UNITED NATIONS
NATIONS UNIES

FRAMEWORK CONVENTION ON CLIMATE CHANGE - Secretariat
CONVENTION - CADRE SUR LES CHANGEMENTS CLIMATIQUES - Secrétariat

FCCC/WEB/IRI(2)/2001/FIN 21 June 2002

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

(In-country review)

I. OVERVIEW

A. Introduction

1. The Conference of the Parties (COP), at its fifth session, by its decision 6/CP.5, adopted guidelines for the technical review of greenhouse gas (GHG) inventories from Parties included in Annex I to the Convention (Annex I Parties), hereinafter referred to as the review guidelines,[2] for a trial period covering the GHG inventory submissions for the years 2000 and 2001. The COP requested the secretariat to conduct individual reviews of GHG inventories for a limited number of Annex I Parties, on a voluntary basis. The secretariat was requested to coordinate the reviews and to use different approaches for the individual reviews by including desk reviews, centralized reviews and in-country reviews.

2. Finland volunteered for an individual, in-country review of its 15 April 2001 inventory submission and this was carried out from 19 to 23 November 2001 in Helsinki, Finland. The lead authors of the review were Mr. Philip Acquah (Ghana) and Mr. William Irving (USA). The sector experts were: Ms. Sevdalina Todorova (Bulgaria) – Energy, Mr. Philip Acquah – Industrial processes, Mr. Vitor Gois (Portugal) – Agriculture, Ms. Kimberly Robertson (New Zealand) – Land-use change and forestry (LUCF), Ms. Tatiana Tugui (Moldova) – Waste, and Mr. William Irving – General issues. Ms. Rocio Lichte and Mr. James Grabert of the UNFCCC secretariat coordinated the review.

3. In accordance with the UNFCCC review guidelines, a draft version of this report was submitted to the Government of Finland for comments, which were then considered and incorporated, as appropriate, into the final report. The review team would like to note the hospitality and openness of the Government of Finland, and the cooperation of the host inventory experts involved in the review.

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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 (2) indicates that for Finland this is an in-country review report.

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

B. Inventory submission and other sources of information

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

4. A summary of the NIR was submitted on 9 April 2001. A report entitled "Greenhouse gas emissions and removals in Finland" (Pipatti R. 2001) was submitted on 11 April 2001 as part of Finland's 2001 GHG inventory submission. This report, together with the summary, is referred to as the NIR in this review report. The NIR was available to the review team as a hard copy and an electronic copy (http://www.vyh.fi/eng/environ/state/air/emis/ghg/ghg.htm).

5. A complete set of CRF tables was submitted on April 9, 2001 for the years 1990–1999 and was available to the review team in electronic format and hard copy.

Other sources of information

6. The secretariat also provided Finland's status report for 2001, parts I and II of the draft synthesis and assessment (S&A) report for 2001, Finland's comments on the draft S&A report, a preliminary list of key sources as calculated by the secretariat,[3] Finland's year 2000 inventory submission, the UNFCCC reporting guidelines[4] and review guidelines. In addition, the expert review team (ERT) was provided with preliminary guidance for experts participating in the individual review of GHG inventories, prepared by the secretariat.

7. Finland also provided the review team with the following documents: Finland's Third National Communication, the National Climate Strategy, Environment Statistics 2001, Energy Statistics 2000, a letter from the Ministry of the Environment to the Executive Secretary of the UNFCCC (dated 18 June 1998) regarding an addendum to Finland's Second National Communication (NC2) and Key Source Identification in the Finnish 1999 Greenhouse Gas Inventory (VTT Energy Reports 34/2001). Additional documents for specific sectors and sources are listed at the end of the report.

C. Emissions profiles, trends and key sources

Emissions profile

8. Total GHG emissions (excluding land-use change and forestry (LUCF))[5] in 1999 were just below 1990 levels, although the total has risen and fallen throughout the 1990–1999 period. The inventory is dominated by carbon dioxide (CO_2) emissions from the combustion of fossil fuels, which accounted for three-quarters of gross emissions in 1999. The large fluctuation in CO_2 emissions was due to economic recession and recovery, and also to variations in the balance between domestic generation and importation of electricity, which is largely influenced by hydropower imports in the wet periods. Methane (CH_4) emissions have decreased significantly

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[3] The UNFCCC secretariat had identified, for each individual Party, those source categories that 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 that provided a full CRF for the year 1990. The key sources identified according to the secretariat's preliminary key source assessment might differ from the key sources identified by the Party itself.

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

[5] 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.

from 8% to 5% of the national total largely due to closure of many landfills and increasing waste-to-energy facilities. Nitrous oxide (N_2O) emissions have remained constant at about 10%. Emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are quite small (0.5%) but growing rapidly. LUCF is a net sink for carbon but an increase in forest harvesting is progressively reducing the size of the sink.

9. The emission profile is typical of Annex I Parties with two notable exceptions. First, Finland has large areas of peat lands, some of which are harvested for fuel or used for agriculture. Peat is the source of almost one-fifth of all emissions through peat combustion for energy, fugitive emissions from peat production and emissions from agricultural soils. Second, Finland has no coal mining activity and very small fugitive emissions of CH_4 from the oil and gas sector.

10. The overall emissions trend for 1990–1998 reported in the 2001 submission has not changed significantly from the trend reported in the previous submission.

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	38,668	22,864	26,777	30,056	48,208	47,996	47,098	54,274	54,888	53,365
CO_2 emissions (without LUCF)	62,466	61,071	58,670	59,172	65,468	62,684	68,130	66,911	64,601	64,186
CH_4	6,141	5,778	5,378	4,988	4,658	4,644	4,466	4,283	4,061	3,931
N_2O	8,414	7,911	7,287	7,480	7,591	7,796	7,847	8,067	7,912	7,749
HFCs	0	0	0	0	7	30	78	168	246	317
PFCs	1	1	1	1	1	1	1	1	1	29
SF_6	71	48	32	26	26	14	14	16	12	32
Total (with net CO_2 emissions/removals)	53,295	36,602	39,475	42,551	60,492	60,481	59,503	66,809	67,120	65,422
Total (without CO_2 from LUCF)	77,093	74,809	71,369	71,667	77,751	75,168	80,536	79,446	76,833	76,243

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

GHG SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)									
1. Energy	59,584	58,783	56,837	57,680	64,059	61,863	67,391	66,277	63,901	63,268
2. Industrial processes	2,852	2,497	2,235	2,137	2,233	2,290	2,364	2,548	2,516	2,832
3. Solvent and other product use	62	62	62	62	62	62	62	62	62	62
4. Agriculture	10,165	9,324	8,392	8,383	8,206	7,820	7,795	7,972	7,793	7,594
5. LUCF[(a)]	-23,798	-38,207	-31,894	-29,116	-17,259	-14,687	-21,032	-12,637	-9,713	-10,821
6. Waste	3,790	3,529	3,236	2,849	2,500	2,435	2,225	2,030	1,840	1,737
7. Other	640	615	608	556	692	699	698	558	720	750

(a) Net emissions.

11. Both Finland and the UNFCCC secretariat performed key source analyses. The two analyses used different methodologies and different levels of disaggregation and thus produced different results, which are discussed under crosscutting issues and in the individual sector reports.

D. General assessment of the inventory

1. Completeness of reporting and conformity with the UNFCCC reporting guidelines

12. The conclusion of the review team is that Finland has adhered to the UNFCCC reporting guidelines for both the CRF and the NIR. Some recommendations for improvements, identified by Finland and the ERT, particularly with respect to the increasing transparency of the NIR, are provided in the sectoral discussions.

Common reporting format

13. Finland provided a complete set of CRF tables for the period 1990–99. This is a significant improvement over the previous submission, which only included tables for the base and most recent year. The CRF includes entries for all categories including actual and potential emissions of HFCs, PFCs, and SF_6, and summary level estimates of indirect GHGs. Standard indicators have been used appropriately with the following exception: Finland did not use the standard notation "0" for sources whose emissions are so small that they would appear as zero after rounding, and instead introduced a country-specific notation key "NZ" that means "nearly zero". In some cases, particularly in the energy sector, there was a lack of transparency concerning where items listed as "IE" (included elsewhere) where included.

14. Details on CO_2 emissions and sequestration from agricultural soils were reported in the LUCF background tables and final estimates were reported under agriculture in the summary tables, consistent with the reporting guidelines.[6] Finland also reported indirect N_2O emissions from fuel combustion and fugitive CO_2 emissions from peat production, which are not covered in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the IPCC Guidelines).

Completeness and transparency of the NIR

15. Finland's 2001 NIR generally adheres to the UNFCCC reporting guidelines. Specific areas where reporting could be improved are identified in the sectoral discussions. The NIR includes annual information from the base year 1990 to the1999 inventory year, which is largely consistent with the CRF. Geographic coverage is for the Finnish mainland as well as the territory of Aland.

16. The NIR provides methodological descriptions for most sources. In some cases, particularly in the energy and LUCF sectors, methodological descriptions are insufficiently detailed. However, during the in-country review, the review team was provided with a large amount of additional information and explanation. The ERT notes that a summary of this information included in the NIR would greatly increase the transparency of the inventory submission and improve the overall report. The level of documentation for emission factors and activity data is generally good but is inconsistent at times. In the energy sector, there are insufficient activity data to enable sample recalculations of emissions. The activity data for the agriculture sector are documented much more thoroughly.

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[6] According to the IPCC Guidelines, CO_2 from agricultural soils is to be included under LUCF. At the same time, the Summary Report 7.A of the IPCC Guidelines allows for reporting CO_2 emissions or removals from agricultural soils either in the agriculture sector (under 4.D Agricultural soils) or in the LUCF sector (under 5.D). The reporting requirements of the CRF follow this approach, however, the CRF allows for reporting of background data only under the LUCF sector (table 5.D).

17. In general, recalculations have been identified and clearly explained. Some activity data changes have not been implemented through the complete time series for certain sources due to resource constraints (e.g., peat consumption); also where estimated values have been used where national data were not available at the time of the inventory (e.g., cement production). The ERT encourages Finland to update these activity data in the next inventory report. The NIR provides a separate section that identifies changes from previous years, and a list of references at the end of each sector description. The ILMARI energy sector data has been aggregated to the CRF reporting levels. However, the team was informed that the basic ILMARI plant level data is confidential. Also some of the fluorinated gases data have been aggregated for reasons of confidentiality. This reduced the transparency of the report.

Conformity with the IPCC Guidelines and the IPCC good practice guidance[7]

18. The methodologies and assumptions used in Finland's 2001 inventory are generally consistent with the IPCC Guidelines.[8] In addition, Finland has made significant progress towards implementing the crosscutting components of IPCC good practice guidance, particularly in key source analysis and uncertainty estimation. The NIR provides the results of both a tier 1 and tier 2 key source analysis. Uncertainty estimates are provided for each source on the basis of expert judgement (tier 1) and the NIR contains a description of the methodology used. Finland has not yet implemented a formal quality assurance/quality control (QA/QC) programme.

19. For most key sources, the selected methodologies are consistent with IPCC good practice guidance. For a small minority of sources, (e.g., landfills) IPCC good practice guidance recommends a more sophisticated method than the one used by Finland. Generally, the activity data and emission factors are appropriate for the selected methodologies. In a few cases, however, Finland has concluded that updated IPCC emission factors are not appropriate for national circumstances (e.g., CH_4 from manure).

2. Crosscutting issues

Institutional arrangements

20. During the in-country review, Finland presented the institutional arrangements for the preparation of the annual inventory. The Inter-Ministerial Working Group (IMWG) has overall responsibility for the national inventory. It comprises technical experts from 10 organizations and determines overall priorities and responsibilities. The Ministry of the Environment is the chair, and the Finnish Environment Institute (FEI) serves as the secretariat. Five national institutions have direct responsibility for estimating GHG emissions: FEI, the Forest Research Institute (METLA), Agrifood Research Finland (MTT), Statistics Finland, and the Technical Research Centre of Finland (VTT). FEI compiles the NIR and completes the CRF; the IMWG reviews and approves the report; and the Ministry of the Environment submits it to the UNFCCC secretariat. The use of private contractors and consultants is very limited. The Ministry of the Environment provides some funding for the various institutes.

21. Finland indicated that in the future it might not be adequate to rely on voluntarily submitted information (i.e., they might need to have a stronger legal basis). The IMWG hopes to

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7 According to the conclusions of the Subsidiary Body for Scientific and Technological Advice (SBSTA) at its twelfth session, the IPCC good practice guidance should be applied by Annex I Parties as far as possible for inventories due in 2001 and 2002, and should be used for inventories due in 2003 and beyond.

8 Specific examples are given in the sectoral discussions, for example section VI. Waste, paragraph 242.

improve the implementation of IPCC good practice guidance, the estimation and treatment of key sources and uncertainty management. It would also like to increase the number of inventory experts. The IMWG itself has a formal mandate but is not a permanent group. Finland anticipates that a permanent national entity may be needed to take formal responsibility for the national inventory system.

Record keeping and archiving

22. Finland does not yet have a centralized national archiving system, but plans are being developed. Currently, experts involved in calculating emissions for specific sources are responsible for providing estimates to the FEI in the form of completed CRF background tables. The calculation sheets themselves are not transferred and they were available to the review team only on an ad hoc basis for selected sectors (e.g., energy,[9] waste, industrial processes).

23. The compilation of the CRF tables is organized and efficient. The sector experts are responsible for completing individual copies of the sectoral CRF tables. The individual CRF spreadsheets are then re-combined into one file. A complete electronic copy of the CRF tables is kept at FEI and is archived each year.

24. FEI has established a rudimentary archiving system for background materials and references, but most of the materials are kept only at the various institutions involved in the sectoral inventory preparation. As with calculation sheets, the review team was able to access reference materials on an ad hoc request basis and availability varied greatly among sectors and sources. For example, national experts indicated that emission factors for energy were developed in the period 1993-1994 and not documented as thoroughly as required in the present guidelines. In certain cases, this resulted in some difficulties in finding some of the originally referenced sources.

Verification and QA/QC approaches

25. Finland has not yet developed a QA/QC plan or implemented a formal QA/QC system across its inventory. The Inter-Ministerial Working Group will make a proposal by the end of the year 2001 for a quality management system possibly based on ISO 9000 standards. QA/QC systems for specific sectors will be developed simultaneously by different organizations, in cooperation with each other. Energy specialists indicated that the energy sector might be the pilot for the QA/QC system developed by Statistics Finland.

26. There are, however, some QA/QC procedures applied informally to the inventory by the respective institutions responsible for activity data and emission factor compilation. Further, the relevant experts in each sector review the results and the IMWG also undertakes a peer review. VTT was responsible for reviewing the methodologies. Statistics Finland checks bottom-up plant-specific energy data on fuel use from the national air emissions database (VAHTI) against data from other sources. The VAHTI database contains plant-specific data reported under the mandatory environmental reporting scheme. These are checked and approved by the Regional Environmental Centers (RECs). Waste generation data are calculated by two different groups and then crosschecked.

[9] The energy sector plant-level data (except plant identification data) were available to the review team during the visit but the time available was not sufficient to allow the calculation sheets to be reviewed.

27. Finland does not currently conduct a third party review or a public review. National experts indicated that because Finland is a small country there are not many additional experts available to review the inventory who are not already involved in its preparation.

Recalculations and changes in relation to previous years

28. Recalculations have led to an increase in total base year emissions by approximately 3% and emissions in 1998 increased by just less than 1%. The significant changes include: CO_2 emissions from agricultural soils, which have increased by almost 50% because of the inclusion of mineral soils for the first time as well as the updating of activity data for organic soils, and CH_4 emissions from pig iron and sinter production which are no longer included in the inventory because plant-specific measurements by Finland show that the emissions are negligible and that the IPCC default emission factor is not applicable.

29. The NIR describes in the overview section the total effect of recalculations and the sectors in which major recalculations occurred. There are more detailed descriptions and justifications of recalculations in the chapters describing individual sectors and sources.

Uncertainties

30. The NIR provides tier 1 qualitative uncertainty estimates based exclusively on expert judgement for all emission factors, activity data and emissions estimates in a comprehensive table. In certain cases, such as waterborne navigation and fugitive emissions from peat production, the uncertainty results published in the NIR do not reflect the most recent improvements in data collection. This will be updated in the next inventory, and it is possible that the overall uncertainty will decrease slightly. Overall inventory uncertainty is estimated to be 7%.

31. Finland is however considering using the tier 2 Monte Carlo method in the future as part of a broader plan to improve the uncertainty and key source analyses, but this will depend on the availability of improved probability distribution. A formal expert judgement elicitation procedure is under consideration.

Key source analysis

32. The NIR provides a detailed description of a tier 2 key source determination. No qualitative criteria were used, but the NIR suggests that additional criteria would not have identified additional key sources. The analysis was performed at a more disaggregated level than is recommended in IPCC good practice guidance and thus identified a larger number of key sources (29 sources for tier 2) than the UNFCCC calculation based on the tier 1 method.

33. There are a few minor differences between the list of tier 1 key sources identified by Finland and the secretariat but, with the exception of N_2O emissions from road traffic, the difference is the result of Finland's having identified additional key sources. To improve transparency, the documentation of the key source analysis should include the numerical results[10] in addition to the list of identified key sources.

[10] The lists of key sources identified according to the tier 1 and tier 2 key source determination did not include the numerical results for each identified key source (for example, in the case of the level assessment, the percentage contribution of a source to the total national inventory or the cumulative total). Detailed numerical results were, however, given from the uncertainty analysis used for the tier 2 key source determination.

34. During the review, Finnish experts presented more detailed results from additional sensitivity analyses completed after the 2001 submission. These additional analyses use different levels of source category disaggregation and also update the global warming potential values. The presentation identified fugitive CO_2 emissions from peat production and CO_2 and N_2O from agricultural soils as the largest contributors to total uncertainty. This is consistent with the priority areas for improvement identified by Finland.

35. The ERT notes that the inclusion of the comprehensive analysis based on the IPCC good practice guidance level in the next inventory submission will facilitate comparability across Parties. However, the detailed level chosen by Finland in its current key source analysis has allowed the identification of more information on the sources of uncertainty in the Finnish inventory.

3. Issues relating to previous reviews

36. The only previous review of Finland's GHG inventory took place as part of the review of the NC2. Finland did not include actual emissions of HFCs, PFCs and SF_6 in its NC2 but estimates are included in the 1999 inventory. Finland no longer adjusts CO_2 emissions upwards to reflect electricity imports as it did in the NC2. At the time of the review of the NC2, the calculation of fugitive CO_2 emissions from peat lands drained for agriculture was in progress. These estimates have already been included in the 1998 and 1999 inventories largely on the basis of expert judgement.

E. Areas for further improvement

Planned or ongoing work by the Party

37. The NIR identifies areas for improvement, particularly with respect to crosscutting elements of the IPCC good practice guidance. These include:

(a) creation of a QA/QC management system by 2003;

(b) implementing the tier 2 Monte Carlo approach for uncertainties;

(c) integrating qualitative criteria in addition to quantitative tests for key source identification; and

(d) establishing an integrated, comprehensive and easily accessible archiving system.

38. Each sector write-up in the NIR includes a detailed description of possible future improvements, which are planned or already under way (e.g., re-distribution of energy activity data between subcategories), or possible future activities (e.g., country-specific CH_4 conversion factors for liquid/slurry manure management systems). These areas are generally consistent with those identified by the ERT.

Issues identified by the ERT

39. Recommended improvements relating to specific source categories are presented in the relevant sections of this report. General recommendations include the following:

(a) *To improve transparency*: the inventory is scientifically rigorous and generally consistent with IPCC good practice guidance at a technical level, but this is not always self-evident given the level of documentation in the NIR. Although the NIR includes information on the activity data and emission factors used, as well as a list of references, the ERT noted that more detailed information, e.g. in the form of basic calculation sheets or detailed activity data, would be helpful for purposes of review, noting constraints due to confidentiality (see paragraph 17 above).[11]

(b) *To incorporate and document existing QA/QC procedures*: this is already being performed by organizations contributing to the inventory, for example, the laboratory QA/QC techniques used by VTT to estimate new emission factors.

(c) *To improve central archiving*: future review teams should be able to have access to all references, calculation sheets and CRF archives in the integrated system being developed.

(d) *To integrate third-party reviews*: third-party reviews of selected parts of the inventory, if not the inventory as a whole, should be integrated, possibly on a periodic basis rather than annually.

(e) *To provide a comparable key source analysis*: a key source analysis at the same level of category disaggregation as the IPCC good practice guidance would improve comparability without precluding more detailed country-specific analyses.

(f) *To broaden the pool of inventory experts*: it would help to have "back-ups" with knowledge of inventory details, and also to train other people to take the place of specialists who are no longer available for estimating emissions or answering questions.

II. ENERGY

A. Sector overview

40. Energy-related activities are the main source of GHG emissions in Finland. In 1999, GHG emissions from the energy sector were 63.3 million tons CO_2 equivalent, accounting for about 83% of the total national emissions (excluding LUCF). Both energy emissions and their share of total emissions have grown by approximately 5–6% since 1990. The emission trend is unstable and extremely dependent on the Nordic electricity market. The sharp drops are related to the "wet years" when most of the electricity is actually imported from hydro power plants in the region. Energy consumption has grown faster than emissions because of the increasing share of biomass, nuclear energy and natural gas cogeneration, in addition to hydropower imports in Finland's current energy mix.

41. Eleven[12] source categories of the sector were identified as key sources in the energy sector according to the secretariat's key source determination. In total the emissions from these sources accounted for more than 80% of overall GHG emissions in 1999. The assessment of key sources provided by Finland is more detailed than that suggested in the IPCC good practice guidance and used by the UNFCCC secretariat. The key sources identified by Finland, but not by the secretariat, though both use the same tier 1 methodology, are N_2O from manufacturing

[11] Detailed calculation sheets were, however, available during the visit but could not be considered owing to time constraints.

[12] Eight are sources of CO_2: coal, oil, gas, other fuels stationary combustion; road and other (off-road machinery), transport and navigation; and fugitive emissions from solid fuels; and three are sources of N_2O: biomass and other fuels stationary combustion and road transport.

combustion of liquid fuels and CO_2 from aircraft combustion. Conversely, the secretariat identified N_2O from road traffic as a key source while Finland did not categorize it as such.

1. Institutional arrangements

42. The Energy and Environment Departments of Statistics Finland (SF) provide the final estimates for the sector, using data from the REC's VAHTI database, and other national statistics (e.g. Electricity Statistics, etc). VTT prepares a sub-set of the final calculations (e.g. transport, off-road machinary), and transfers them to Statistics Finland for final allocation according to the IPCC requirements. The institutional arrangements are generally sufficient for preparing the annual inventory. However, the ERT notes that the current number of dedicated experts is inadequate given the task of the energy sector inventory. It is critical to increase the human resources.

2. Completeness

43. The energy sector is largely complete with respect to sources and gases covered. The fuel combustion subsector was adequately complete. However, in the estimates of fugitive emissions from oil and natural gas, only a limited number of sources for CO_2 and CH_4 are covered, though there are activity data available for some of the not estimated sources (e.g., transport, refining/storage, distribution of oil products). These emissions are prejudged to be negligible by Finnish experts.

3. Transparency

44. Although the methodology and emission factors were provided in the relevant documentation, the activity data were presented in aggregated form or not provided for reasons of confidentiality, thereby reducing the transparency of the inventory. The national experts explained that Statistics Finland data are currently confidential under the existing Statistics Act. For example, the NIR does not include an energy balance or sample worksheets to replicate the calculations or to follow the fuel aggregation or sectoral allocation of fuel consumption data (the sectoral breakdown and fuel aggregation levels used in the energy balance sheets are not the same as in the GHG inventory, which makes comparison somewhat difficult), but includes references to such sheets.[13]

4. Methodologies, emission factors and activity data

45. Annex B of the NIR provides a description of the methodologies and assumptions used and also includes references to sources of methodologies, emission factors and activity data. The methodologies used in the energy sector are generally consistent with the detailed bottom-up approaches suggested by IPCC good practice guidance, particularly for key sources. The Finnish inventory team has also developed country-specific methods for sources typical for Finland (e.g., emissions from peat production) that could be a useful contribution to the pool of methodologies under the IPCC.

46. For activity data Finland uses a well-developed statistical system that was originally designed for purposes other than GHG inventories' compilation. The emissions estimate for fuel combustion utilizes country and plant-specific data that are not available in the NIR for cross-checks in a disaggregated way for reasons of confidentiality.

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13 Calculation sheets were available during the visit, but could not be considered owing to time constraints.

47. The emission factors used are a mix of default, country-specific and plant-specific. Documentation of the source of emission factors and the rationale for their selection are not provided on all occasions. Some of the emission factors used are not consistent over the inventory time series.

5. Recalculations

48. Finland recalculated its energy sector inventory for the years 1990 and 1998 and provided the corresponding recalculation tables in the CRF for 1999. However, from the trend tables in the submissions for 2000 and 2001 it becomes apparent that recalculations of the energy sector were made for the entire time series with the largest differences being noted for 1996 and 1991. The recalculations for years different from 1990 and 1998 are not documented in the 2001 submission. The changes for 1990 and 1998, after the recalculations have been carried out, are negligible. For example, in the base year the change in emissions from fuel combustion are: CO_2 – +0,01%, CH_4 – +0,21% and N_2O – -0,29%. The change is attributed to improved activity data and slightly revised emission factors. The most significant change is for the estimate of fugitive CH_4 emissions for 1998 (an increase by about 51%). While not documented in the submission, the change was explained to the review team as having resulted from an updating of preliminary data. Recalculations in the energy sector affecting the trend in emissions are mostly due to corrected plant level activity data or corrected total fuel consumption data in the Energy Statistics.

49. Finland intends to recalculate its emissions from the sector for the entire time series. Some revisions are ongoing (e.g., revisions of data for non-point sources of fuel consumption), while others will be included in the recalculations when the updating of the emission factors, data corrections and data allocation revisions takes effect.

6. Uncertainty estimates

50. Finland has provided disaggregated uncertainty estimates for all energy source categories using the tier 1 approach (expert judgement). Generally, the uncertainty ranges for energy source categories are consistent with the ranges in the IPCC good practice guidance. Among the sources with the highest uncertainty rates are fugitive CO_2 emissions from peat production (+/-100%) and indirect emissions of N_2O from fuel combustion (+/-153%). There are no methods for either of these sources in the IPCC Guidelines.

51. The Finnish inventory team demonstrated its efforts to diminish the uncertainties associated with the estimates. A good example is the application of the LIPASTO model which has reduced by a half the uncertainty figures in transport.

7. Verification and QA/QC approaches

52. There are no formal documented QA/QC procedures in the energy sector. There are some internal procedures such as: a comparison of fuel data with data from previous years, and emissions comparisons with companies' mandatory environmental reports.

8. Conformity with the UNFCCC reporting guidelines and the IPCC Guidelines

53. The energy sector inventory for Finland is generally in conformity with the IPCC Guidelines. The estimates are based on detailed tier 2/3 methods and rely on a well-developed inventory system. All efforts were made to develop country-specific methodologies for sources not covered in the IPCC Guidelines (e.g., emissions from peat).

54. The reporting of inventory output also meets the requirements of the UNFCCC reporting guidelines. There are a few small revisions that might improve comparability of the results with the estimates of other Parties. These are listed at the end of the energy section of this report.

B. Reference and sectoral approach

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

55. According to the UNFCCC reporting guidelines, Parties are required to submit CO_2 emissions estimated using the reference approach and to explain any difference greater than 2% compared to the national approach emissions. The Finnish inventory contains such estimates and comparisons. For 1999 the difference reported is less than 1%. Even so, explanations were provided in the documentation box of table 1.A(c) of the CRF. The difference in liquid fuel emissions for the years in the period 1990 to1999 is attributed to the fact that the national approach does not include the statistical difference in total consumption. The overall difference in emissions varies within the range –8.3% to +9.3% during the 1990s. Some further elaboration on the issue is provided in Finland's comments on the S&A report.[14]

56. Some problems were identified with the reference approach itself that could affect the transparency of the estimates and comparison of the methods. These include the need to specify the unit of fuel produced, imported and exported, the use of more individual fuels in the table, and the revision of figures for stock changes and oxidation factors. A brief comparison with the energy balances for 1999 indicated that the information is used in an aggregated way; moreover, some elements were missing (e.g., stock change).

Issues raised in the draft S&A report

57. The comparisons with the international energy data indicated some inconsistencies in the figures for fuel consumption and in specific values for import, export and stock changes. The reference approach data for 1999 are 3.4% lower than those reported by the International Energy Agency (IEA). For liquid fuels, the difference is 6.4%. The growth rates of overall apparent consumption between 1990 and 1999 are quite different in the two data sets. According to the CRF apparent consumption decreased by 0.1%, while according to the IEA it grew by 7.2%. The Finnish team was aware of the issue and pointed out that a study is under way to account for the differences. It considers that possible reasons may be: different allocations, reporting levels and NCVs on the one hand, and a lack of updating and missing background data on the other.

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

58. The Finnish inventory follows the IPCC method and subtracts carbon stored in feedstocks and other non-energy use of fuels from total combustion emissions in the reference approach. However, the inventory assumes that the remaining fuel is combusted and emitted as part of total national emissions as a new source category (7. Other). Such an approach leads to

[14] Probably one reason for these differences is attributable to changes in national emergency reserve stocks of oil products. These reserve stocks are confidential and are not transparent in the official energy statistics. Due to new legislation on the maximum sulphur content of fuels, these reserve stocks were gradually changed in the first half of the 1990s. Thus, certain parts of the import/export and consumption activity actually took place in different years. These changes are not fully reflected in stock changes nor statistical differences of oil products. It seems, however, that the cumulative difference is close to zero. There may also have been other issues related to customers' stock changes, as well as in the allocation of certain oil products in the customs statistics data.

overestimating since the standard emission factors for fuel combustion are not appropriate in this case.

3. International bunker fuels

59. Emissions from international bunkers were equivalent to about 4% of total GHG emissions in Finland in 1999. About two-thirds of bunker fuel emissions are from marine transport and about one-third from aviation. Total emissions from international bunkers have fluctuated somewhat during the 1990s with no discernable trends. A clear jump in the CH_4 emission factor of jet kerosene for aviation is observed in the period in both bunkers and domestic aviation. The reduction is from values of 88 kg/TJ to about 3 kg/TJ. The change for the N_2O emission factor is from 32 to 3 kg/TJ. New figures are consistent with the values used worldwide, but they are used only for 1999. The emissions for the other years in the time series are estimated using the old emission factors.

60. Emissions from ships en route to Sweden that stop at the island of Aland are estimated as bunker emissions. This approach is consistent with the definition of bunkers provided in the IPCC good practice guidance.

C. Key sources

1. Stationary combustion:[15] coal, oil, gas and other fuels – CO_2; biomass and other fuels – N_2O

Trends

61. The uneven trend in total CO_2 emissions from fuel combustion is due to annual changes in the Nordic electricity market. In the long term, the shift towards lower oil-dependency has curbed CO_2 emissions, but their share is still the greatest. Consumption by coal-fired condensing power plants accounts for the other significant part of CO_2 emissions. This consumption is unstable. There is a discernable trend in CO_2 emissions from gaseous and other fuels (peat). The Government's policy has emphasized the consumption of natural gas which has a lower CO_2 emission factor. However, the increased use of peat has added to CO_2 emissions because of its high emission factor.

62. The N_2O emissions from biomass and peat combustion are defined as key sources based on a trend assessment. Both energy sources are increasing their share of the overall energy mix in Finland.

Completeness

63. All sources and sub-sources of stationary combustion are included in the inventory.

Methodologies

64. The national bottom-up method (ILMARI model) used to estimate emissions from stationary combustion is described in the NIR. The method is consistent with the tier 2/3

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[15] In the disaggregated key source definitions for the sector, Finland identifies the following key sources for fuel combustion: solid and other fuels from 1.A.1 Energy industries and 1.A.2 Manufacturing industries; and liquid fuels for 1.A.4 Other sectors and 1.A.5 Other. In this review, the key sources as identified by the UNFCCC secretariat, have been followed.

approach in the IPCC Guidelines and good practice guidance and matches the statistical data available in the country.

65. The method for estimating CO_2 emissions accounts for fuel type and fuel consumption per plant/source category. N_2O emissions are calculated using detailed plant level activity data and technology-based emission factors for individual boiler or process type. There are N_2O emission factors available for about 250 categories of boilers and processes.

66. In terms of conformity with the IPCC Guidelines and good practice guidance and comparisons across countries, a few items should be borne in mind:

(a) emissions from coke and residual oil in blast furnaces from iron and steel are reported under 1.A.2 Manufacturing industries and construction and not in the industrial processes sector;

(b) emissions from autoproducer power plants recently sold to energy companies and new plants constructed by energy companies to serve the manufacturing industry are both accounted for under autoproducers;

(c) Indirect N_2O emissions caused by nitrogen deposition due to NOx emissions are included in the energy sector;

(d) Emissions from waste incineration are also reported under the energy sector because all such activity in Finland has energy recovery systems. This is consistent with good practice.

Activity data

67. Detailed activity data for large point sources are compiled from the VAHTI database and then combined with other data from special surveys, electricity statistics, district-heating statistics and manufacturing industry statistics. Aggregate sectoral (sub-sectoral) data for other sources (small combustion, residential, etc.) are based mainly on separate research projects, studies or surveys.

68. The data used were referenced in the NIR and the actual database was briefly demonstrated to the review team. It was, however, not available for use by the review team or by the public, for confidentiality reasons.

69. The only sources for cross checking were the aggregated data sheets provided in the Energy Statistics yearbooks. The level of aggregation reduces the transparency of the allocation of the 50 fuel items and 248 economic branches mentioned, as well as the overall transparency of the inventory. An indication on the inclusion of some fuels that are not given in the IPCC reference approach under solid, liquid, gaseous and other fuels would be a useful clarification that could be provided in the NIR. This also applies to the coverage of the sectors/branches included in the sectoral approach, where the allocation of some combustion activities such as military combustion, off-road machinery, etc. is not always self-evident.

Emission factors

70. The emission factors used are a combination of plant-specific and country-specific data developed for Finland's first inventory as well as IPCC default values. Some emission factors are due to be revised because they are based on measurements made in the early 1990s and do

not account for efficiency improvements over the inventory period. Although there are references for the sources of emission factors, their documentation is insufficient and no explanation supporting the choice of emission factor is available.

Issues raised in the draft S&A report 2001

71. The S&A report identified some significant deviations of implied emission factors over the inventory period. Some of the changes are explained by not yet updated plant level emission factors for 1992 to1994. The low emission factor for "solid fuels" is explained by the inclusion of coke oven and blast furnace gases in the solid fuels category. The high value for "other fuels" is due to the high emission factor of peat, which is included in this category.

2. Mobile combustion:[16] Road transportation – CO_2 and N_2O; Navigation and other transportation – CO_2

Trends

72. The trend in road transportation CO_2 emissions is rather unstable with a drop in the middle of the period followed by an increase in emissions. However, 1999 emissions are still under the emission level for 1990. N_2O emissions are steadily increasing because of the wider use of catalytic converters.

73. Emissions from domestic navigation are also increasing. There is a sudden doubling of the emissions for 1999 due to the inclusion of emissions from gasoline under this source.

74. Emissions of CO_2 from off-road machinery are only provided for 1990, 1998 and 1999.

Completeness

75. The LIPASTO calculation system covers emissions and energy consumption for all traffic modes. The LIISA sub-model covers all road and vehicle types in a consistent manner. The results obtained with the LIISA model do not necessarily match the results provided in the official inventory due to some adjustment and rearrangement of the data. The vehicle types considered are personal cars, vans, buses, semi-trailers and articulated vehicles. Eight road types were considered. For off-road machinery, 43 types of machinery are considered by TYKO. Waterborne emission estimates (MEERI sub-model) cover domestic traffic of passenger and freight ships, port emissions, leisure and fishing boats and icebreakers.

Methodologies

76. Emissions from transport are estimated using the LIPASTO and TYKO models developed by the Technical Research Centre of Finland (VTT) which correspond to the level of complexity of the IPCC tier 2/3. CO_2 emissions are estimated on the basis of fuel consumption and fuel-specific emission factors (g/kg fuel). Emissions of CH_4 and N_2O are based on vehicle mileage (km/yr) of different vehicle types on different road types and emission factors per km driven (g/km). For off-road machinery emission estimates are based on work done (kWh) and emission factors (g/kWh) based on average emissions per working hour.

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[16] According to the key source assessment by Finland using tier 1 and tier 2 approaches, the following mobile sources were identified as key sources: tier 1 – CO_2 from road transportation; navigation, aircraft, off-road machinery; tier 2 – CO_2 and N_2O emissions from road transportation; CO_2 from navigation and off-road machinery; N_2O from aircraft.

Activity data

77. National experts have a high level of confidence in the estimates of CO_2 emissions because fuel consumption by road traffic is known very precisely. Finland has very detailed activity data covering the transport sector. The methodology used is highly data intensive. Inputs include: mileage [km/a] by areas (municipalities), road types, speed limit areas and vehicle types; vehicle characteristics (type, engine, non catalytic/catalytic converters, age distribution); specific fuel consumption, etc. The activity data for the sector are based on the road registry of the Finnish Road Administration, the Finnish Maritime Administration, annual sales statistics and the VTT database. The outputs of the LIPASTO and TYKO models are used as inputs for the ILMARI calculation system. They are reallocated in a way that is not fully transparent and poorly documented.

Emission factors

78. The NIR provides a list of the CH_4 and N_2O emissions factors used in the LIISA 1999 model by road, fuel, speed limit and vehicle type, as well as correction factors reflecting the change in fuels and vehicle technologies. Many emission factors are based on measurements and are updated on a temporary basis. The remainder come from the IPCC Guidelines, country-specific measurements and from literature sources. Emission factors used by LIPASTO and TYKO are extensively referenced.

Issues raised in the draft S&A report

79. The increase in the road transport implied emission factor (IEF) for N_2O highlighted in the S&A report was explained by the increasing use of catalytic converters in recent years. The IEF for CO_2 is based on national references.

80. The lower activity data for gas/diesel oil for domestic navigation compared to the IEA data was attributed to an update of preliminary data.

3. Fugitive CO_2 emissions from solid fuels – peat production

81. In Finland, the preparation and profiling of peat soils and stockpiling of peat for combustion lead to significant fugitive emissions of CO_2. It is estimated that the annual fugitive CO_2 emissions from the two sources is about 3.5 Tg representing 5% of total national emissions.

Trends

82. Because of limited activity data, constant emissions are reported over the entire time series.

Completeness

83. The ERT notes that Finland has included emissions from this country-specific source category even though it is not covered in the IPCC Guidelines.

Methodologies, activity data and emission factors

84. The country-specific methodology estimates emissions from the two sub-sources, namely areas with active peat production and lands classified as reservoirs for future peat production. The methodology for the source is documented in several studies made available to the review

team. The ERT notes that the methodology could be further refined to account for the annual differences instead of the current assumption of constant annual emissions.

85. The activity data and emission factors for peat production areas and land classified as reservoirs for future peat production are provided in referenced studies. They have high uncertainty rates and are under review.

D. Non-key sources

1. Fuel combustion – CH_4

86. The ERT reviewed the estimate for CH_4 emissions from stationary fuel combustion in more detail than other non-key sources. The main source of emissions is biomass. The majority of emissions come mainly from small scale burning of wood in the source category “Other sectors”. This source produces the bulk of CH_4 emissions in the energy sector and there is little information available on either the activity data or emission factors.

Trends

87. CH_4 emissions from stationary combustion have grown by about 14%. The increase is due to increased biomass use.

Completeness

88. All sources are covered.

Methodologies

89. The method is well documented in the NIR. It matches the statistical data available for Finland and is considerably more detailed than the alternative tier 1 approach for non-key sources.

Activity data

90. The activity data for the method contain many different sources and data sets. It was demonstrated to the review team, but it is not generally available for public use for confidentiality reasons.

Emission factors

91. The emission factors are a combination of country-specific data developed for Finland’s first inventory and some default values. The database set needs to be updated to include emission factors for new technologies and revision of existing emission factors. The comparison over the period indicated some changes in the IEF, as well as some changes made when recalculating the 1998 estimates (e.g., the CH_4 IEF for other fuels for public electricity and heat production changed from 3.33 kg/TJ (2000 submission) to 6.38 kg/TJ (2001 submission). The rationale for the revision was not documented.

Issues raised in the draft S&A report

92. The S&A report has identified some deviations in the IEF over the period 1990 to1999. Some of the changes are due to the high uncertainty of the emission factors for biomass. These emission factors were said to be subject to future revisions.

E. Areas for further improvement

1. Planned or ongoing work by the Party

93. Finland has a detailed plan for improving its GHG inventory for each of its sources. Some specific improvements for the energy sector are as follows:

(a) Fuel combustion

(i) Recalculation of 1991 emissions using the current model and revision of other years to avoid inconsistencies in the time series.

(ii) Ongoing research to update activity data from residential, service sector and off-road machinery fuel consumption. The changes should not affect total CO_2 emissions but they might affect the sectoral splits. Total emissions of other gases may change (in particular CH_4, NMVOC, NOx and CO).

(iii) Harmonization of emissions between the ILMARI and LIPASTO calculation models.

(iv) Revision of the CO_2 emission factor for combustion of municipal solid waste.

(v) Updating of the non-CO_2 emission factors used in ILMARI which are currently based on research data from the beginning of the 1990s.

(vi) Further study of the allocation of gas, oil and residual fuel oil to different sectors and types of use.

(vii) Further study of emission factors for small combustion of wood in order to achieve better annual comparability.

(b) Fugitive emissions

(i) Calculation of emissions for the whole time series will be made when improved activity data and emission factors for the sub-sources are available.

(c) International bunkers

(i) Harmonization of emission factors in the ILMARI and LIPASTO calculation models.

(ii) Improved emission factor data on non-CO_2 emissions will be incorporated in the calculation system when they are available.

94. Some of the planned improvements could be of value to other Parties, particularly in the methodologies for peat lands, which are relevant for some other countries but are not covered by the IPCC Guidelines and good practice guidance.

2. Issues identified by the ERT

95. The main findings of the review team in the sector are summarized below:

(a) General issues:

(i) *Uncertainty*: further efforts are needed to reduce the uncertainty of the emission factors and activity data and joint uncertainty of some sources, such as biomass and peat burning (100% uncertainty).

(ii) *Transparency*: the transparency of the estimates is very much reduced as a result of the confidentiality of the information at Statistics Finland. For the reference approach, a reference energy balance sheet would make it easier to follow the estimation procedure.

(iii) *Verification and QA/QC*: QA/QC should be developed to implement QA/QC for all sources in the energy sector. Documentation, record keeping and archiving should be carried out in a systematic manner.

(iv) *CRF references*: most of the secondary products are indicated as included elsewhere (IE) in the relevant CRF table without reference to where they are included. All these fuels could be indicated separately in order to improve the transparency of the table.

(v) It is not clear exactly where the waste emissions (indicated as reported in table 6.C) are reported in table 1.A(a). Another difficulty concerns the reporting of indirect N_2O emissions which are not provided in table 1.A(a) but are given in the total for table 1. This is not explained in the CRF itself (e.g. in the documentation box). A reference to the relevant part of the NIR where the explanation can be found would be useful.

(vi) *Staff*: the energy sector is the most important in the country with about 11 identified key sources. Finland is encouraged to consider the level of the human resources involved in the preparation of the emission estimates for the sector.

(b) Methodological issues:

(i) *Reference approach*: the reference approach estimates were found to be incomplete and too aggregated and they did not match the energy balance sheets. A more disaggregated split of fuels is necessary to account for the different secondary fuels, as well as checks and revisions of stock changes and oxidation factors.

(ii) *Clear allocation and aggregation of data*: the distribution of fuels between the subcategories within the energy sector should be refined, made consistent over the entire period and clearly documented (e.g., military use; indirect N_2O emissions).

(iii) *Update of the country-specific emission factors and documentation*: Finland is expecting to revise its emission factors database. The revisions should be accompanied by clear references to the sources of emission factors to be used in the future and the rationale for their selection, as well as updates over the period covered in the inventory time series.

(iv) *Methodological refinements (peat, feedstocks)*: revision of the way in which feedstocks are treated is needed in order to avoid overestimation of emissions. The peat methodology needs refinement to allow for annual updates of emissions.

(v) *Full coverage of sources (tier 1 for fugitive)*: regarding completeness of the inventory, it is recommended that all fugitive emissions for which the input data have been calculated be included, even though they are considered to be negligible.

III. INDUSTRIAL PROCESSES AND SOLVENT USE

A. Sector overview

96. The Industrial processes sector represented 3.7% of total national emissions in the base year (1990). The key sources identified with the tier 2 approach are N_2O emissions from nitric acid production and HFCs from refrigeration and air-conditioning. Three additional sources were identified using the tier 1 approach: CO_2 emissions from cement production, CO_2 emissions from lime production, and CH_4 emissions from ethylene.

97. CO_2 equivalent emissions in the sector declined by 28% from 1990 to 1993 and increased by 33% from 1993 to 1999 to 3% below the1990 level. The trend was driven by the economic recession and subsequent recovery in the early to mid-1990s.

1. Institutional arrangements

98. The industrial sector inventory is the direct responsibility of Statistics Finland, the Technical Research Centre of Finland (VTT), and the Finnish Environment Institute (FEI). Statistics Finland is responsible for CO_2, CH_4 and N_2O sources and FEI has responsibility for the fluorinated gases and NMVOCs. Both Statistics Finland and FEI maintain databases of emission factors, activity data and the CRF tables.

2. Completeness

99. The industrial processes inventory covers all significant source categories and gases in accordance with UNFCCC and IPCC guidelines. Emissions from a number of mineral product sub-sources were not estimated, such as limestone and dolomite use, soda ash production, asphalt roofing and road paving. The inventory experts explained that emissions from some of these sources are considered negligible and for others no activity data have been collected. CO_2 emissions associated with coke consumption in the iron and steel industry were included in the energy sector consistent with good practice.

100. Regarding emissions from the solvent and other product use sector, no CO_2 emissions from identified sources have been estimated (CRF Table 3). This was explained in CRF Table 9 as being due to lack of emission factors for the carbon content in estimated NMVOCs from respective sub-source categories.

101. N_2O emissions from the use of N_2O have been estimated for 1990 and 1998 and interpolated for the other years. Finland clarified that these N_2O emissions are a very minor source in Finland's inventory and that all use of the gas is covered in the inventory. NMVOCs were estimated for relevant sub-categories of the industrial processes sector and also for source

categories under the solvent and other product use sector (categories 3. A to C) as well as specific country sources identified (under category 3.D "Other"*)*.

3. Transparency

102. The methodologies used for the industrial processes sector are a mix of country-specific and IPCC default. They are referenced and summarized in the NIR. Finland notes that some IPCC default factors are not suitable for some source categories. For reasons of confidentiality, activity data for some fluorinated gases are aggregated and this makes the reporting lack transparency.

4. Methodology, activity data and emission factors

103. Finland used a mix of country-specific, IPCC default and IPCC good practice methodologies in the industrial processes sector. Generally, the emission factors are IPCC defaults, with the exception of N_2O emissions from nitric acid production which is a key source. The plant-specific emission factor (0.009t/t), however, is on the upper limit of the range of the IPCC defaults (0.002-0.009t/t).

104. Activity data are compiled from plant and process level data reported by relevant industries under the country's mandatory environmental permitting and monitoring system. The system requires mandatory reporting of plant and process level data to the Regional Environmental Centres (REC), which is transmitted to Environment Finland. The database constitutes the VAHTI register managed by Environment Finland. In addition, the Statistics Act of Finland mandates data disclosure, which facilitates industry response to national survey and data collection by Statistics Finland.

105. The VAHTI database/register was available to the review team. The national inventory experts acknowledged that data gaps existed as a result of ineffective transmission from RECs to the VAHTI database. Further, the existing data sets, which were not developed for inventory preparation needed modification to meet the needs of both the environmental permitting and monitoring system under the country's national pollution inventory (NPI) program and also the national GHG inventory.

5. Recalculations

106. Recalculations are well documented in the NIR and in tables 8(a) and 8(b) of the CRF. In the 1999 inventory, CH_4 emissions from pig iron and sinter production were removed from the inventory because of evidence of near zero emissions recorded by plant level measurements. This removal led to reductions in industrial processes CH_4 emissions of 85% to 89% in the four years reported (i.e. 1990, 1997-1999). CH_4 emissions from the iron and steel category are thus based on coke production only.

107. The methodology for estimation of emissions of the fluorinated gases in 1999 was based on the IPCC good practice guidance through a country project, while the estimates for previous years (1990-1998) were based on a country-specific approach. The ERT notes that recalculations were not made for 1990-1998 regardless of the differences in the methodologies which could have introduced inconsistency in time series. Finland, however, explained that the decision to recalculate the entire time series was delayed in order to obtain two years of overlapping data to facilitate the comparison of the two methods. Later analysis proved that the two methods gave

comparable results for 1999 and 2000, and hence a decision not to recalculate the period 1990-1998 was made.

108. The recalculation in the consumption of SF_6 based on improved IPCC and country-specific methodology led to a 60% decrease in SF_6 emissions in 1998 and 1999 compared to the previous methodology.

6. Uncertainties

109. The uncertainties for the industrial processes sector were estimated based on expert judgement. The uncertainty estimates ranged from 3% to10% for activity data and from 5% to 40% for emission factors. The high uncertainties in emission factors were reported for CH_4 from iron and steel production (20%) and fluorinated gases (40%). Finland noted that in future, more resources would be allocated to the development of quantitative and qualitative uncertainty estimates.

7. Verification and QA/QC

110. Although there are no formal QA/QC procedures in place, the activity data obtained from the VAHTI register, which are used in the GHG inventories are subject to source verification and approval by the REC. The environmental permitting and monitoring system thus provides a mechanism of QA/QC. The ERT notes that the system should be documented and improved on as part of any future formal QA/QC plan.

8. Confidentiality

111. The major issues regarding confidentiality of activity data in the sector's inventory were mainly encountered in the reporting of fluorinated gases. Activity data had to be aggregated to ensure confidentiality, thus making the reporting non-transparent in the case of some HFC-species and emission sub-categories. The national inventory experts attribute this to the fact that the existing mandatory environmental permitting system does not currently cover the fluorinated gases. In addition, Finland observed that the level of disaggregation of HFC/PFC/SF_6 sub-sources by individual chemical required in the CRF is very extensive. At this level of detail, the number of companies behind a reported figure could easily become less than four, which has been the threshold for confidentiality.

9. Consistency with the UNFCCC reporting guidelines and the IPCC Guidelines

112. The estimates and reports of emissions in the CRF and NIR for the industrial processes sector are mostly consistent with the IPCC Guidelines and the UNFCCC reporting guidelines. The specific areas to further improve the industrial processes inventory identified by the ERT as well as by Finland's planned improvements are outlined in paragraphs 134 and 135 below.

10. Issues related to previous reviews

Review of the Second National Communication (NC2)

113. Finland did not report actual emission of fluorinated gases in the NC2, though potential emissions estimates were provided. A project implemented in 1999 had carried out a national survey and collection of activity data which facilitated the estimation of both potential and actual emissions for the entire time series 1990 to1999.

B. Key sources

1. 2.B.2 Nitric acid production – N_2O

Trends

114. N_2O emissions from nitric acid production have decreased by about 20% since 1990. The explanation in the NIR indicates that the reduction is due to the decline in the demand for nitrogen fertilizer as a result of environmental regulations. The closure of one plant had caused the sharp reduction in the activity data from 1990-1992.

Methodology, activity data and emission factors

115. Finland used the tier 2 method in accordance with IPCC good practice. Activity data were obtained directly from nitric acid plants and the emission factors are based on plant-level measurements carried out in 1999 by DEKATI.

Uncertainties

116. The uncertainty estimates are 5% for activity data at the plant level and 20% for emission factors. The higher uncertainty for emission factors is due to the small number of measurements.

Findings identified in the draft S&A report

117. National experts indicated that although the IEF for N_2O is the highest among reporting Parties, the value was obtained from plant measurements and is appropriate for national conditions. Fluctuations in emissions during the early 1990s were explained by the closure of one of the three production plants in 1992.

2. 2.F Consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6

Trends

118. Emissions from the consumption of HFCs, PFCs and SF_6 constitute about 0.5% of national GHG emissions. The most significant of the F-gases are HFCs which are estimated to have increased over 1000 times between 1990 to 1999 as a result of the phasing out of CFCs under the Montreal Protocol. Exponential growth in total emissions of F-gases began in 1994 and over the period total emissions grew from 55 Gg CO_2 equivalent (1994) to 378 Gg CO_2 equivalent (1999).

Methodology, activity data and emission factor

119. The tier 1b and tier 2 methods were used for potential and actual emissions estimates, respectively, in accordance with the IPCC good practice guidance while a different country-specific approach was used for 1990 to1998. Analysis has shown that the two methods give comparable results.

120. The sources of emissions identified included refrigeration and air conditioning, aerosols, foam blowing, electrical equipment, fixed fire fighting systems, and electronic manufacturing. The FEI carried out a project for the collection of the activity data. The data sources included import and export data of the Association of Finish Technical Traders (AFTT) and other non-member companies, as well as thermal destruction data. Other sources were annual sales of domestic refrigeration appliances and registration of new vehicles in Finland. The emission

factors, which are documented and referenced in the NIR, were a mix of IPCC defaults based on good practice guidance and IPCC Guidelines, as well as country-specific.

Uncertainties

121. The uncertainty is approximately 10% for activity data and 40% for emission factors. The reported difficulties in the collection of activity data included confidentiality of information which is currently not subject to the country's mandatory environmental permitting system.

Response to findings identified in the draft S&A report

122. The inventory officials explained that the decrease in SF_6 emissions from 1990 to 1999 was due to the peaking of annually installed new capacity of electrical equipment in 1990 and the higher emission factors for equipment installed prior to 1994. The increase in actual emissions of SF_6 from 1998 to 1999 resulted from the aggregation of confidential emissions data from magnesium production in 1999 with other actual SF_6 emissions data, which had not been carried out in previous years.

123. Regarding the low ratios of potential to actual SF_6 emissions, Finnish officials detected mistakes made in transferring emissions figures from the calculation system into the CRF. These mistakes will be corrected and recalculation tables completed accordingly.

124. In response to why there should have been a significant increase in PFC emissions from 1998 to 1999 (0.9 to 28.55 GgCO_2 equivalent), officials noted that in 1999 a new refrigerant (R-413A) was introduced in Finland which contained a PFC-component (perfluoropropane).

3. 2.A.1 Cement production – CO_2

Trends

125. CO_2 from cement production was identified as a key source according to the tier 1 assessment, but not the tier 2 level assessment. This sub-source category contributed 0.8% of total GHG emissions in 1999. Emissions decreased significantly in 1990 to 1993 because of the economic recession and consequent decline in the construction industry and cement demand. The emissions in 1999 were still only 20% of 1990 levels.

Methodology, activity data and emission factors

126. The methodology is described in the NIR as the tier 1 IPCC good practice methodology based on cement manufacture. The emission factor reported is, however, very low compared with the tier 1 IPCC default emission factor. Activity data were obtained from manufacturing industry statistics and also directly from production plants. The methodology does not indicate cement production by type, lime content of clinker or clinker and cement ratios in accordance with the tier 1 method of the IPCC good practice.

127. The choice of emission factors was not explained adequately in the NIR. The report implies that Finland assumed an average lime content in clinker of 60%, which is relatively low compared to the recommended average of 65% in the IPCC good practice. This might be the reason for the low final emission factor (0.47t-CO_2/t cement) compared with the IPCC default (0.499t-CO_2/t cement). Finnish experts agreed to verify this factor from various clinker and cement production plants in order to increase the transparency and reduce the uncertainty of the present methodology.

Uncertainties

128. The uncertainties in emission factors and activity data are estimated to be 5%.

Response to findings identified in the draft S&A report

129. The cement activity data reported by Finland were preliminary and this may explain why they differ from the data published by United Nations.

130. Officials attributed the decrease and subsequent rise in emissions to the economic recession in early 1990 which led to decline in construction sector activity.

C. Non-key sources

1. 2.A.2 Lime production – CO_2

Trends

131. CO_2 emissions from lime production contributed 496 Gg (0.65%) to national total emissions. The level of emissions in 1999 was almost the same as in the base year 1990. The lime sector showed a dramatic recovery from the recession.

Methodology, emission factors and activity data

132. The IPCC default methodology was used with activity data from manufacturing industry statistics and also reports direct from production plants. Finland assumed the IPCC default emission factor and did not account for different types of limestone used as recommended in IPCC good practice. Inappropriate stoichiometric ratios can potentially lead to overestimation of CO_2 emissions.

Uncertainties

133. The uncertainties estimate by expert judgement for activity data is 10% and 5% for the default emission factor.

D. Areas for further improvement

1. Planned or ongoing work by the Party

134. Potential areas of improvement identified by the Finnish industrial processes inventory team are summarized as follows:

(a) Plant-specific emission factors will be studied for the source categories where IPCC defaults are currently being used so as to establish their suitability. These include CH_4 emissions from ethylene and coke production.

(b) Emission factors for N_2O from nitric acid production, CO_2 from cement and F-gases will also be improved.

(c) Sector experts for F-gases have proposed the expansion of the mandatory reporting of pollutants to include sources and emissions of F-gases under the country’s national pollution inventory (NPI) program.

(d) The development of country-specific models for NMVOCs inventories for the solvent use sector based on methodologies of Australia and the USA to meet the UNECE guidelines.

2. Issues identified by the ERT

135. Finland is encouraged to improve the industrial process sector inventory by:

(a) Developing a higher tier methodology and emission factors for estimating CO_2 from cement and lime production.

(b) Increasing the scope of industrial activity data collection for the sub-source categories of the sector not currently estimated.

IV. AGRICULTURE

A. Sector overview

136. Total GHG emissions from agriculture have declined substantially from 10,164 GgCO_2 equivalent in 1990 (13% of total emissions) to 7,598 GgCO_2 equivalent in 1999 (10% of total emissions). The key sources identified by Finland agree with those identified by the secretariat in the draft S&A report.

1. Institutional arrangements

137. Estimates of emissions from agriculture are performed by VTT (Technical Research Institute) and MTT (Agricultural Research Institute/Agrifood Research Finland). VTT is responsible for estimates of all emissions of CH_4 and N_2O, and MTT is responsible for estimating emissions of CO_2 from soil cultivation. It is expected that MTT will have total responsibility for the sector in the near future.

2. Record keeping and archiving

138. All calculation sheets are stored in spreadsheets in VTT, which submits only CRF tables to FEI. The calculation sheets, which were available only in Finnish language, were available during the agriculture evaluation, but could not be considered owing to time constraints.

3. Completeness

139. The emission inventories from agriculture in Finland are almost complete for all years from 1990 to 1999. The ERT notes that other country-specific source categories identified would have to be quantified. These are CH_4 and N_2O emissions resulting from domestic reindeer, and N_2O emissions in soil resulting from residues of some crops that were not quantified. Emissions from field burning of agricultural residues were not estimated but are considered to be negligible.

4. Transparency

140. Generally, the NIR includes most of the necessary information concerning methods, activity data and emission factors required to perform the recalculations of the emission estimates. The only exception is CO_2 from organic soils for which the information in the NIR and the CRF is not sufficient to allow the emissions estimates to be reconstructed. However, this gap was addressed during the visit. For some sources the activity data were not fully presented and the review team had to derive the data from descriptions in other source categories.

5. Methodology, emission factors and activity data

141. All methodologies used to estimate emissions followed the IPCC Guidelines and are consistent with IPCC good practice guidance. Finland used country-specific parameters and emission factors, where available.

6. Recalculations

142. Since its 2000 inventory submission, Finland has updated and recalculated some estimates. Differences from previous submissions are documented in the CRF and discussed in each source category in the NIR. All methodological modifications have been done in a consistent way for the entire time series.

7. Uncertainties

143. The uncertainty analysis was performed by VTT after publication of the final version of the NIR. Some, but not all, the information about the uncertainty analysis can be found in the NIR. The assumptions used for estimating the uncertainty levels are not documented.

8. Verification and QA/QC

144. The agriculture inventory QA/QC system for Finland is under development. There are formal quality control procedures for the activity data officially collected by the Ministry of Agriculture Information Centre. These activity data are also the basis for all agricultural statistics and calculations in Finland, and are considered to be very reliable by national experts.

9. Conformity with the UNFCCC reporting guidelines and the IPCC Guidelines

145. Finland followed the IPCC Guidelines. The default methodologies and emission factors have all been updated to take account of IPCC good practice guidance, where available, except for the emission factor for CH_4 from manure management which Finland decided not to revise.

146. All CRF tables relating to agriculture were reported for all years from 1990 to 1999. CO_2 emissions from cultivation of agricultural soils were reported under the agriculture sector in the summary tables, although underlying basic information was filled in in the CRF background data table under LUCF. Finland considers that these emissions are caused by agricultural activities, not by land-use change, and supports its reporting decision on the basis of the IPCC Guidelines (Summary table 7A, Reporting Instructions). Notation keys were used in all cells of the CRF tables but there were some inconsistencies in the use of "NZ", not occurring (NO), not applicable (NA) and not estimated (NE).[17]

[17] (1) Enteric fermentation for poultry is reported as "NA" (table 4.s2), given that a default methodology is not available. At the same time, it is recognized that such emissions might exist, therefore, notation key "NE" or "0" might have been more appropriate. (2) N_2O from Anaerobic lagoons is "NA" (table 4.s2) whereas it should be "0" or "NE"; (3) notation keys in table 4.B(b) and additional information in 4.B(a) should be used in a consistent way; (4) in the additional information table in 5.D the "NO"/"IE" notation key for Aquic soils is unclear; (5) generally "NZ" was used as an indicator of near zero values which is not in accordance with the reporting guidelines.

B. Key sources

1. 4.A Enteric fermentation – CH_4

Trends

147. CH_4 emissions from enteric fermentation decreased from 86.8 Gg CH_4 in 1990 to 74.0 Gg in 1999. Relevant source categories are dairy cows and non-dairy cattle.

Completeness

148. Coverage of enteric fermentation is complete with the possible exception of reindeer. The reindeer population in Finland is substantial and herding could in some aspects be considered an anthropogenic activity. Finland decided not to include this category in the inventory because of a lack of emission factors. To ensure completeness, the ERT recommends that Finland prepare an initial estimate for reindeer according to the recommendations in the good practice guidance for animals for which no emission estimation methods are described, and then use country-specific emission factors if reindeer are found to be an important source.

Methodologies and emission factors

149. The tier 2 method was used for cattle in accordance with IPCC good practice guidance which recommends the detailed methods for the most important livestock. The tier 1 method was used for other species. Both methods are documented and referenced in the NIR.[18] Emission factors from cattle were estimated according to the tier 2 IPCC methodology on the basis of Gross Energy Intake (GE) and the default CH_4 conversion rate (Ym) set out in the good practice guidance for developed countries.

Issues raised in the draft S&A report

150. The draft S&A report observed that the CH_4-IEF for dairy cattle is relatively high compared to the IPCC defaults for western Europe and other reporting Parties, while for non-dairy cattle the CH_4-IEF is lower. These differences are due to Finland's use of the relatively new good practice methodologies for estimating feed intake, as well as a country-specific characterization of livestock.

Activity data

151. The feed intake of dairy cows, heifers, bulls and mother cows was estimated according to the energy model presented in the IPCC good practice guidance, with an enhanced characterization of livestock. The dairy cattle subcategory referred to in both NIR and CRF tables is equivalent to dairy cows, which is consistent with IPCC good practice guidance.

152. For cattle, swine and horses, the national statistics and those of the Food and Agriculture Organization of the United Nations (FAO) are in almost complete agreement. For sheep and goats, there is a significant statistical difference in the early 1990s. The figures delivered in the national inventory are from the statistics of the Information Centre of the Ministry of Agriculture and Forestry, which are official data and considered to be more reliable. Finland had been unable to determine the origin of FAO's statistical data. In the review Finland provided published

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[18] In CRF table Summary 3, Finland reports the method as tier 2 and the emission factors as country-specific/default. However from the information available, Finland should report the method as mixed tier 1/tier 2.

statistics on animal livestock in the "Yearbook of Farm Statistics 2000", available in Finnish, with summaries and relevant tabular data in English.

153. The following issues should be better addressed:

(a) From the data provided in the CRF it can be seen that the weight of dairy cows increased steadily over the period. Although this was not addressed in the NIR, it was explained during the visit that it had been an expert judgement based on the results from the annual statistical information that shows that milk production per cow increased steadily over the period. This could have resulted in cows becoming bigger.

(b) The digestibility of feed was set as 70% by the Association of Rural Advisory Centres. This is higher than the proposed IPCC default value for western Europe (table A-2 of the IPCC Guidelines). The NIR documents this value in two personal communications (Korpilo, 1993; Malkia,1996/1999), but the reference description is not included in the final list of references.

(c) Mature body weight of bulls and mother cows was assumed to be equal, which might be unrealistic.

Recalculations

154. Emissions of CH_4 from enteric fermentation were recalculated, resulting in new emission estimates. The only differences were in feed intake estimates, reflecting the new energy model introduced in the IPCC good practice guidance and that an increase in the animal weight of cows had been taken into consideration. Animal numbers for the entire time series were maintained. Emission estimates from the entire time series were recalculated in a consistent way.

Uncertainty

155. In the NIR, the uncertainty level of the activity data was estimated as 10%, in accordance with information from the original statistics, although it is not clear whether this includes the uncertainty of the cattle feed intake estimates. The uncertainty of emission factors was estimated as 30%. These same values were considered in the key source identification in the Finnish 1999 GHG inventory. However, the overall uncertainty referred to in the key source identification was 32% as opposed to 30% in the NIR.

2. 4.B Manure management – N_2O

Trends

156. N_2O emissions from manure management – not including emissions in grazing/pasture – decreased steadily during the period analysed, from 1.79 Gg in 1990 to 1.32 Gg in 1999. The vast majority of emissions resulted from solid storage (97-98%).

Completeness

157. The inventory of N_2O from manure was considered complete.

Activity data

158. Finland estimated the quantity of manure produced from feed intake alone without incorporating bedding or litter which is considered to be negligible. The quantity of manure that

is deposited directly on pasture was estimated, from length of pasture season, at about 21% to 23% of total manure produced. The rest was divided between liquid/slurry and solid storage. About 30% of total manure was treated in liquid systems before 1995 and 36% thereafter. This marked change occurred because Finland decided not to interpolate data in a smooth evolution throughout the 1990 to 1999 period, but to change the allocation only in 1995. Finland hardly used manure for the production of biogas because of structural constraints on the average size of farms.

159. The total quantity of nitrogen from livestock was estimated from annual average nitrogen excretion per head, with country-specific values as determined by the Finnish Environment Institute reported in the NIR in Finnish only. It appears that actual values are available for 1990 and 1995 and that interpolations and extrapolations were done for the other years, partly based on expert judgement.

Methodologies and emission factors

160. N_2O emissions from manure management systems were estimated using the default methodology in the IPCC good practice guidance, country-specific N-excretion rates and manure management usage, and default emission factors based on table 4.12 of the IPCC good practice and table 4-22 of IPCC Guidelines.

Recalculations

161. The emission estimates were recalculated because of a change in activity data (manure produced) which reflects the new feed intake estimates.

Uncertainty

162. The key source identification in the Finnish 1999 GHG inventory estimated activity data uncertainty to be 10%. The uncertainty of emission factors is 100%. The NIR did not provide any estimates of uncertainty levels for this source.

Issues raised in previous reviews

163. Livestock nitrogen excretion per head increased for cattle between 1990 and 1995, decreased for sheep, goats, swine and chicken (>5 month) over the same period, and was constant for other poultry. However, after 1995 the excretion rates decreased for species other than poultry. The decrease was attributed to feeding improvements. Comparing the excretion rates with IPCC defaults (table 4-20), it is evident that the country-specific values are lower than the IPCC defaults and those of other Parties, according to the draft S&A report, particularly for cattle and swine. The lower values for Finland were attributed to a lower nitrogen content in feed relative to other Parties.

3. 4.D.1 Direct emissions from soils – N_2O

Trends

164. Direct N_2O emissions from soil decreased continuously from 1990 (11.64 Gg N_2O) to 1999 (9.09 Gg N_2O). The most important source categories are the use of synthetic fertilizers and the cultivation of organic soils, while sludge spreading and N-fixing crops are minimal contributors.

Completeness

165. The estimate of N_2O emissions from soil cultivation is complete except for agricultural residues from certain vegetable crops.

Methodologies and emission factors

166. The country-specific volatilization factor for ammonia and NO_x from synthetic fertilizers is ten times lower than the IPCC default (0.1 kg NH_3-N +NO_x-N/kg N). This was justified and documented on the basis of expert information from VTT. The difference is attributed to the high acidity of Finnish agricultural soils and a reduced use of urea and fertilizers, which are usually embedded deep into the soil (7–8 cm) during sowing operations. IPCC default emission factors were used for estimating N_2O emissions.

167. The quantity of nitrogen added to the soil from nitrogen fixation and from crop residues was estimated according to the methodology proposed in equations 4.26 and 4.29 in the IPCC good practice guidance. Finnish experts explained that a mix of IPCC default and country-specific factors had been applied. However, it is not clear which are default and which are country-specific, and there are no documentation references.

168. Finland used an emission factor of 8 kg N_2O-N/ha/a for N_2O from organic soils including peatsoils, which is the new updated value recommended in the IPCC good practice guidance (page 4.7). This value is slightly higher than the previous IPCC default (5 kg N_2O-N/ha/a).

Activity data

169. Nitrogen fertilizer data was available from the Ministry of Agriculture and Forestry of Finland and sales statistics of Kemira Agro Oy. Differences of up to 22% were observed between the reported value in the CRF/NIR and that of FAO, although both show a decreasing trend. Finland considers the data of its Agriculture Ministry to be the more reliable.

170. Annual crop production data for both nitrogen fixers and non-nitrogen fixers came from the Information Centre of the Ministry of Agriculture and Forestry. Information collected from FAO by the ERT revealed that Finland had not considered certain vegetable and fruit crops. The inclusion of their residues as a nitrogen source in soils could possibly increase emissions of N_2O.

171. The ERT noted that the value for $Frac_{NCR}$ for wheat in the NIR is ten times higher than the default value in the good practice guidance and it is not transparently documented.

172. Apart from synthetic fertilizers, manure, crop residues and sewage sludge, Finland stated that there was no significant use of other sources of nitrogen on agricultural soils. Forestry wastes were left in forests and industrial wastes were not applied to soils. Urban waste was used as fertilizers but in very negligible quantities.

Uncertainty

173. The key source identification in the Finnish 1999 GHG inventory estimated activity data uncertainty to be 30% and emission factor uncertainty to be 100%. Hence, overall uncertainty is 104%.

Issues raised in previous reviews

174. The draft S&A report for 2001 observed that there may be an inconsistency between the N_2O-IEF for both direct and indirect sources because the IEF is the same as the IPCC defaults, although the Party specifies in table Summary 3 that the emission factor is default/country-specific. The ERT noted that Finland had used country-specific parameters and therefore the notation key should be country-specific for the method but not for the emission factor.

175. The draft S&A report also observed that in the CRF tables the N_2O-IEF used for synthetic fertilizers, animal wastes applied to soil, N-fixing crops and crop residues, was different from that of other Parties. The ERT identified that the IEF in CRF table 4.D for N-fixing crops and crop residues had a different unit notation – kg N_2O-N/kg N instead of kg N_2O-N/kg dry biomass. The use of a different unit should have been stated in the documentation box of that table.

4. 4.D.3 Indirect emissions from nitrogen used in agriculture – N_2O

Trends

176. Indirect N_2O emissions from agricultural soils fluctuated between 2.46 to 2.04 Gg N_2O between 1990 and 1999. The vast majority of emissions (76% to 79% of total indirect emissions) were the result of leaching and runoff.

Completeness

177. The reporting of indirect emissions of N_2O from soil cultivation is complete for all sources.

Activity data

178. Owing to a probable error in the reporting of $Frac_{GASM}$ in the NIR and because the quantity of manure applied to soil is not explicitly declared (although it appears that volatilization from pasture/grazing has been included), it is not very clear which fractions of manure contributed to indirect emissions. The reporting in the NIR of individual contributions to volatilisation could improve transparency.

Methodologies and emission factors

179. Finland used the default emission factors EF_4 and EF_5 from the IPCC Guidelines but it also used country-specific values for some parameters: $Frac_{GASF}$, $Frac_{GASM}$ and $Frac_{LEACH}$.

180. The emission factor for leaching was set at 15%, which is half the default emission factor in the IPCC Guidelines but within the range (10% to 80%). The emission factor for volatilization from manure is given as 0.03 in the NIR and as 0.31 in the CRF. During the review the latter value was assumed as an error. Because the amount of nitrogen deposited in the soil from manure is not clearly stated in either the NIR or the CRF, before the review, it was ambiguous what was the right $Frac_{GASM}$ used, and what was the actual quantity of manure considered as fertilizer.

Uncertainty

181. The key source identification in the Finnish 1999 GHG inventory estimated activity data uncertainty to be 40% for indirect sources. The uncertainty of emission factors is 150. The overall uncertainty is the highest in the agriculture sector: 155%.

5. 4.D Agricultural soils (soil cultivation) – CO_2

Trends

182. Emissions of CO_2 from cultivation of soils ranged between 1,727 Gg CO_2 and 3,215 Gg CO_2 over the 1990–1999 period. Cultivation of organic soils is the major contributor to emissions (40% to 60%). Cultivation of mineral soils was estimated to be a sink for all years except 1995. Emission of CO_2 from soils shows a strong variation over the years from 1990 to 1999, which is hardly unexpected from a process that is inherently slow. This is also agreed by the Finnish national experts and can be explained by the basic methodology proposed in the IPCC Guidelines and the rapid annual variations in set aside. Because this variation does not correspond to the effective annual variation in carbon uptake, it was concluded that another method should be used which could better address the difficulties presented by the long time needed to arrive at a stable carbon content and the short period in which most of the land-use change took place.

Completeness

183. Emissions of CO_2 from soil could be considered complete for agricultural soils. Emissions or sinks of CO_2 from peatland under forest soils were not quantified, but this should be considered under LUCF.

Transparency

184. The information reported in the NIR is not detailed enough allow estimates of CO_2 from organic soils to be reconstructed. This is due to the fact that the areas under each category were not presented. However, the national emission factor considers a division between peatsoil and other organic soils, and between pasture and upland crops. In the CRF tables the division between these two land uses is reported but is not further divided by soil type. Finland emphasized the difficulty it had in distinguishing between organic soil and peat soil.

Activity data

185. Land-use change data used to estimate CO_2 emissions from mineral soils is taken from Finnish Agricultural Soil Statistics and from unpublished statistics of the Finnish Soil Analysis Service. This information is only reported for all years in the CRF tables for three soil classes: high activity soils, low activity soils and sandy soils. It is divided into long-term cultivated, improved pasture, set aside (<20 years), forested and abandoned. The NIR contains information for 1990 only. The percentage of each soil type was assumed to be the same for all land-use classes. Organic soils in Finland have been subdivided into peatsoil and other organic soils according to national classification of soils. Although it is known that the use of both organic and peatsoil in agricultural activities is decreasing in Finland, there is no specific information on these particular soil types. Therefore, estimates were made by MTT according to statistics of abandonment of agricultural areas and on the assumption that 50% of those areas was peatland or organic soil and 50% mineral soil. It was recognized that the percentages were an expert guess

and that the estimates needed further improvement. It must however be stressed that this procedure resulted mostly in errors in activity data trend and had no impact on the magnitude of the emissions estimates.

Methodologies and emission factors

186. Emissions of CO_2 from mineral soils were estimated according to the methodology considered most feasible in the IPCC Guidelines: the carbon-balance approach from land-use change. The carbon contents were set for each soil type and land use according to the IPCC Guidelines, although neither the NIR nor the CRF tables contain detailed information of the basic parameters used in the determination of the final emission factor.

187. Finland uses country-specific emission factors for estimating CO_2 from peatsoil and other organic soils. These emission factors are different from the default IPCC emission factors (although of similar magnitude) and are based on scientific measurements collected by MTT, but they are still not documented in the NIR.

Recalculations

188. Substantial recalculations were done for this source category: (1) first time estimates of CO_2 emissions/removals from mineral soils; (2) improvements in organic soils area under cultivation.

Uncertainty

189. The uncertainty levels are not reported in the NIR but only in the key source identification in the Finnish 1999 GHG inventory. They resulted from expert assessments but they are not documented in any report. However, according to the NIR, the uncertainties in the emissions from mineral and organic soils were already assumed to be considerable.

190. The uncertainty of activity data was considered to be 30% and the uncertainty of the emission factor was considered to be 100%. It might be helpful to disaggregate the uncertainty estimates between mineral soils, organic soils and liming since they are expected to be very different.

C. Non-key sources

1. 4.B Manure management – CH_4

Trends

191. This source category shows a decrease in emissions from 9.47 Gg CH_4 in 1990 to a minimum value of 8.82 Gg CH_4 in 1993. Thereafter emissions increased until 1997 (10.69 Gg CH_4), finally decreasing to 10.01 Gg in 1999. Cattle (44-50%) and swine (41-46%) have an almost equal importance in the emissions.

Completeness

192. The emission inventory is considered complete.

Transparency

193. All information is available in the NIR to allow reconstruction of the estimates. The choice of the methane correction factor (MCF) value for liquid/slurry systems is not suitably documented.

Methodologies and emission factors

194. CH_4 emissions from manure management were calculated using the tier 2 method in accordance with IPCC good practice.

Activity data

195. The activity data used are based on total manure produced, which was estimated from livestock using the methodology proposed by IPCC good practice.

Uncertainty

196. In the NIR, the uncertainty level of the activity data was estimated as 10% in accordance with information from the original statistics, although it is not clear if this also includes the uncertainty of the cattle feed intake estimates. Uncertainty of emission factors was estimated as 30%, although it is not clear if this uncertainty already includes the newly available MCF values in IPCC good practice guidance.

Issues raised in previous reviews

197. The draft S&A report 2001 indicates that the CH_4-IEFs are low compared to the IPCC defaults for cool-western Europe. Finland uses the default MCF parameter for cold climates as proposed in the IPCC Guidelines rather than the higher MCF for liquid/slurry proposed in the IPCC good practice guidance. Finland believes the new MCF is not applicable given the very cold climate. This should be documented in the NIR.

D. Areas for further improvement

1. Planned or ongoing work by the Party

198. The national experts for agriculture consider that it might be better to prepare feed intake estimates on the basis of actual feed intake statistics which are available in Finland, rather than on energy based models. This methodological shift is under consideration. Finland also recognizes that expert opinions used in parameter setting should be improved by widening the range of experts. Under the Finnish Global Resarch Programme (FIGARE), it is expected that an agricultural research project aimed at improving emission factors from mineral and organic soils and of N_2O emission factors will be established.

199. Finnish experts also consider that further research is needed on how to better estimate trends in peatsoil and other organic soils.

200. The IPCC Guidelines for the determination of CO_2 emissions from mineral soils were considered insufficient.

201. Finland is considering crossing land-use change with soil types to improve the estimates of CO_2 from soil cultivation.

202. Finland considers to assess uncertainties of CO_2 emissions from cultivation of soils separately for organic and mineral soils and liming.

2. Issues identified by the ERT

203. Finland should incorporate all necessary information in the NIR to allow reconstruction of the emissions estimates.

204. Statistics for livestock, crop production and use of fertilizers should be cross checked with international information (FAO, in particular) and discrepancies should be explained and corrected.

205. Finland should consider including emissions from reindeer under management or it should explain clearly why they are not included in the inventory.

206. Finland should document the absence of litter and bedding in manure estimates.

207. The ERT agrees that the method for estimating CO_2 emissions from soil may not be adequate for conditions in Finland and that a new model should be developed that incorporates land-use variations in a shorter time scale.

208. A better knowledge of the evolution of the abandonment of agricultural soils should be obtained.

209. Finland should consider the uncertainty in the MCF for liquid/slurry (CH_4 from manure management) and the new default values of the IPCC good practice guidance in determining whether this is a key source or not. It should clearly base its decision on not changing to the new MCF value.

E. References

210. Documents referenced in the NIR and CRF summary report are mostly in Finnish and not translated into English. They are essential for the understanding of the assumptions used in the agriculture estimates. The ERT recommends that the NIR includes a short summary of the underlying assumptions.

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

211. In Finland LUCF constituted a net sink in 1999. Generally the sink has decreased since 1990, although it has varied considerably from a sink of 38,200 - 9,700 Gg CO_2 during the 1990 to 1999 period. In 1999, the sink was estimated at 10,800 Gg CO_2 and, if included in the national total, it would offset 15% of total emissions.

1. Institutional arrangements

212. The Finnish Forest Research Institute (METLA) is responsible for the preparation of the LUCF inventory. The results are then passed on to the Finnish Ministry of Environment and they incorporate it directly in the national inventory.

2. Completeness

213. The inventory of CO_2 emissions and removals from forestry in Finland is almost complete in that all above ground emissions and removals from forests are included. In Table 5, however, CO_2 emissions from forest and grassland conversion, and abandonment of managed lands are reported as "IE". The documentation box to this table notes that these are included in category 5A3. This should also be noted in the completeness table 9. Emissions from forest soils were not reported. Background information was provided in table 5.D on emissions from agricultural soils, however, this source category is accounted for in the agriculture sector. Emissions of the other GHGs, CH_4 and N_2O, have not been reported owing to a lack of data.

3. Transparency

214. Information provided in the NIR and CRF is not sufficient to provide full transparency of the LUCF inventory. No information was provided in CRF tables 5.A, 5.B and 5.C, as Finland uses country-specific methodology in this sector. The final emissions and removal estimates are provided in CRF sectoral table 5. A description in the NIR of how the emissions and removals in CRF tables 5.A, 5.B and 5.C are included in the CRF sectoral table 5 would be useful. Reporting of disaggregated activity data would improve the transparency in the estimates in CRF sectoral table 5.

215. The NIR does not provide all the necessary information on activity data (volume increment, drain and CO_2 emissions and removals by species). The NIR was not explicit about which forest components are included in the conversion factor from stem volume to total tree carbon. The ERT was informed that the expansion factor included all above ground tree components (branches, needles) and roots. The reference source in the NIR for the conversion factor quotes a third reference for these numbers. Original sources should be referenced and made available to the ERT.

216. Emissions from harvested wood are reported in CRF table 5.A.5 as "IE", but it is not clear where they are included in the CRF. This should also be indicated in the completeness table (table 9). In the sectoral report, forest and grassland conversion and abandonment of managed land are given as "IE", but currently the completeness table does not reflect this.

4. Methodologies, emission factors and activity data

217. Finland used a country-specific method to estimate CO_2 emissions and removals from forest and other woody biomass for 1990–1999. The methodology used is consistent with IPCC Guidelines, but provides a more accurate estimate of carbon stock changes in the forest. The Finnish National Forest Inventory (NFI), internationally recognized as one of the most advanced forest inventories, is used to estimate stem volume increment for three tree species (pine, spruce and non-coniferous). The total increment is updated annually, but the measurements for different years come from different regions of the country. An average increment over the five years preceding the measurement is applied.

218. The stem volume of wood taken out of the forest (drain) is estimated annually based on cutting removals data from forest industries and estimated household use for each species. It is assumed that all wood commercially harvested and harvested for household use is emitted in the year of harvest, which is consistent with IPCC methodology. It is also assumed that all branches and needles are taken off site and emitted in the year of harvest. In effect, this means that the

forest floor/litter carbon pool is not included in accounting or is assumed to be in equilibrium, but this is not required by the IPCC Guidelines.

219. Conversion factors are applied to the stem volume increment and drain to estimate total tree carbon taken off site, including branches, needles and roots. The annual change is calculated by subtracting the emissions (drain) from the removal (increment) figures. The NFI also includes the change in carbon due to harvesting of wood, forest conversion to other land uses and abandonment of managed land implicitly in the increment and drain estimates.

220. All of Finland’s forest is included in the inventory although 5% of the total forest area is not available for wood supply (METLA, 2000). The IPCC Guidelines consider forests unmanaged for wood products to be in equilibrium and these should be excluded from the calculations.

5. Recalculations

221. No recalculations were made and there are no plans to recalculate emissions/removals in the coming year.

6. Uncertainties

222. Uncertainty estimates (standard error and 95% confidence level) are provided in the NIR for stem volume removals. Uncertainty estimates are not provided for stem volume emissions, nor are they provided for the final CO_2 emission and removal estimates for forestry. There is some discussion in the NIR about the contributors to uncertainty for the CO_2 emission and removal estimates.

7. Verification and QA/QC approaches

223. The methodology used for the National Forest Inventory (NFI) has been peer reviewed. The NFI also has its own internal verification and quality control system within METLA. No documentation was provided on the NFI quality control system.

8. Conformity with the UNFCCC reporting guidelines and the IPCC Guidelines

224. The Finnish methodology for LUCF is country-specific and consistent with the IPCC Guidelines. In line with the IPCC Guidelines, Finland has estimated CO_2 emissions and removals on the basis of their detailed National Forest Inventory. While it is not a requirement, the IPCC Guidelines suggest the results could be reformatted and presented in a form comparable to other Parties that do not use forest inventory data. Further, the UNFCCC reporting guidelines state that Parties that do not report tables 5.A to D of the CRF should report country-specific information in a transparent manner, also providing suggestions for a possible sectoral background data table suitable for the calculation methods. Finland should utilize one of these options to provide transparency.

225. Inventory reporting in the CRF and NIR is generally consistent with UNFCCC reporting guidelines. It was noted that the NIR did not contain enough information to allow the methodology used to estimate GHG emissions and removals from the forestry sector to be fully understood. The in-country review presentations and discussions with Finnish experts allowed a full understanding of the methodology.

B. Areas for further improvement

1. Planned or ongoing work by the Party

226. In the NIR the Finnish experts have identified that the factors for converting stem volume to total tree carbon need to be improved, and research is currently under way to develop better conversion factors. This would enable forest and woody biomass stocks to be recalculated.

227. The NIR also mentions the need for research on forest soil carbon. This is currently under way and forest soils may be included in the future if it is calculated that forest soils are a source of CO_2.

2. Issues identified by the ERT

228. *Completeness:* forest soil carbon should be included in the inventory because it could have a major impact on total carbon stocks. Similarly, when data are available, CH_4 and N_2O emissions shoul be included in the inventory.

229. *Transparency:* while transparency in country specific-methods is not required, it would be useful to disaggregate the data provided in table 5 to show activity data in sectoral background tables 5.A-C. The inclusion of volume increment and drain for each tree species category in the NIR (table 6.1 or E.2) would also facilitate transparency.

230. *Methodologies, emission factors and activity data:* all Finland's forests are included in the inventory but 5% are classified as nature conservation areas and are unavailable for harvesting of wood products. Conservation forests that are in equilibrium should be excluded from the inventory. If conservation forests that were subject to harvesting (and are returning to equilibrium) are included in the inventory an explanation as to why should be given in the NIR.

231. The factors (especially the expansion factor component) for estimating conversion of stem volume to total carbon are unrepresentative of Finnish forests and are based on a very small number of biomass studies conducted in Finland and other countries. While country-specific information is preferred over IPCC defaults, these country-specific factors could be improved on.

232. *Uncertainty estimates:* there are no uncertainty estimates for emissions from stem volume drain from the forest or overall emissions and removals from forest and other woody biomass stocks. When the conversion factors for converting from stem volume to tree carbon have been updated for each tree species category and have an uncertainty estimate associated with them, an overall uncertainty estimate can then be calculated.

233. *Verification and QA/QC:* QA/QC for the NFI should be updated to include the entire system to enable CO_2 emissions and removals from the LUCF sector to be estimated and details should be included in the NIR.

234. *Consistency with the energy sector:* consistency checks between forest harvesting and biomass use in the energy sector were estimated by Finnish experts to be very good, although it was not clear exactly how this had been assessed.

VI. WASTE

A. Sector overview

235. Overall, the waste sector is not a large source of emissions in Finland. CH_4 emissions from solid waste disposal are a key source, representing about 2% of total emissions in 1999. There has been a more than 50% decrease during the 1990s. Emissions from wastewater treatment are much smaller at 0.2%.

1. Institutional arrangements

236. The Finnish Environment Institute prepared the GHG inventory for the waste sector. The activity data in the early 1990s and the waste composition data for industrial, construction, and demolition waste were based on research and surveys carried out by Statistics Finland and VTT.

2. Completeness

237. The waste sector inventory is largely complete. Waste incineration without energy recovery is reported as "nearly zero", and energy-related emissions from waste incineration are included in the energy sector. All CRF tables were completed.

3. Transparency

238. The NIR provides a description of the methods used to estimate waste sector emissions. The selection of parameters is adequately presented and referenced. However, the ERT noted that since a large number of landfills have been closed the question of emissions over the period of activity would have to be considered.

4. Recalculation

239. CH_4 emissions from the waste sector were recalculated for the 1990 base year and reported in table 8(a). In the 2001 submission, CH_4 emissions from solid waste for the year 1990 were estimated to be 25% greater than in the 2000 submission. For wastewater, CH_4 emissions were recalculated to be 83% greater in the most recent report. The NIR documents and explains the recalculations. CH_4 emissions from solid waste disposal sites (SWDS) for 1998 were recalculated in 2001. The emissions after recalculation were 6.61% lower due to improved activity data. An explanation was provided in table 8(b) of the CRF.

5. Uncertainties

240. Finland provided estimates of uncertainties for all waste sources. The uncertainty associated with the tier 1 method for CH_4 emissions from solid waste disposal was considered to be significant (Pipatti et al., 1996). The uncertainties in activity data are estimated to be 30%, uncertainties in emission factors to be 40% and combined uncertainty to be 50%.

6. Verification and QA/QC approaches

241. The quality management system for the national GHG inventory is currently under development and will be used for the inventory in 2002. Waste disposal data reporting is mandatory in Finland under the national environmental permitting system. The data are

approved by the RECs before input into the VAHTI register. This constitutes a form of QA/QC at the plant level.

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

242. CH_4 emissions from solid waste disposal have been estimated using the IPCC default method, whereas the IPCC good practice guidance recommends use of the first order decay model when landfills are a key source. A change of model is under consideration.

B. Key sources

1. 6.A Solid waste disposal – CH_4

Trends

243. CH_4 emissions from SWDS have decreased considerably from 3.6 Tg CO_2 equivalent (1990) to 1.7 TgCO_2 equivalent (1999), representing a 50% reduction. The trend is driven by increased recycling, increasing waste-to-energy plants, and recovery of CH_4 under Finland's legislation on waste minimization.

Completeness

244. CH_4 emissions from SWDS and emissions of CH_4 and N_2O from wastewater treatment (not including uncollected domestic wastewater) are estimated.

Methodologies

245. CH_4 emissions from solid waste disposal have been calculated using the default methodology from the IPCC Guidelines (mass balance methodology) and national emission factors. The IPCC default method assumes that waste is converted into CH_4 during the year in which it is landfilled rather than over a period of decades. In the case of Finland, the amount of waste disposed of yearly at the SWDS has decreased significantly over the time series, and thus the tier 1 method is likely to overstate the actual reduction in emissions.

246. Finland is considering changing to the tier 2 "first order decay model". The Finnish Technology and Climate Change Programme is making an effort to estimate the historical data and emissions factors (decay coefficients). The results of the project are expected by the end of the year 2001 and will be implemented in the 15 April 2003 inventory submission.

Activity data

247. The activity data are well documented in the NIR. The quality of the activity data has been improving, since Finland introduced a tax on landfilled waste. All landfills in Finland need a permit to operate and are obliged to inform the Regional Environmental Agencies of the amount, type and origin of waste disposed of at landfills. This information is then recorded and stored in the Regional Environment Centre (VAHTI registry).

248. An error in the reporting of activity data was identified in table 6.A of the CRF for the year 1990 (submission 2000). Annual municipal solid waste disposed of at the SWDS was reported as 123.00 Gg instead of 1,123.00 Gg. This error caused the IEF to be miscalculated by an order of magnitude 0.59 instead of 0.059.

Emission factors

249. The emission factors are sufficiently documented in the NIR. An average MCF of 0.7 was chosen based on the assumption that half of the waste goes to small landfills and half to larger landfills (Pipatti & Wihersaari, 1998). Since three-quarters of the population lives in urban areas and might be served by large landfills, the "half to half" assumption could lead to underestimation of the MCF. Improved documentation of the definition of small versus larger landfills in Finland, and how waste is disposed of at these landfills, would help to clarify this issue.

250. Degradable organic carbon (DOC) content is based on the composition of the waste and can be calculated from a weighted average of the carbon content of various components of the waste stream, DOC=0.20 (based on waste composition in 1990). Waste composition data are obtained from environmental permit reports from RECs on the VAHTI register, which use European waste catalogue classifications. It is well documented in the NIR.

251. Finland's country-specific value (0.5) for fraction dissimulated DOC is lower than the IPCC default value (0.77). The rationale for this is based on the fact that climate conditions do not permit an optimal degradation of municipal solid waste (e.g., mean temperature 10 - 15 ^{0} C Vaisanen, 1997).

252. Per capita CH_4 emissions have decreased from 34.8 kg in 1990 to 17.0 kg in 1998 and are within the range of other Annex I Parties.

Recovery

253. Gas recovery from landfills increased from 3 Gg CH_4 in 1995 to 9 Gg in 1999 according to the Finnish Biogas Association (Leinonen & Kuittinen, 2000). Three of the ten landfill gas recovery operations are located at closed landfills. Because the tier 1 only considers recently deposited waste, the inclusion of recovery at closed landfills could lead to a distorted time series. There is no explicit mention of this issue in the IPCC good practice guidance, but the recommendation of the review team is that recovery from closed landfills should only be counted when a time-lag model is used.

C. Non-key sources

1. 6.B Wastewater treatment

254. CH_4 emissions from domestic and industrial wastewater treatment have been estimated using a national method, which is consistent with the IPCC methodology.

255. The activity data for the estimate is the biochemical oxygen demand (BOD) load in domestic wastewater and the COD load in industrial wastewater. The BOD data for domestic wastewater are based on data from the Regional Environmental Centre (VAHTI registry) and the Waste and Sewage Works Register.

256. The value for the maximum CH_4 producing capacity used in the calculation is B_o0.25 kg CH_4/kg BOD or COD (IPCC default value). The MCF for domestic wastewater is 0.025 and for industrial wastewater it is 0.005. The values are based on expert judgement.

257. N_2O emissions cover only the emissions caused by the nitrogen load to waterways. The estimation methodology is consistent with the IPCC method for leaching/runoff of agricultural

nitrogen to waterways. The nitrogen loads are obtained from the Regional Environmental Centre (VAHTI registry) and the Waste and Sewage Works Register. The N_2O emission factor is 0.025 kg N_2O-N kg load to the waterway (IPPC default). The IEF is 0.01 CH_4 kg/kg DC.

2. 6.C Waste incineration

258. Waste incineration without energy recovery is estimated to be almost zero and emissions from waste incineration were included in the energy sector.

D. Areas for further improvement

1. Planned or ongoing work by the Party

259. Finland is planning to change from the tier 1 “mass balance model” to the tier 2 “first order decay model” for CH_4 emissions from landfills.

260. National experts are working to improve activity data and emission factors (in particular, the MCF) for landfills; they will also review the waste composition data.

2. Issues identified by the ERT

261. Finland is encouraged to improve its activity data collection for type of SWDS (managed and unmanaged).

262. Implementation of the FOD method/tier 2 for CH_4 emissions from solid waste disposal will make the methodology consistent with IPCC good practice guidance.

263. Finland should investigate the contribution of emissions from uncollected wastewater from rural areas to determine if it is significant.

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