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NORWAY

REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY SUBMITTED IN THE YEAR 2003[1]

(Desk review)

I. OVERVIEW

A. Introduction

1. In accordance with decision 19/CP.8 of the Conference of the Parties, the United Nations Framework Convention on Climate Change (UNFCCC) secretariat coordinated a desk review of the 2003 greenhouse gas (GHG) inventory submission of Norway. The review took place from 13 to 31 October 2003, and was conducted by the following team of nominated experts from the roster of experts: Generalist – Mr. Samir Amous (Tunisia) and Mr. Bernd Gugele (European Community), Energy – Mr. Lambert Schneider (Germany) and Mr. Francis Yamba (Zambia), Industrial Processes – Mr. Luis Conde Alvarez (Mexico) and Mr. Tinus Pulles (the Netherlands), Agriculture – Mr. Vitor Góis (Portugal) and Mr. Haruo Tsuruta (Japan), Land-use Change and Forestry (LUCF) – Mr. Mikhaill Gytarsky (Russia) and Mr. Tomás Hernández-Tejeda (Mexico), Waste – Ms. Elizabeth Scheehle (United States) and Mr. Charles Jubb (Australia). Mr. Samir Amous and Mr. Mikhaill Gytarsky were the lead reviewers of this review. The review was coordinated by Ms. Sevdalina Todorova-Brankova (UNFCCC secretariat).

2. In accordance with the UNFCCC "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention", 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.

3. The expert review team (ERT) commends Norway for the improvement of its inventory submission since the previous review, particularly with regard to the improvement of the quality assurance/quality control (QA/QC) plan. It acknowledges the Party's supportive attitude to the review and its efficient cooperation with the review team, including the efforts it has made to provide additional reference materials and detailed and comprehensive answers in response to the questions of the review team.

B. Inventory submission and other sources of information

4. In its 2003 submission, Norway submitted a set of common reporting format (CRF) tables for the years 1990 and 1998–2001. A national inventory report (NIR) has been submitted, which is structured following the outline of the revised UNFCCC reporting guidelines adopted by decision 18/CP.8. Where needed the ERT also used previous years' submissions, additional information provided during the review and other information. The full list of materials used during the review is provided in annex 1 to this report.

[1] In the symbol for this document, 2003 refers to the year in which the inventory was submitted, and not to the year of publication. The number (1) indicates that this is a desk review report.

C. Emission profiles and trends

5. In the year 2001, the most important GHG in Norway was carbon dioxide (CO_2), contributing 74.0 per cent to total[2] national GHG emissions expressed in CO_2 equivalent, followed by methane (CH_4) – 12.4 per cent – and nitrous oxide (N_2O) – 9.9 per cent. Perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) taken together contributed 3.7 per cent of the overall GHG emissions in the country (HFCs 0.5 per cent, PFCs 1.8 per cent and SF_6 1.4 per cent of the total). Excluding LUCF, the Energy sector accounted for 64.6 per cent of total GHG emissions, followed by Industrial Processes (18.8 per cent), Agriculture (9.0 per cent) and Waste (7.3 per cent). Total GHG emissions (without LUCF) amounted to 56,222 Gg CO_2 equivalent and increased by 8.1 per cent between 1990 and 2001. There were increases in emissions of CO_2 without LUCF (+19.3 per cent), CH_4 (+8.5 per cent), N_2O (+1.3 per cent) and HFCs (+1,591,399 per cent), whereas emissions of PFCs and SF_6 decreased, by 66.2 per cent and 65.1 per cent, respectively. The main increases in CO_2 emissions were in energy industries, where they were due to large increases in oil and gas production, and in transport, due to large increases in emissions from diesel road vehicles and from navigation related to the petroleum sector. The main increases in CH_4 emissions were in the oil and natural gas sector due to increases in oil and gas production. N_2O emissions increased primarily from transport because of increasing use of catalytic converters.

D. Key sources

6. The Party does not provide a new key source analysis but presents the same results as the year before. It does not provide a table with key sources (as source category/gas combinations) but provides tables with those parameters – activity data (AD), emission factors (EFs) – which contribute most to the level and trend for the years 1990 and 2010. Norway has performed a tier 2 analysis to determine key sources by both level and trend. The key source analysis is summarized in the NIR and described in more detail in a separate report on uncertainties in the Norwegian Greenhouse Gas Inventory (SN 2000). The 2002 in-country review report mentions that Norway indicated that it uses this key source analysis to prioritize work to improve the accuracy of its national inventory. The ERT encourages Norway to include in its next submission a clearer description of the link between the key source analysis and the improvement programme, for example, by providing a summary overview of these plans in the section on key sources. The key source analysis performed by the Party and that performed by the secretariat[3] produced different results, mainly because of the different approaches used (tier 2 and tier 1, respectively).

E. Main findings

7. The national inventory submitted by Norway is generally in conformity with the UNFCCC reporting guidelines. The Party mentions in the NIR that the following improvements have been carried out in response to the previous review report: (a) the various sectors are described in more detail in the 2003 NIR than in the 2002 NIR, especially Agriculture and LUCF; (b) the issue of CO_2 capture and storage, which is of relevance for Norway, is also described in the 2003 NIR; (c) the use of notation keys is more extensive than before; and (d) table 4.B(b) has been completed with data on N_2O emissions from manure management.

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[2] In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO_2 equivalent excluding LUCF, unless otherwise specified.

[3] The 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 providing a full CRF for the year 1990. Where the Party has performed a key source analysis, the key sources presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key source assessment conducted by the secretariat.

8. Issues identified in previous reviews as needing further attention are: (a) the provision of CRF tables for the complete time series; (b) further extension of the use of notation keys; (c) more detailed description of methods, EFs, sources of AD, quantitative uncertainty analysis and verification procedures in the NIR; and (d) further implementation of the *Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) with the development and implementation of a QA/QC plan.

F. Cross-cutting topics

Completeness

9. Norway has submitted inventory data for the years 1990, 1998, 1999, 2000 and 2001 using the CRF and summary data for the period 1990–2001 inclusive. As Norway has commented, because resources are limited it has decided to give priority to improving the quality of the inventories rather than to compiling the CRF for the missing years. The NIR provides a general assessment of completeness and mentions that the Party plans to submit a complete set of CRF tables for all years in 2004. However, in the course of the review the Party informed the ERT that it will not submit a full set of CRF tables for all years in the 2004 NIR. In addition the NIR notes a few minor sources for which estimates of emissions are not included, such as N_2O from aerosol propellant used in spray boxes, CH_4 from agricultural waste, CO_2 from agricultural soils, N_2O from the application of industrial and urban wastes on fields, and CO_2 removals from forest soils. These sources have been omitted because of lack of data or because they were not prioritized in the national inventory work because their contribution to the national GHG emissions total is insignificant. Norway notes that, as the national inventory system is being improved, several of the above sources/sinks are expected to be addressed in the near future.

Transparency

10. In general, the CRF and the NIR are fairly transparent in terms of documentation of background information and the assumptions and methodologies used for preparing the inventory. However, in some sectoral background tables notation keys are still only used in a limited way, and their extended use would further increase the transparency of the inventory. A number of background documents were made available during the review, which contributed to the transparency of the Norwegian submission. A key document for understanding the methods and data used in developing the national inventory is *The Norwegian Emission Inventory* (SN/SFT 2000). The ERT encourages Norway to incorporate additional information from these background documents in its next NIR. Transparency would be further improved by removing a few inconsistencies between the CRF and the NIR. AD for cement, ammonia and calcium carbide production are missing for confidentiality reasons.

Recalculations and time-series consistency

11. The Party has provided recalculated estimates (table 8(a)) and explanatory information for 1990 and 1998–2000 (table 8(b)). A few inconsistencies were found between the recalculations performed by the secretariat and those performed by the Party, and were clarified by the Party in its response to the earlier stage of the 2003 review. The recalculations performed by the secretariat show that Norway has also made recalculations for the years 1991–1997, for which no CRF tables have been provided. For the inventory year 1990 (base year) the effects of the recalculations are an increase of 0.09 per cent in CO_2 equivalent emissions excluding LUCF and a decrease of 0.30 per cent including LUCF. The largest changes resulting from the recalculations are for N_2O and in the Agriculture sector. The recalculations for N_2O from agricultural soils are due to a revision of EFs and of AD and to the inclusion of emissions from sewage sludge applied on fields. For the inventory year 2000 the effects of the recalculations are an increase of 0.72 per cent in CO_2 equivalent emissions excluding LUCF and of 1.09 per cent including LUCF. For 2000 as well, the largest changes due to recalculations are for N_2O from agricultural soils, for the same reasons as mentioned above. The reasons for the recalculations are explained in a transparent

manner in CRF table 8(b) and in the NIR. The ERT encourages Norway to provide the full CRF inventory (including tables 8(a) and 8(b)) for every year recalculated.

Uncertainties

12. Norway has not provided new quantitative uncertainty estimates but presents the results of the two studies also included in the 2002 NIR (SFT/SN 1999a and SN 2000). In response to the draft review report, Norway clarified that it believes that the uncertainty estimates provided in the 2002 NIR in general are still valid as a basis for its tier 2 key source analysis. In SN 2000, the uncertainty level of total Norwegian GHG emissions in 1990 was estimated to be 21 per cent, using the tier 2 method. The estimated uncertainty in trend is 4 per cent for the period 1990–2000. The major elements of the uncertainty analysis of SN 2000 are summarized in annex 5 of the NIR. In SFT/SN 1999a, a qualitative evaluation of the uncertainty in the Norwegian GHG inventory of each gas was made, addressing EFs, AD and direct measured emissions, using the tier 1 method. The uncertainty in level in the report SFT/SN 1999a was found to be 11–17 per cent for 1996, which is somewhat below the tier 2 uncertainty estimates for 1990 mentioned above. Qualitative uncertainty estimates are provided in CRF table 7; according to these tables, the uncertainty has not improved compared to the previous year.

Verification and quality assurance/quality control approaches

13. The Party mentions that it has not yet implemented a formal QA/QC or verification plan. However, several checks are formalized and include: (a) a stepwise procedure in the preparation of the final national emission inventory, including recalculations to ensure time-series consistency; (b) checking of the data and relevant information collected by the Norwegian Pollution Control Authority (SFT) and Statistics Norway (SN), and the following up of all discrepancy issues; and (c) quality control of the emission estimates through comparison with corresponding figures calculated earlier and consistency checks with figures for the neighbouring years. In 2001, a total quality management project was started. One of the results of this project is that SN designed a new emission model in 2002/2003, which (a) makes automatic controls easy, (b) handles long time series better, and (c) registers all changes made to the inventory system (including time and responsible person). In addition, the new model facilitates the QA/QC of input data rather than the output data only. Input data include emissions reported from large plants, AD, EFs and other estimation parameters. In terms of verification, the NIR mentions that emission estimates for a source are often compared with estimates based on different methodology. Examples are Metal Production and Agriculture. It also mentions a project where the Norwegian emission inventory was compared with the inventories of Canada, Sweden and New Zealand.

G. Areas for further improvement

Identified by the Party

14. The improvements identified by the Party and related to general issues include: (a) the provision of a full description of the improved inventory system and documentation of the new emission model in a comprehensive report in 2004; (b) improved use of notation keys; and (c) making the inventory more complete by addressing several of the sources/sinks not yet addressed. In addition, sector-specific improvement plans are mentioned in the NIR.

Identified by the ERT

15. The ERT identified the following major areas for improvement related to cross-cutting issues in the inventory: (a) a key source analysis for the latest year should be provided with a ranked list of key source categories (in the form of source category/gas combinations) in addition to the list of parameters; to ensure a transparent link between the key source analysis and the improvement programme, conclusions as regards future developments should be included in the section on key sources of the NIR; (b) more explanation should be provided as to why certain parameters have high uncertainty (e.g., AD for oil used for domestic shipping); the conclusions from the uncertainty analysis should be linked to the

improvements planned; (c) CRF tables should be provided for all years for which recalculations have been made; (d) a QA/QC plan and other procedures according to the IPCC good practice guidance should be further developed; (e) a section should be included in the NIR summarizing planned improvements which are not sector-specific in the chapter on recalculations (as provided for in the structure of the NIR as outlined in FCCC/CP/2002/8 (chapter 10.4)); and (f) more information should be provided on country-specific EFs and conversion factors and how they have been derived.

16. Recommended improvements relating to specific source/sink categories are presented in the relevant sector-specific sections of this report.

II. ENERGY

A. Sector overview

17. In the year 2001, the Energy sector contributed 64.6 per cent of total GHG emissions in Norway (without LUCF). Fuel combustion is the main source, accounting for 91.2 per cent of GHG emissions in the sector. Fugitive emissions (8.8 per cent) are also significant because of the extent of Norway's oil and natural gas activities. Fugitive emissions have grown substantially, by about 40 per cent from 1990 to 2001, mainly as a result of the increase in oil and gas production. Within the Energy sector, the most important sources are emissions from road transportation with 27.4 per cent and manufacture of solid fuels and other energy industries (mainly offshore gas turbines) with 25.4 per cent of emissions from the sector. Public electricity and heat production is a minor source (0.8 per cent), as electricity is produced using almost exclusively hydropower. In 2001, GHG emissions in the Energy sector were well above the 1990 level – by 24.1 per cent.

18. In the Energy sector, Norway uses mostly country-specific methodologies, including some sophisticated models. The EFs used are mainly country-specific for CO_2 emission estimates, and country-specific, IPCC and CORINAIR default EFs for CH_4 and N_2O emission estimates. For the years reported, estimates are largely complete. For some sectors, in particular fugitive emissions, the use of notation keys should be improved. The description of methodologies in the NIR has improved considerably compared with the 2002 submission. To further improve the transparency of the inventory, more background information should be provided for emission and oxidation factors and net calorific values, including the rationale for their choice and references.

19. Carbon dioxide EFs for various fuels are provided on page 55 of the NIR and in table E2 in SN/SFT 2000. For these EFs, the only clear and transparent reference is to a publication of 1990 (SN/SFT 1990). The Norwegian team agrees that there is a need to examine whether some of the EFs used in the Norwegian inventory should be updated, and this is planned as future work. To improve the transparency and consistency of the reporting in the NIR and the CRF, the ERT encourages Norway to provide in the NIR clear and transparent references for all EFs and net calorific values for specific fuels and for the whole time series where they change over time. The ERT also encourages Norway to undertake a reassessment of the appropriateness of its EFs and net calorific values and, if necessary, adapt them on a continuous basis.

B. Reference and sectoral approaches

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

20. In 2001, the difference between the reference and the sectoral approaches amounts to 32.0 per cent for energy consumption and 7.3 per cent for CO_2 emissions. Norway explained the differences between the approaches during the review. The extent of its production of oil and gas and the use of energy as feedstock affect the reference approach estimates. The end-use energy statistics used for the sectoral approach are considered to be accurate. However, while in 1999, 2000 and 2001 in the reference approach CO_2 emissions were approximately 8 per cent higher, they were about 4 per cent lower in 1990. This contrariwise deviation in the base year cannot be sufficiently explained by systematic differences

between the approaches. The ERT encourages Norway to consider and explain the contrariwise deviation between the estimates for the base year and more recent years of the inventory.

21. As in the previous submission, there are significant differences between the AD reported in the CRF and the International Energy Agency (IEA) data, in particular regarding liquid fuels and natural gas. The ERT encourages Norway, in cooperation with the UNFCCC secretariat, to further explore the differences between its AD and the IEA data. The ERT notes that additional information from IEA on the sources of its data would be helpful in this regard.

International bunker fuels

22. GHG emissions from international bunkers (marine and aviation) have been estimated and reported separately from domestic estimates, in accordance with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC Guidelines). A new methodology has been applied to separate domestic from international fuel use for aviation. The ERT noted the rather high uncertainty of the new method (about 20 per cent) and encourages Norway to reduce the uncertainty if possible. The ERT also encourages Norway to provide a more detailed description of the methodology in its next inventory submission, as the relevant background information (SN 2002) is only available in Norwegian.

Feedstocks and non-energy use of fuels

23. According to information provided by Norway during the review, Norway estimates the content of carbon stored separately for different sectors and fuels. While significant amounts of natural gas were used as feedstocks in 1998–2001, Norway reports that no natural gas was used as feedstock in 1990. In responses during the review, Norway explained that natural gas is only used in one plant which was not yet operating in 1990. To enhance the transparency of its reporting, the ERT encourages Norway to include in its future submission a more detailed description of how the country-specific values of carbon storage from feedstocks were derived.

C. Key sources

Stationary combustion: natural gas – CO_2

24. According to the NIR, CO_2 emissions from combustion of natural gas in Manufacturing of Solid Fuels and Other Energy Industries (category 1.A.1c) are one of the most important emission sources in the Norwegian inventory. According to the NIR, Norway uses an average CO_2 emission factor of 57.3 t/TJ, taken from OLF 1994. However, the implied emission factor (IEF) in the CRF tables varies in the time series (between 57.16 t/TJ and 57.56 t/TJ). In its responses to questions from the ERT, Norway explained that for one specific plant a different EF is used, which affects the IEF, and that it intends to evaluate the choice and references of net calorific values and to collect field-specific CO_2 EFs for natural gas. The ERT encourages Norway to reassess the appropriateness of the CO_2 EFs for natural gas and to develop, if possible, a methodology to estimate the CO_2 EFs with field-specific information in a continuous manner, reflecting changes in the composition of natural gas over time, and to document the approach transparently.

Mobile combustion: liquid fuels – CO_2, and N_2O

25. Some country-specific CO_2 EFs are quite high or low compared with those reported by other Parties and the IPCC default values. This is the case, for example, with gasoline (where the Norwegian EF is 71.3 t/TJ, while the IPCC default is 73 t/TJ) and with heavy fuel oil (the Norwegian EF is 78.8 t/TJ, whereas the IPCC default is 77.4 t/TJ). The ERT recommends that the Party provide clear references to the national EFs used in its calculations.

26. Norway uses a sophisticated road traffic model, which is described in the NIR and in SN/SFT 2000. The N_2O IEF for gasoline appears to be rather high (24.5 kg/TJ in 2001) and higher than the IPCC

default range (which is 1–20 kg/TJ). In describing the model in the NIR, the ERT encourages Norway to provide more key background information, for instance, by providing the N_2O EFs for different pollution control technologies.

Fugitive emissions: oil and natural gas operations – CO_2 and CH_4

27. Norway estimates CO_2 and CH_4 emissions from the extraction, processing and transport of natural gas and oil using mostly specific EFs from the relevant sites (platforms, terminals, etc.). EFs are mostly reported directly by operators to the Government. In response to previous reviews, the description of the methodologies and sources of emissions has been improved. However, as the methodology and EFs are highly country-specific and differ partly from the IPCC default range (e.g., the IEF for oil transportation is significantly higher than the IPCC default value, while emissions from venting appear to be relatively low), the ERT encourages Norway to provide more background information in the NIR or in a separate report, in particular to explain how data are gathered and what EFs are applied to the different activities.

28. As indicated in the 2001 review, for several activities it is unclear whether and where they have been estimated. According to the NIR, the exploration and production of both oil and natural gas seem to be included under 1.B.2c Venting and Flaring. However, the NIR does not provide any information as to whether fugitive emissions from the transport and distribution of natural gas have been estimated. Notation keys have not been used. The ERT encourages Norway to document more transparently the methodologies used and the allocation of emissions in the CRF tables.

D. Non-key sources

Stationary fuel combustion: biomass – CO_2

29. As indicated in the previous review, the CO_2 IEFs for fuel combustion of biomass are generally rather high compared with those reported by other Parties. The ERT encourages Norway to check the methodology and estimates for this source, although it notes that this is not one of the higher-priority tasks.

Stationary fuel combustion: other fuels – all gases

30. In categories 1.A.1a Public Electricity and Heat Production and 1.A.2d Pulp, Paper and Print, Norway reports the combustion of "other fuels", but the fuels are not specified in the CRF or the NIR. The CO_2 IEFs (23.9 t/TJ) appear to be quite low compared with those of other Parties. In its response to the draft review report, Norway further explained the composition of the "other fuels" as being mainly residential and commercial waste and biomass. The ERT encourages Norway to specify transparently which fuel types are included under "other fuels" in the CRF tables and to provide relevant background information in the NIR.

III. INDUSTRIAL PROCESSES AND SOLVENT USE

A. Sector overview

31. In the year 2001, total GHG emissions from the Industrial Processes sector in Norway amounted to 10,570 Gg CO_2 equivalent, that is 28.4 per cent of net emissions or 18.8 per cent of total emissions excluding LUCF. Of these about two-thirds was emitted by 2.C Metal Production and a little over one-fifth originated from processes included under category 2.B Chemical Industry.

32. Emissions from the Industrial Processes sector in Norway have been fairly stable over time. According to the NIR, this is because the increase in CO_2 emissions has compensated for the decrease in PFC and SF_6 emissions from aluminium and magnesium plants. Norway provides an explanation for this trend in the NIR.

33. The ERT has no indications that any industrial sources occurring in Norway have not been reported. The submission is therefore considered complete.

34. Norway reports in the NIR that recalculations have been done only for non-key sources. In table 8 Norway presents the changes that result from the recalculations.

35. Norway reports industrial AD as confidential in a number of industrial processes (cement, ammonia, nitric acid and carbide production). The related emissions include all those from mineral production, about half of chemical industry and a small part of emissions from iron and steel production. The ERT understands that national experts have access to these AD and use them in calculating emissions, and that Norway has a QA/QC process for verification of emissions data reported by industrial enterprises, as reported in the NIR. Apart from the confidential AD, the CRF and NIR are clear and provide all the information necessary to ensure the ERT that the inventory for the sector is transparent, complete and consistent.

36. In 2001, total GHG emissions from solvent use amounted to 164 Gg CO_2 equivalent, which is less than 0.5 per cent of the national total.

B. Key sources

Aluminium production – PFCs

37. The earlier stage of the 2003 review activities identified Norway's reported ratio of tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) from aluminium production as the highest among reporting Parties (24.5 instead of the order of 10 reported for other Parties). Norway responded that this was caused by the country-specific procedure applied, whereas recent measurement data indicated that a ratio of around 15 was probably more realistic. The ERT encourages Norway to evaluate the PFC data and consider using the new measurement results in the calculation of PFC emissions.

Magnesium foundries – SF_6

38. The NIR mentions that SF_6 emissions from magnesium foundries are expected to decrease significantly as result of the closure of primary magnesium production. Only secondary magnesium foundries will continue operation in Norway, and emissions are expected to decrease by 60–80 per cent.

C. Non-key sources

39. Norway responded adequately to the questions raised in the earlier stages of the review process on the non-key sources in the sector (lime production, limestone and dolomite use, iron and steel, food and drink production, and consumption of halocarbons and SF_6).

IV. AGRICULTURE

A. Sector overview

40. In the year 2001, the Agriculture sector emitted 5,045 Gg of CO_2 equivalent and accounted for 9 per cent of the overall GHG emissions in Norway. Emissions from the sector are comparatively stable over 1990–2001, with an overall decrease of 4 per cent over the period.

41. Following the recommendation of the previous review, the description of country-specific data in the NIR has been considerably improved.[4] While some of information required is still lacking and descriptions are not fully transparent in the 2003 report (as pointed out for each source category below), in the additional information provided to the ERT, Norway stated that it is preparing a new documentation report for its national GHG inventory with extended descriptions of methods, AD, EFs

[4] It is good practice that Norway reported the N_2O and ammonia (NH_3) emissions from agricultural soils in detail, in annex 2, in addition to providing the general description in the NIR.

and other information needed to make its reporting more transparent. Also during the review, the Party provided the ERT with some sources of AD, country-specific EFs for biological nitrogen (N) fixation, crop residues and cultivated area of histosols (e.g., Aakra and Bleken 1997). The ERT encourages Norway to improve transparency by including in its next submission more complete and transparent documentation of country-specific EFs and methodologies. In this respect the ERT encourages Norway to demonstrate the use of its common livestock population database for all calculations that are directly or indirectly dependent on livestock numbers: CH_4 from enteric fermentation; total manure produced; N excreted; CH_4 and N_2O emissions from manure management; ammonia (NH_3)-N emissions from livestock; and direct and indirect N_2O emissions from soils. It would be preferable to provide animal-related information in the NIR to a level of detail similar to that presented in the appendix to table 4.B(a) attached to the 2000 NIR.

42. As regards completeness, only since this year's submission has Norway started to report the new N_2O emissions from manure management and municipal sewage sludge applied to fields in table 4.D. Norway still has no estimates of emissions of N_2O from the application of industrial and urban wastes on fields, but states in the NIR that these will be included in its NIR in future. CO_2 from liming of agricultural soils is reported under category 4.D Agricultural Soils. In future submissions the source is planned to be moved under category 5.D CO_2 Emissions and Removals from Soil.

43. Norway has recalculated its GHG emissions for 1990–2001, since it has included N_2O emissions from manure management and sewage sludge applied to the fields, and has revised the data on animal populations and the EF for cultivation of histosols following the IPCC good practice guidance. As a result, the figures for N_2O emissions from the Agriculture sector increased for all years (e.g., by 8.6 per cent for 2000). However, Norway has not provided detailed CRF tables for the years 1991–1997. The issues still needing further elaboration include: the use of the same values for N_2O emissions from nitrogen-fixing crops, crop residues, cultivation of histosols, and nitrogen leaching and run-off from 1990 (except for crop residues and nitrogen leaching) to 1998 and for 2001; more detailed documentation of the AD for sewage sludge applied to fields (except for 1999, for which data are given in table 8, annex II); and the explanation of a sudden decrease in N_2O emissions in sewage sludge from 2000 (0.041 Gg N_2O) to 2001 (0.027 Gg N_2O).

B. Key sources

Enteric fermentation – CH_4

44. Norway uses a tier 1 approach to estimate emissions from this source. In line with the IPCC good practice guidance, the ERT encourages Norway to consider the use of the tier 2 method to estimate CH_4 emissions from dairy and non-dairy cattle, since they represent a significant part of emissions from this source category. The origin of the AD and procedures used to establish livestock numbers are not sufficiently explained in the NIR. The data on livestock population and animal size are only available in CRF table 4.A, and the detailed information on age and sex groups actually used in the inventory and given in the 2003 NIR is not comparable with that given in appendix table 4.B(a) of the 2002 submission. The livestock numbers in the SN statistics differ from those reported to the Food and Agriculture Organization of the United Nations (FAO). In its response to the ERT's questions, Norway explained how the livestock numbers were derived and the differences between the national and FAO data. To improve the transparency of its reporting, the ERT encourages Norway to include these explanations, together with information on livestock population size and emission factors used for each animal category, in its future inventory submissions.

Direct emissions from agricultural soils – N_2O

45. In the additional information box to table 4.D of the CRF, a non-default value of $Frac_{GASF}$ of 0.04 (=88.6/1976) is reported, with no explanation in the NIR as to how this value is derived and verified. While 88.6 t N is indicated to be the value for NH_3 emissions from synthetic fertilizers (according to the documentation box), no explanation for 1976 t N is provided. The determination of $Frac_{GASF}$ needs

further clarification and documentation, and AD must be reported for each synthetic fertilizer type listed in table 7 of annex 2 to the NIR. Norway agreed that corrections and explanations are needed, and these will be included in the next inventory.

46. Total N excretion per animal waste management system (AWMS) in 2001 as reported in table 4.B(b), excluding pasture range and paddock, is 52,386,609 kg N/yr, which is not the same as the value of 51,388,790 kg N/yr that is reported in table 4.D for N input to soil in animal wastes applied to soil. According to the NIR, the share of N that goes to pasture range is referenced to Aakra and Bleken (1997) and made constant and equal to 1:3. However, $Frac_{GRAZ}$ is reported as 0.23. Norway responded that the figure for N lost in grazing estimated by Aakra and Bleken (1997) and used in table 4.D is more accurate than the default values in table 4.B(b). The ERT encourages Norway to include the necessary documentation for the data used and make consistent use of the data.

47. Norway uses a non-default $Frac_{GASM}$ of 0.17 in the additional information box to CRF table 4.D. It is derived from a formula (0.17=168.3/1009.4) included in table 4.D, but is not further documented. Norway should document this country-specific EF, showing the data source or references. Norway replied that it would consider the ERT's comment and make the necessary corrections in next year's inventory.

48. The ERT encourages Norway to add more detailed information for the description of the country-specific methodologies used to estimate emissions from N leaching and run-off, N-fixing crops, crop residues, atmospheric deposition and animal production. In response to the draft review report, Norway has indicated that it will give more detailed explanations of the methodology used for this source category in its 2004 NIR.

C. Non-key sources

Manure management – CH_4

49. The ERT identified that the specific methodology used to calculate CH_4 emissions from manure management with a tier 2 approach was not clearly described in the NIR, and that no explanation was provided for the country-specific values of volatile solid excretion (VS), methane-producing capacity (Bo), and IEF (or methane correction factor, MCF) in table 4.B(a) of the CRF. In response to the draft ERT report, Norway indicated that this information would be included in the updated documentation report in next year's submission.

Manure management – N_2O

50. The ERT noted that Norway has used different N excretion data for calculating N_2O emissions from manure management (table 1 of annex 2) and NH_3 emissions from agricultural sources (table 5 of annex 2), while IPCC/UNFCCC strongly requests Parties to use the same database for the relevant AD. Norway replied that the issues will be considered and the necessary revisions will be included in the 2004 submission. Norway should deliver more detailed information about the specific age and sex sub-groups that are actually used in calculations, in the same way as it did in the appendix to table 4.B(a) in the 2002 NIR.

Field burning of agricultural residues – CH_4 and N_2O

51. The AD used for the estimates should be consistent with the AD used to estimate N_2O emissions from crop residues (table 4.D). However, $Frac_{BURN}$ is reported as 0.00 in the additional information box to table 4.D, and in table 4.F a value of 0.15 is used as the fraction of straw burned in field. In response to ERT's raising the issue, Norway replied that it would consider the ERT's comment and address it in its 2004 submission.

Animal production – N_2O

52. The N excretion data are 18,731,760 kg N/yr in 2001, which is very different from the value of 30,978,656 kg N/yr from pasture range and paddock in table 4.B(b) of the CRF, even when the $Frac_{GRAM}$ of 0.17 in table 4.D is considered. $Frac_{GRAZ}$ does not agree with the data in table 4.B(b), which shows that the N in pasture range and paddock is approximately 27 per cent of total N. At the same time $Frac_{GRAZ}$ is reported as 0.23 and this value is not referenced. Norway is considering reviewing this issue and documenting the data in its future submissions.

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

53. In the year 2001, the LUCF sector was a net sink of 33.7 per cent of Norway's CO_2 equivalent emissions. In its response to the 2002 review, Norway provided a detailed and transparent description of the AD and the methods used for calculating CO_2 emissions and removals in the NIR and the CRF. The Party reports on 5.A Changes in Forest and Other Woody Biomass Stocks for all years, while categories 5.B, 5.C and 5.D are reported as "not estimated" ("NE") in table 5. As further clarified by Norway, Forest and Grassland Conversion (5.B) and Abandonment of Managed Lands lead to insignificant emissions removals in Norway but are included in the overall number for Changes in Forest and Other Woody Biomass Stocks (5.A). The notation key used should therefore be corrected to "included elsewhere" ("IE"). With regard to Emissions and Removals from Soil (5.D), it is correct that emissions are not estimated. Being reported under Agriculture (CRF table 4.D), CO_2 emissions from liming in table 5.D are not included in the totals for the LUCF sector. In line with the previous review, the ERT encourages Norway to provide estimates for afforestation and deforestation in tables 5.B and 5.C and for soils in table 5.D. In its comments to the draft ERT report, Norway indicated that it will make more comprehensive estimates for the Land Use, Land-use Change and Forestry (LULUCF) sector on the basis of the IPCC good practice guidance for LULUCF and will include them in the relevant submissions. Norway is also encouraged to check for consistent use of notation keys within the sector: for instance, instead of "NE", "IE" should be used for reporting on emissions from liming.

54. Norway has used a country-specific method to estimate forest balance and derive annual growth rates, and this is described in the NIR. A combination of country-specific and IPCC default conversion factors has been applied to calculate carbon emissions and removals, and they are provided in the NIR. The NIR and the CRF also include information on uncertainty estimates and source-specific verification, as well as the QA/QC elements for the LUCF sector, which indicate that they are of low quality and that the coverage of sectoral source and sink categories is only partial. No recalculations have been done in the LUCF sector in the 2003 submission.

B. Sink and source categories

Changes in forest and other woody biomass stocks (5.A)

55. According to the NIR, the increase in overall removals by 94.2 per cent since 1990 for this category is attributed to increment in the growing stock, whereas harvesting has been kept at the same level. However, the data on biomass removed from boreal forests in CRF table 5.A are provided only in Gg of carbon (C) released. The ERT encourages Norway to include the data on removals in tons of dry matter in the CRF, as requested in CRF table 5.A. According to the NIR, logging residues and natural losses are calculated as a percentage of felling in total, but no quantitative value for the percentage is provided. The removals in forest and other woody biomass stocks may be overestimated as a result of the use of the same biomass expansion factor (1.90) for both coniferous and deciduous forests, whereas overall removals may be underestimated because of insufficient accounting for fuelwood consumption. Norway has indicated that the issue will be addressed when it implements the new good practice guidance for LULUCF. The consistent use of fuelwood consumption and enhancement of the accuracy of the increment data are identified in the NIR as priority issues for further improvement of the inventory

in the LUCF sector. In addition to the issues identified by the Party, the ERT encourages Norway to check for the use of biomass expansion factors appropriate to specific forest types within the country. In its response to the draft ERT report Norway provided the factors used to calculate logging residues and natural losses. To improve the transparency of the reporting, the ERT encourages Norway to include these factors in its next submission.

VI. WASTE

A. Sector overview

56. In the year 2001, the Waste sector accounted for 7.3 per cent of total emissions in Norway (excluding LUCF) compared with 7.6 per cent in 1990. Emissions increased by 3.4 per cent from 1990 to 2001 and declined by 2.9 per cent from 2000 to 2001. The time series exhibits minor variability around the trend over the period 1990–2001. Emissions of CH_4, the main GHG from this sector, increased by 1.7 per cent from 1990 to 2001, and declined by 2.1 per cent from 2000 to 2001.

57. The Party's inventory is complete, covering all emission sources. However, although a comprehensive NIR is provided, the omission of data and notation keys from the CRF tables reduces the transparency of the inventory. The issue of omissions from the CRF tables was raised in previous reviews. It is recommended that the Party ensure that all relevant cells include data or a notation key.

58. Subsequent to the previous review, formal QA/QC procedures involving internal checks and analysis of any changes in the trend have been implemented to ensure the internal consistency of the emission estimates, as well as the identification and correction of any errors in the data reported.

59. Overall, the Party's inventory submission is of a high standard. With regard to planned improvements in the inventory, the Party states in the NIR that documentation of all procedures involved in the preparation of inventory data for solid waste disposal on land will be finalized in 2003 and included in future submissions.

B. Key sources

Solid waste disposal on land – CH_4

60. To estimate emissions from managed waste disposal, the Party uses a modified IPCC tier 2 method, referred to in the CRF as model (M), clarifying that it is a modified tier 2/country-specific method for municipal waste and a country-specific method for industrial waste. This method is in accordance with the IPCC good practice guidance. AD are obtained from a range of sources which are outlined in the NIR. The method results in a high IEF, as was noted in the previous stage of the 2003 review activities. The Party responded that the high IEF could be due to the half-lives of waste used, the fact that the model accounts for waste deposited since 1945, and the assumption of 55 per cent CH_4 in landfill gas. It was further noted that the IEF had declined from 2000 to 2001, most likely as a result of a reduction in landfilling of household waste. Further analysis of this issue by the Party is recommended. In its response to this review, the Party indicated that the issue would be examined.

61. The NIR notes that CH_4 recovery data for 1998–2000 have been changed, and that data on industrial and manufacturing waste for the same period have been revised in the 2003 submission. Further clarification of the changes made is recommended. The Party advised the ERT that the recalculations were due to errors in recovery data and in the AD used in the model.

62. No information is provided on unmanaged waste disposal. Because of the lack of data or notation keys it is not clear whether this activity is occurring or not. Similarly, an estimate of the waste generation rate has been omitted from the additional information table.

C. Non-key sources

Solid waste disposal on land – CO_2

63. The CRF notes that the estimates for CO_2 are partial or included elsewhere ("PART/IE"), and the NIR comments that emissions from waste combusted for energy purposes are included in the Energy sector. The NIR states that these emissions comprise both direct emissions and indirect emissions from oxidation of CH_4 in the atmosphere. This appears to be inconsistent with the IPCC Guidelines, given that the requirement is to report CO_2 arising from the incineration of solid waste at solid waste disposal sites (SWDS) under the Waste sector where this is used as a waste management practice. The ERT recommends that further explanation of this emission source be provided. The Party responded that 7.5 per cent of waste to landfills is fossil carbon (C). The contribution of fossil C to CH_4 generation needs further discussion and clarification.

Waste-water handling – CH_4

64. No information is reported on industrial waste water, and emissions from domestic and commercial waste water are very small. The NIR states that industrial waste-water emissions are small, and that only around 2 per cent of domestic and commercial waste water is anaerobically treated. Norway is encouraged to review this information and ensure that data or notation keys are included in the CRF. This will facilitate transparency in the reporting of emissions from waste water.

65. In respect of recalculations, the NIR notes that the Party has adopted the IPCC good practice guidance value for the degradable organic component (DC) of 0.6 kg CH_4/kg BOD (biochemical oxygen demand) for domestic and commercial waste water. Clarification is required as to whether the original measure of DC was BOD or a combination of BOD and chemical oxygen demand (COD), given that the IPCC Guidelines default values for BOD and COD are identical.

Waste-water handling – N_2O

66. Notation keys are omitted from the CRF table and should be included. The NIR states that emissions are calculated from nitrification/denitrification that occurs in pipelines and the N_2O emissions that occur in the waste-water plants in the biological step. It would be helpful to future reviews if the Party provided more information and explanation on the methodology used. In response to the draft review report, Norway noted that this is planned for future submissions.

Waste incineration – CO_2, CH_4, N_2O

67. AD and notation keys have not been entered and it is recommended that these be included. Norway indicated that it would consider reporting the different fractions of waste and the associated CO_2 emissions in its next submission.

Waste (Other)

68. Emissions of indirect GHGs from tobacco are reported. Direct GHGs are not reported. In the response to this draft report, Norway explained that it regards tobacco as biomass and CO_2 emissions are therefore not calculated and reported. Emissions of N_2O and CH_4 are considered negligible. The ERT encourages Norway to provide these and other relevant explanation in its next NIR.

ANNEX 1: MATERIALS USED DURING THE REVIEW

A. Support materials on the CD-ROM and the web page for the review

2003 Inventory submissions of Norway including CRF for years 1990–2001 and an NIR.
2002 Inventory submissions of Norway.
UNFCCC secretariat (2003). "Report of the individual review of the greenhouse gas inventory of Norway submitted in the year 2002 (In-country review)". FCCC/WEB/IRI(2)/2002/NOR (available at http://unfccc.int/program/mis/ghg/countrep/norincountrep.pdf).
UNFCCC secretariat. "2003 Status report for Norway" (available at http://unfccc.int/program/mis/ghg/statrep03/nor03.pdf).
UNFCCC secretariat. "Synthesis and assessment report of the greenhouse gas inventories submitted in 2003, Part I": FCCC/WEB/SAI/2003 (available at http://unfccc.int/program/mis/ghg/s_a2003.html), and Part II – the section on Norway) (unpublished).
Norway's comments on the draft "Synthesis and assessment report of the greenhouse gas inventories submitted in 2003" (unpublished).
UNFCCC secretariat. Review findings for Norway (unpublished).
UNFCCC secretariat. "Handbook for review of national GHG inventories." Draft 2003 (unpublished).
UNFCCC secretariat. "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 (available at http://www.unfccc.int/resource/docs/cop5/07.pdf).
UNFCCC secretariat. "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention." FCCC/CP/2002/8 (available at http://unfccc.int/resource/docs/cop8/08.pdf).
UNFCCC secretariat. Database search tool – *Locator* (unpublished).
IPCC. *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000* (available at http://www.ipcc-nggip.iges.or.jp/public/gp/gpgaum.htm).
IPCC/OECD/IEA. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, volumes 1–3, 1997* (available at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm).

B. Additional materials

Responses to questions during the review were received from Mr. Eilev Gjerald (SFT), including additional material on the methodology and assumptions used:

SN 2000: *Uncertainties in the Norwegian Greenhouse Gas Inventory* (available at http://www.ssb.no/emner/01/04/10/rapp_200013/rapp_200013.pdf).
SFT/SN, 1999a: *Evaluation of uncertainty in the Norwegian emission inventory.* Kristin Rypdal. Statistics Norway. SFT-report 99:01.
SFT/SN 1999b: *Utslipp fra veitrafikk i Norge* (Emissions from road traffic in Norway. Model) (available at http://www.sft.no/publikasjoner/luft/1622/ta1622.pdf).
SN 2002: *Utslipp til luft fra norsk luftfart 1989–2000* (Emissions to air from Norwegian air traffic 1989–2000) (available at http://www.ssb.no/emner/01/04/10/rapp_200208/rapp_200208.pdf).
SN/SFT 2000: *The Norwegian Emission Inventory*. Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants. Ketil Flugsrud, Eilev Gjerald, Gisle Haakonsen, Sigurd Holtskog, Henning Høie, Kristin Rypdal, Bente Tornsjø and Fredrik Weidemann. Statistics Norway/ Norwegian Pollution Control Authority. SN-report 2000:1.
OLF 1994: *Anbefalte retningslinjer for utslippsberegning. Identifisering, kvantifisering og rapportering av forbruks- og utslippsdata fra aktiviteter i norsk oljevirksomhet.* (Recommended guidelines for emission calculations. Identification, quantification and reporting of data on consumption and

emissions from activities in the Norwegian oil and gas sector), Stavanger: Norwegian Oil Industry Association.

OLF 1998: *Retningslinjer for utslippsrapportering* (Guidelines for emissions reporting). Stavanger: Norwegian Oil Industry Association.

Aakra, A. and Bleken, M.A. 1997: "N_2O emission from Norwegian agriculture as estimated by the IPCC methodology", in *Proceedings of the International Workshop on Dissipation of N from the Human N-cycle, and its Role in Present and Future N_2O Emissions to the Atmosphere*. Oslo, 22–25 May 1997.

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