian Emission Inventory – Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants" contains much of the information relating to methodological issues that was not provided in the 2001 NIR. As explained in paragraph 4 above, this report has not been reviewed by the ERT during this desk review.

model is used to quantify emissions from road traffic. The energy data are provided by Statistics Norway.

39. The Norwegian estimation methods for the energy sector are fully harmonized with the IPCC Guidelines and are largely in accordance with the IPCC good practice guidance. The in-depth national approach is reflected in the prevalence of tier 2 methods and country-specific emission factors in table Summary 3 for combustion sources, although the table indicates some use of default emission factors for $CH_4$ and $N_2O$. According to Norway's comments on the draft of this report, a national methodology equivalent to tier 2 methods and national emission factors are also used for the significant fugitive emissions associated with oil and gas in Norway. For both sources of emissions, estimates are based on data reported by the companies.

### 5. Recalculations

40. Norway reports recalculated data for 1998 in table 8(a) of the 1999 CRF and detailed explanations in table 8(b). Overall, the recalculations result in very minor changes in the previous estimates of $CO_2$, $CH_4$ and $N_2O$ emissions from the energy sector. The most significant change occurs in relation to fugitive $CO_2$ and $CH_4$ emissions in subsector 1.B.1 Solid fuels, where the revised values for both gases have been reduced by 96%. This is explained by a change from a tier 1 default method to a tier 2 method for calculating $CH_4$ emissions from coal mining.

### 6. Conformity with the UNFCCC reporting guidelines and the IPCC Guidelines

41. The Norwegian models for estimating emissions from the energy sector take full account of the IPCC Guidelines through the application of well-developed national methods, generally equivalent to IPCC tier 2 methods, and detailed databases of energy and country-specific emission factors. There is full coverage of sources and gases, as reported in table 7 Overview. In addition, the NIR states that many elements of the IPCC good practice guidance are already being implemented. The information available suggests that some emissions associated with pipeline transport of oil and natural gas may be assigned to subsector 1.A.1 (c) Energy industries (manufacturing of solid fuels and other energy industries) rather than subsector 1.A.3 (e) Transportation (other transportation), given the great difference between their respective $CO_2$ emissions under gaseous fuels. However, in its response to the draft of this report, Norway confirmed that combustion emissions from pipeline transportation was reported under 1.A.3 Transport as required by the reporting guidelines.

42. Reporting in accordance with the UNFCCC reporting guidelines is at an advanced stage through well-completed CRF submissions in 2001, supported by an NIR. However, important other items not yet reported in the NIR include calculation sheets and information on uncertainties and QA/QC activities.

## B. Reference and sectoral approach

### 1. Comparison between reference and sectoral approaches

43. The CRF tables covering the estimation of $CO_2$ by using the reference approach are fully completed for 1990 and 1999 with good consistency in the basic data used for these years. Energy consumption and $CO_2$ emissions under the reference approach in 1999 were 36.3% and 7.2% higher, respectively, than for the sectoral approach. This contrasts with the findings for 1990 when, although energy consumption was also higher under the reference approach, $CO_2$ emissions were 7.8% lower than for the sectoral approach. Similar explanations are given for

both years in the documentation boxes. The ERT notes the somewhat low carbon emission factor of 23.49 t/TJ for bituminous coal among the list of country-specific values listed for the reference approach (refer also to paragraph 49 below).

### 2. Treatment of feedstocks and non-energy use of fuels

44. The reference approach calculations take full account of carbon storage in feedstocks and non-energy uses of fuels. For all fuel types relevant to Norway, except natural gas in table 1.A(d), the proportions adopted for carbon storage correspond to those provided in the IPCC Guidelines. In the case of natural gas feedstocks, all carbon is assumed to be sequestered, whereas the recommendation of the IPCC is that only about one third of the carbon is permanently stored. In its comments on the draft of this report, Norway explained that this assumption is justified by country-specific data.[18] The ERT notes the small change from 0.73 in 1990 to 0.82 in 1999 for the proportion of carbon stored by liquefied petroleum gas (LPG) feedstocks. Almost 60% of the carbon in the products covered by table 1.A(d) is emitted in industrial processes.

### 3. International bunker fuels

45. Emissions from international bunkers are reported in accordance with the IPCC Guidelines. Only very minor differences, of about one per cent, are evident between the IEA reported uses of marine bunker fuels in 1999 and those that appear in the CRF. However, in the case of international aviation, the IEA reported value for the use of jet kerosene was almost double that of the CRF. The Party has stated that the IEA amount includes the domestic share, which must be allocated to subsector 1.A.3(a).

## C. Key sources

46. The secretariat's preliminary key source analysis for Norway shows that the majority of the energy subsectors, covering stationary and mobile combustion of fuels and fugitive emission sources, are identified as key sources, even in cases where they contribute less than one per cent of total GHG emissions. This is due to the occurrence of important GHG emission sources across all IPCC reporting categories in Norway and a reduced influence from energy industries. The Party has performed its own tier 2 key source identification. The NIR describes the main emission sources according to the results of this evaluation but it does not include the source ranking.

### 1. Stationary combustion – $CO_2$

47. Emissions of $CO_2$ from stationary combustion of oil and gas accounted for 30% of Norway's GHGs in 1999 and for 30% of the emission trend.

48. The $CO_2$ implied emission factor (IEF) of 56.3 t/TJ in 1999 for liquid fuels under subsector 1.A.1.b Petroleum refining was the second lowest among reporting Parties. Norway confirmed that this IEF is determined by refinery gas. The same IEF appears for liquid fuels in subsector 1.A.2.c Chemicals in 1990 and 1999. This is also explained by the aggregation of refinery gas with oil under liquid fuels, as indicated in the documentation box in the case of the chemical industry.

[18] Norway also referred to the following document: Rypdal, K., $CO_2$ emissions estimates for Norway. Methodological difficulties. SN-document 2001:14.

49. The $CO_2$ IEF of 86.12 t/TJ for solid fuels under 1.A.1 Energy industries is among the lowest across the reporting Parties for 1999. This value occurs in subsectors 1.A.1.a, 1.A.2.b, 1.a.2.d and 1.A.4.c where the activity amounts are all very small. It is consistent with the rather low $CO_2$ emission factor for coal used in the reference approach. This IEF has been confirmed by Norway as the country-specific emission factor for Spitzbergen coal.

50. The combustion of gas in subsector 1.A.1.c Manufacture of solid fuels and other energy industries is the largest single source of $CO_2$ emissions in Norway. The NIR states that such emissions are associated with electricity generation and pumping operations for oil and natural gas installations. The ERT notes that according to the IPCC Guidelines, the emissions from pipeline transport should be assigned to subsector 1.A.3.e Other transportation rather than 1.A.1.c. While Norway's comments on the draft of this report state that combustion emissions from pipeline transportation are reported under 1.A.3, it remains unclear how the split between 1.A.1.c and 1.A.3.e is made, given the high emissions in the former source-category.

**2. Mobile combustion**

51. Emissions of $CO_2$ from mobile combustion in 1.A.3.b Road transportation accounted for 16.6% of total GHGs according to the key source level assessment.

52. The $N_2O$ IEF of 18.44 kg/TJ for gasoline combustion in subsector 1.A.3.b Road transportation is the second highest of the reporting Parties for 1999. In response to the draft review report, Norway informed the ERT that, though it assumes the $N_2O$ emission factor to be in accordance with good practice, it plans to make some further investigations into this factor.

**3. Fugitive emissions**

53. Fugitive emissions of $CO_2$ and $CH_4$ in 1.B.2. Oil and natural gas account for approximately 5% of total GHGs. A substantial proportion of the fugitive $CO_2$ emissions in the 1999 CRF are attributed to the transport of crude oil, which was also confirmed by Norway in its response to the draft of this report. However, the NIR states that these indirect emissions of $CO_2$ are associated with exploration and extraction. The use of tankers, rather than pipelines, to transport oil accounts for the high $CH_4$ emission factor (three times as high as the default value) under 1.B.2.a.

54. No fugitive emissions are reported in category 1.B.2.b relating to the exploration, production, transmission and distribution of natural gas, and no notation keys appear in the sectoral background data table. Fugitive emissions of both $CO_2$ and $CH_4$ appear under other leakage in this category but no associated activity data are given. Fugitive emissions of both $CO_2$ and $CH_4$ are reported for venting and flaring of gas under 1.B.2.c. In providing some further information during the review, Norway indicated that it is difficult to achieve a full breakdown of activity data among the various activities where fugitive emissions occur. In its response to the draft of this report, Norway explained that a split in the reporting can not be made because oil and gas production integrates production of both oil and gas. The corresponding notation key should have been "IE".

## D. Non-key sources

55. Very low IEFs are indicated for $CO_2$ from other fuels in subsectors 1.A.1.a Public electricity and heat (25.19 t/TJ) and 1.A.4.a Commercial/institutional (4.83 t/TJ) but the individual amounts of emissions concerned are very small.

56. The change by Norway in the methodology employed with respect to $CH_4$ emissions from coal mining has resulted in the lowest IEF (0.54 kg/t) for this subsector among the reporting Parties. The NIR describes how this is justified by the circumstances of the source concerned.

57. The amount of jet kerosene used in the CRF under 1.A.3.a Civil aviation (domestic) is almost double the IEA figure. The Party has confirmed that the CRF data are the more reliable as they are based on annual surveys of domestic consumption by airlines.

### E. Areas for further improvement

#### 1. Planned or ongoing work by the Party

58. Norway plans to use the data reported to the IEA for the application of the reference approach relating to emissions in 2000.

59. The Party intends to improve on completeness and transparency relating to the reporting of fugitive emissions in its next submission.

#### 2. Issues identified by the ERT

60. More information is needed in order to assess fully the transparency of inventory methods for emissions in the oil and gas industry as well as the background to the various country-specific emission factors. In its response to the draft of this report, Norway stated that, though it considers the inventory methods to be transparent, it intends to improve documentation of the methodology and country-specific emission factors of this sub-sector in its forthcoming documentation report.

## III. INDUSTRIAL PROCESSES

### A. Sector overview

61. Emissions resulting from industrial processes accounted for 26% of total emissions in Norway in 1990, decreasing to 20% in 1999. Industrial processes accounted for 17% of $CO_2$ emissions, which were 13% of all GHGs in 1999. The decrease in industrial processes from 1990 to 1999, -18% in $CO_2$ equivalent, was due basically to the figure for fluorinated gases, which has dropped by 59%, although HFCs increased almost 10,000 times in the same period. $CO_2$ relating to metal production accounted for 50% of total industrial processes emissions, of which 60% emanated from ferro-alloy production.

62. HFC, PFC and $SF_6$ emissions accounted for 10% of the country's total emissions (without $CO_2$ from LUCF) in 1990 and for only 3.8% in 1999. During the 1990–1999 period, the contribution of PFCs to total emissions of fluorinated GHGs decreased from 58.1% to 52.5%, and the contribution of $SF_6$ dropped from 41.9% to 39.1%. The share of HFCs in total emissions of fluorinated gases was negligible in 1990 but increased to 8.4% in 1999.

63. Information provided in the draft S&A report is confirmed.[19]

[19] The information contained in the report entitled "The Norwegian Emission Inventory – Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants" (SN/SFT 2000), which was also mentioned in the draft 2001 S&A, has not been used, as this report was not part of this desk review.

64. Norway uses a non-referenced notation for figures in the CRF: they are written in red, blue or black. The notations "NO" (not occurring), "NE" (not estimated), "NA" (not applicable), "IE" (included elsewhere) and "C" (confidential), are generally not used as they should be.

### 1. Completeness

65. Norway submitted industrial processes inventory data for the years 1990 and 1999 using the CRF. Omissions in the industrial processes sector are related to metal production ($CH_4$ and $N_2O$) and mineral products ($N_2O$). Emissions in these source categories are described in Norway's CRF as probably insignificant. In its response to the draft of this report, Norway confirmed that it considers these emission sources to be insignificant, and noted that the inventory could be improved in this area although this would be of low priority.

### 2. Consistency

66. Coverage of the industrial processes sector (NIR and CRF) is broadly consistent with the IPCC Guidelines and the UNFCCC reporting guidelines.

67. The ERT noted a lack of full coverage of the 1991–1998 period in the CRF, which limited consistency in the industrial processes sector.

### 3. Recalculations

68. Recalculations were made by Norway for the years 1990 and 1998. For 1990, recalculations in industrial processes were made in metal production, which changed by -2.2% (ferro-alloy production). New estimates are based on reported data from each company. The emission data include emissions from carbonaceous ores, dolomite and so on. Correction was made for water in coal and coke. The percentage of moisture varies from plant to plant and year to year, but averages about 10%.

69. For inventory year 1998, the same explanation was given for a -6.3% change in metal production (ferro-alloys production), but no explanation was given for the +1.1% change in mineral production. Activity data for ferro-alloy production in this year will be given only in the 2002 submission, according to a comment by the Party on the draft S&A report.

70. Recalculation of $SF_6$ actual emissions relating to the source category consumption of halocarbons and $SF_6$ resulted in a -0.11% change in 1990 emissions and a -1.2% change in 1998 emissions. Zero difference is noted, according to CRF table 8(a), between initial and recalculated emissions of PFCs from aluminium production, in both 1990 and 1998.

71. Recalculations of $SF_6$ and PFCs are not covered by CRF table 8(b) Recalculation – explanatory information.

### 4. Transparency

72. A general description of methods and data used is included in the NIR.

73. The activity data for the source keys in industrial processes are not provided in full for the base year and for 1999.

74. For the items nitric acid, calcium carbide, plastic, ferro-alloys and magnesium/nickel/ anodes, emission estimates were reported but no corresponding activity data or notation key (for example "C") were provided.

### 5. Comparability

75. The ERT came to the conclusion that comparability with regard to HFC, PFC and $SF_6$ emission estimates is sufficiently high.

76. The lack of activity data and a more detailed description of methods used makes comparability with regard to other emissions difficult, as there are country-specific (or even plant-specific) emission factors involved.

### 6. Methodology

77. The NIR and CRF (table Summary 3) contain a general description of methodology and steps taken to estimate emissions in the industrial processes sector.

78. No details of methodologies are provided in the NIR; however, reference to the report describing methodologies for estimating emissions is included.

79. The national inventory model is used to estimate emissions although emissions of fluorinated gases are calculated separately.

80. Methodologies from the IPCC Guidelines (IPCC tier 1a and tier 2) were used to estimate actual and potential emissions of fluorinated gases. A special model based on the survey for the years 1993–1997 was used to estimate the amount and distribution of chemicals in manufactured products and in operating systems.

### 7. Emission factors and activity data

81. There are some country-specific (or even plant-specific) emission factors involved, which cannot be assessed, such as for ferro-alloys, nitric acid and cement.

82. No activity data for PFCs and $SF_6$ from metal production and hence no implied emission factors are provided in the CRF.

83. The activity data for the key source categories in industrial processes are not provided in full for the base year and 1999.

84. Activity data on HFCs are presented in the appropriate CRF table (table 2(II).F). Some activity data, including data on fluorinated gases, are included in the NIR.

### 8. Good practices

85. The ERT concluded that in the industrial processes sector elements of good practices were introduced into the inventory process.

### 9. Uncertainty

86. Uncertainties of HFC, PFC and $SF_6$ estimates are not addressed in Norway's inventory submission 2001.

## B. Specific findings

Metal production

87. The Party's comments on the draft S&A report indicate a production of magnesium (category 2.C.4.2). Aluminium is also reported under 2.C.5 Other – magnesium/nickel/anodes.

## C. Key sources

### 1. 2.C.2 Ferro-alloy production – $CO_2$ (6.0% level assessment; 2.4% trend assessment)

88. $CO_2$ IEF in 1999: 2.83 t/t.

### 2. 2.B.2 Nitric acid production – $N_2O$ (3.3% level assessment; 7.0% trend assessment)

89. For reasons of confidentiality no activity data were provided in the CRF nor in the NIR, as there is only one plant. However, this should be reported as C.

### 3. 2.C.3 Aluminium production – $CO_2$ (3.2% level assessment)

90. Sources of the methodology and emission factor used were not given.

91. $CO_2$ IEF in 1999 (3.59 t/t) was among the highest among reporting Parties and higher than the IPCC defaults (1.5–1.8 t/t). In its response to the draft of this report, Norway explained this high IEF as owing to the unit for the IEF's being t $CO_2$ per t anodes consumed, whereas the default emission factors refer to t $CO_2$ per t aluminium produced.

### 4. 2.A.1 Cement production – $CO_2$ (1.6% level assessment; 1.6% trend assessment)

92. For confidential reasons, activity data were not provided (reported as C).

93. Emission data were provided for 1990 and 1999 only. Emissions increased by 34%.

94. In the NIR, Norway indicates, "due to growth in production emissions increased by 35% from 1990-94, and now have stabilised on the emission level of 1994".

### 5. 2.C.4.2 $SF_6$ use in magnesium foundries (1.3% level assessment)

95. No activity data were provided in the CRF nor in the NIR.

### 6. 2.B.1 Ammonia production (0.6% level assessment)

96. For reasons of confidentiality, activity data for ammonia production were not provided (reported as C) (one plant only).

97. Emissions from 1990 to 1999 reduced by 44% because, as the Party said, the ammonia factory has been partly closed down since 1998. The reduction in emissions is caused by the subsequent decrease in consumption of LPG in the process. (The factory has now been reopened.)

### 7. 2.B.4 Carbide production – $CO_2$ (2.6% trend assessment)

98. The 20% decrease in emissions of $CO_2$ is caused by smaller production volumes, with a subsequent reduction in the amount of petrol coke used in the process, as indicated by the Party. For calcium carbide only emissions but no activity data or corresponding notation key (e.g. "C") were reported.

### 8. PFCs from aluminium production – $CF_4$ and $C_2F_6$ (2.0% level assessment)

99. From 1990 to 1999, emissions of PFCs were reduced by as much as 63%, as a result of technological and process control improvements.

100. All emissions in this source category are estimated. Norway's NIR contains neither information about methods applied to estimate emissions of PFCs from aluminium production,

nor estimates of quality. According to Norway's response to the draft of this report, methodologies used in the calculation of PFCs from production of aluminium are described in detail in the documentation report (SN/SFT 2000) (see also paragraph 4 above). Norway further informed the ERT that the estimates are based on plant-specific measurements. Uncertainties of estimates are addressed neither in the CRF nor the NIR, although technologies used in aluminium production are generally described in the NIR. The IEF decreased from 3.49 to 1.11 tonnes $CO_2$ equivalent in the years 1990–1999. Norway explained in its response that emissions had been reduced due to improved technology and process control.

**9. Substitutes for ozone-depleting substances (ODS) (2.5% trend assessment)**

101. Total actual emissions from HFCs and PFCs used as substitutes for ODS amounted to 0.18 Mt of $CO_2$ equivalents in 1999. Compared to emissions in 1998, this represents an increase of about 36%.

102. Refrigeration and air conditioning equipment were the biggest source of halocarbon emissions in 1999. The increased provision of air-conditioning systems in new cars amplifies the rapid growth in this source category. Foam and foam blowing fire extinguishing products and aerosol propellants make a small contribution to overall emissions. As stated in the NIR, Norway does not manufacture halocarbons or $SF_6$.

103. Actual emissions of ODS substitutes were calculated using the IPCC tier 2 methodology, and potential emissions by employing the tier 1 methodology. The ratio between potential and actual emissions in 1999 is about five.

104. Activity data are provided in the CRF, and IEFs are calculated. Quality is self-assessed by Norway as high for HFCs. However for PFCs, assessment of quality and estimates of uncertainty are lacking for all gases.

## D. Non-key sources

Fluorinated gases

105. The largest $SF_6$ emission source in Norway is magnesium production. Electrical switchgears and the use of $SF_6$ as trace gas are the most important source of non-process emissions of $SF_6$.

106. The 1999 $SF_6$ emission estimate reported in CRF table 10 Emission trends differs from the value reported in other tables of the CRF.

## E. Areas for further improvement

Issues identified by the ERT

107. Norway may wish to consider including a more detailed description of the methods used in some source categories and the background to the various country-specific emission factors, as well as information on uncertainties in the NIR. Norway may also wish to provide some additional relevant information required in the CRF (information regarding fluorinated gases in overview table 7, information on PFCs and $SF_6$ in table Summary 3).

108. The ERT encourages Norway to use notation keys in the CRF tables.

# IV. AGRICULTURE

## A. Sector overview

109. Norway's inventory submission conforms to the UNFCCC reporting guidelines and the IPCC Guidelines. Norway has provided the following information required by the COP:

(a) A complete NIR and a set of CRF tables;

(b) Disaggregated estimates of all GHGs and sources not controlled by the Montreal Protocol using methods consistent with the IPCC Guidelines;

(c) A clear description of the methodologies used to calculate emissions and removals;

(d) References to sources of information relating to emission factors and activity data and the rationale for selection;

(e) Recalculated estimates (CRF table 8(a), and explanatory information (CRF table 8(b)), for these recalculations for the years 1990 and 1998. In addition, the NIR contained additional information on changes in activity data and emission factors;

(f) Major studies to quantify uncertainty.

110. The data provided by Norway using the CRF in electronic format were the same as those reported in the NIR. There were no notable differences, therefore, between the information provided in the CRF and in the NIR.

111. The Norwegian Pollution Control Authority has compiled the report in cooperation with Statistics Norway. Statistics Norway is responsible for developing the emission models, for the collection of activity data and for the calculations.

112. Emissions from the agricultural sector were estimated using both the IPCC Guidelines and country-specific emission factors and parameters, where available, or default emission factors and other parameters.

113. The largest sources of agricultural GHG emissions are $N_2O$ from soil processes and $CH_4$ from enteric fermentation from cattle and sheep.

### 1. Completeness

114. $N_2O$ emissions from manure management are not covered in the current inventory. Norway informed the ERT in its response to the draft of this report that $N_2O$ emissions from manure management would be included in the inventory in the submission due by 2003.

### 2. Trends

115. During the period 1990–1999, $CH_4$ emissions from agriculture increased by about 8.5% (101.3 to 109.9 Gg), mainly from enteric fermentation, while $N_2O$ has shown a decrease of 3.3% (8.6 to 8.3 Gg), resulting in an overall increase of about 2%.

### 3. Draft S&A report 2001

116. The main issues raised in the draft S&A report were relating to activity data, time series consistency, key sources and non-key sources. Norway provided responses to all issues raised in the draft S&A report.

## B. Key sources

### 1. 4.A Enteric fermentation – $CH_4$

117. The reporting of emission estimates for this source category conforms to the UNFCCC reporting guidelines.

118. $CH_4$ emissions from humans were also reported in this category. Norway informed the ERT in its response to the draft of this report that these emissions were no longer included in the 2002 NIR.

Methodology

119. Methane emissions from ruminants were estimated using the IPCC Guidelines and country-specific emission factors. The tier 1 method was used. Differences occur for sheep and swine in activity data values compared to other sources. In its response to the draft of this report, Norway explained the differences from other sources of data as being owing to correction of data according to good practice to take into account the fact that the lifetime of an animal can be less than a year, which is particularly important for sheep which may be counted in the summer and slaughtered in the autumn. This could result in possible deviations from other sources of data.

Recalculations

120. Recalculations have been performed in the agricultural sector. Regarding enteric fermentation, no big change was reported.

Activity data and emission factor

121. Norway uses annual data for animal populations, which are prepared by Statistics Norway. In its response to the draft of this report, Norway informed the ERT that yearly population data were based on administrative data from the Norwegian Agricultural Authority (as these data are the basis for providing financial support). The yearly annual population data are calibrated using the animal population census which takes place every 10 years.

Uncertainty

122. No specific information is provided in the NIR in relation to quantitative estimates of uncertainty. Major studies to quantify uncertainty, which take account of the IPCC good practice guidance, have been completed, and several reports on the subject have been published.

### 2. 4.D Agricultural soils – $N_2O$

123. The reporting of $N_2O$ emission estimates for agricultural soils are in conformity with the UNFCCC reporting guidelines. Several emission factors and parameters were country-specific.

124. The consumption of lime combined with an emission factor of 0.44 tonne/tonne is used. Therefore, emissions of GHGs from this source have been reduced by about 25%. Estimates of the fraction of synthetic N fertilizer applied to soils which volatilizes as $NH_3$ and $NO_X$ were reported.

Methodology

125. $N_2O$ emissions from agricultural soils were estimated using the IPCC Guidelines and country-specific parameters.

Recalculations

126. Norway reports recalculated data for 1990 and 1998 using table 8(a) of the CRF, and provides detailed explanations in table 8(b) and in the NIR. For the base year 1990, $CH_4$ emissions were decreased by 0.95%, and $N_2O$ emissions were increased by 0.36%.

Activity data and emission factors

127. Activity data used were provided by Statistics Norway. Mainly IPCC default emission factors were used, with country-specific emission factors when available. The activity data and emission factors used in the Norwegian inventory model are described in the report of the Norwegian Emission Inventory (SN/SFT 2000).

Uncertainty

128. Published studies to quantify uncertainty, which take account of the IPCC good practice guidance, have been completed and reports are available.

### C. Non-key sources

#### 1. 4.B Manure management – $CH_4$

129. $CH_4$ emission estimates are provided. Information on activity data and other parameters for additional livestock types are provided in the NIR, while data for $N_2O$ is not reported (see also paragraph 114 above for information provided by Norway in its response to the draft of this report).

130. $CH_4$ IEF values for sheep are higher than IPCC values. Norway informed the ERT in its response to the draft of this report that, in contrast to the practice in most other countries, in Norway sheep are kept indoors for parts of the year. This practice leads to the manures being stored, and consequently the rates of emissions are different.

#### 2. 4.D Agricultural soils

131. Norway included $CO_2$ from liming of agricultural soils in this category.

## V. LAND-USE CHANGE AND FORESTRY

### A. Sector overview

132. The LUCF sector constitutes a reported sink for $CO_2$ of 17,742 Gg in 1999 which, in absolute terms, is equivalent to 42.6% of Norway's total 1999 gross $CO_2$ emissions. A country-specific method was used for the estimation of emissions for the LUCF sector.

#### 1. Institutional arrangements

133. The GHG inventory in the LUCF sector is part of the NIR and CRF tables prepared by the Norwegian Pollution Control Authority. Statistics Norway provided data for the LUCF sector and other sectors of the CRF in accordance with a cooperation programme on emission inventories established with the Norwegian Pollution Control Authority. The Norwegian Institute of Land Inventory undertakes a national forest inventory each year. From this survey,

and from annual estimates of fillings and other removals, the figures for uptake and emissions of $CO_2$ were calculated.

### 2. Verification and QA/QC

134. The NIR does not include information on quality assurance, quality control or verification review procedures for the 1990 and 1999 LUCF sector estimates. The NIR notes that as a general rule the estimation methods follow the IPCC Guidelines. The CRF table 7 Overview, however, does include qualitative indicators for estimated sources, with the value of "L" (low) being given to the quality of the estimate for changes in forest and other woody biomass stocks.

### 3. Completeness

135. Within the LUCF sector, estimates of emissions for changes in forest and other woody biomass stocks (for boreal forests) are reported only in CRF table 5 Sectoral report for LUCF. Tables 5.A, 5.B, 5.C and 5.D were not utilized, given that the IPCC methodology was not used.[20] The calculations were shown in appendix table 5.A attached to the CRF tables. Norway stated in its NIR, "According to the IPCC Guidelines, the reporting of emissions and uptake from LUCF should focus on three activities, namely changes in forest and other woody biomass stocks, forest and grassland conversion and abandonment of managed lands. In Norway it is difficult to separate the contributions from the three different categories, hence we have reported the uptake and emissions under changes in forest and other woody biomass stocks. This can be found in table 5 of the reporting tables. To provide more detailed information, we have enclosed an additional table (see appendix table 5.A on the last page of the reporting tables in appendix 2 and 3 to this report). We calculate the emissions employing the IPCC default method, where harvested wood is counted as emissions the year the harvest takes place. Hence, uptake in harvested wood products is not included."

### 4. Transparency

136. Notation keys should have been used in table 5 where no estimates were given. The NIR gives details as to how the estimates for the LUCF sector were obtained.

### 5. Recalculations

137. Norway provided recalculated estimates in table 8(a) for 1990 and 1998. An explanation for these recalculations was provided in table 8(b).

### 6. Uncertainties

138. Qualitative uncertainty estimates were provided in summary report table 7 of the CRF, but no additional information was provided in the NIR.

### 7. Consistency with the UNFCCC reporting guidelines and the IPCC Guidelines

139. The LUCF sector for Norway can be regarded as being mostly consistent with the IPCC Guidelines and the UNFCCC reporting guidelines.

[20] According to the UNFCCC reporting guidelines on annual inventories, these tables should be filled in only by Parties that use IPCC default methodologies.

## B. Specific source and sink categories

### 1. 5.A Changes in forests and other woody biomass stocks

Methodology

140. Some details were provided in the NIR on the methodology used to calculate the 1999 estimate of removals by forests and other woody biomass stocks of -17,742 Gg of $CO_2$. It would have been helpful if Norway had included some key details in the documentation box to table 5.A.

Activity data

141. The source of the activity data for forests and other woody biomass stocks was reported on page 32 of the document *Greenhouse Gas Emissions in Norway 1990–1999* (Oslo, April 2001) as being the Norwegian Institute of Land Inventory.

Conversion factors and implied emission factors

142. Conversion factors and IEFs for forests and other woody biomass stocks were not reported in the CRF.

### 2. 5.B Forest and grassland conversion

143. Net emissions from forest and grassland conversion were not reported.

### 3. 5.C Abandonment of managed lands

144. Net emissions from abandonment of managed lands were not reported.

### 4. 5.D $CO_2$ emissions and removals from soil

145. Net $CO_2$ emissions and removals from soil were not reported.

## C. Areas for further improvement

146. Norway is encouraged to check the data for gross removals and net removals of $CO_2$ in table 5. The figure of -17,742 Gg of $CO_2$ reported as $CO_2$ removals is actually net $CO_2$ removals. Norway informed the ERT in its response to the draft of this report that corrections have been made in the 2002 NIR.

147. Norway, although using a country-specific method, is encouraged to attempt to present data on its changes in forest and other woody biomass stocks in the format of table 5.A, as this would facilitate comparison with other Parties in the future.

# VI. WASTE

## A. Sector overview

148. The quantity of 1999 GHG emissions from the waste sector was slightly higher than that of 1990; however, the contribution of this sector to total national emissions had decreased.

149. Emissions from key sources had decreased slightly due to three management mechanisms: (i) a disposal tax was introduced, applying to landfill sites, (ii) gas recovery was promoted and (iii) waste recovery was significantly increased.

### 1. Completeness

150. The information provided in the additional information boxes was sufficient, but original sources of annual waste were not indicated.

### 2. Trends

151. The trend for $CH_4$ emissions from the waste sector shows a slight increase from 1990 to 1997. According to the NIR, however, waste disposal tax, waste recycling, schemes and gas recovery are increasingly being implemented. Accordingly, $CH_4$ emissions from the waste sector show a maximum in the year 1996. Regarding emissions from waste-water handling, it is interesting to observe that from 1990 to 1999 the increase in $CH_4$ emissions from this source was 5% whereas for the same source category the increase in $N_2O$ emissions was 32%.

## B. Key sources

### 1. 6.A Solid waste disposal on land

Methodology

152. The methane generation rate constant is quite high, as is also indicated in the draft S&A report. $CO_2$ from waste disposal on land is noted as "report only combusted at the site". However no details of on-site combustion are given. The draft S&A report indicated no data for population and waste generation rate in table 6.A of the CRF. Since the tier 2 method was introduced, population and waste generation rate data have been omitted but original sources of waste quantities should be indicated.

Emission factor

153. The IEF is quite high compared to other Parties. This may be due to the methane generation rate constant (0.07) which implies rapid degradation. The high degradable organic carbon (DOC) fraction reported (0.27) indicates high organic waste content. Waste composition was similar to that of other Annex I Parties using DOC fraction 0.11 (for example, Italy). The reason for the rapid degradation has still to be explained. In its response to the draft of this report, Norway informed the ERT that, in addition to the methane generation rate constant of 0.07, the rapid degradation of organic waste might have been owing to the fact that Norway used a higher half-life (9.5 years for consumer waste, and 11.5 years for production waste and industrial waste) in its calculation model. The model also takes into account the kinetics of methane production based on waste deposited since 1945. Furthermore, Norway uses a share of 55% methane in the produced landfill gas which might be higher than other Parties, whereas the share of landfill gas removal (flaring, oxidation layer or electricity production) might be lower in Norway.

## C. Non-key sources

### 1. 6.B Waste-water handling

Methodology, emission factor and activity data

154. There was a lack of activity data for industrial waste water, domestic and commercial waste water and $N_2O$ estimates from human sludge, whereas annual industrial waste-water volumes were indicated in the additional table.

155. No IEFs were calculated despite the tabulation of industrial waste-water volumes.

156. Activity data in table 6.B and the additional information box were found to be incomplete.

### 2. 6.C Waste incineration

Methodology

157. The amount of waste was provided in the activity data but the type of waste was not specified. However, no estimations of $CO_2$ and $CH_4$ were taken into account. According to Norway's comment on the draft S&A report, emissions from waste incineration were reported in the energy sector. Therefore, no implied emission factors were calculated, despite the existing data in the CRF regarding waste quantities.

Recalculation

158. Recalculation resulted in a reduction of about 1.8%.

## D. Areas for further improvement

159. The ERT recommends complete reporting of activity data for waste-water handling.

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