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

Centralized review

I. OVERVIEW

A. Introduction

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

2. The centralized review of Finland took place from 9 to 13 September 2002. It was carried out by a team of nominated experts (expert review team - ERT) from the roster of experts, working at the headquarters of the UNFCCC secretariat in Bonn. The assignments of the experts were as follows: Generalists – Mr. Bernd Gugele (European Community) and Mr. Marius Taranu (Republic of Moldova); energy – Mr. Lambert Schneider (Germany) and Mr. Mohammad Soltanieh (Iran); industrial processes – Ms. Deborah Shafer (USA) and Mr. Mauro Meirelles de Oliveira Santos (Brazil); agriculture – Ms. Anna Romanovskaya (Russian Federation) and Mr. Tomoyuki Aizawa (Japan); land-use change and forestry – Mr. Aquiles Neuenschwander (Chile) and Mr. Daniel Martino (Uruguay); and waste – Mr. Davor Vešligaj (Croatia) and Mr. Jens E. Frøiland Jensen (Norway). Mr. Jens E. Frøiland Jensen and Mr. Marius Taranu were the lead reviewers for this centralized review. The review was coordinated by Ms. Astrid Olsson and Ms. Sevdalina Todorova-Brankova (UNFCCC secretariat).

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

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[1] In the symbol for this document, 2002 refers to the year in which the inventory was submitted, and not to the year of publication. The number (3) indicates that this is a centralized review report.

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

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

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

B. Inventory submission and other sources of information

4. In its 2002 submission, Finland submitted common reporting format (CRF) tables for the years 1990–2000. Finland submitted a national inventory report (NIR) in 2002 describing the methods and basic data used to produce its GHG inventory. The submission was received in the secretariat on 9 April 2002.

5. The status report 2002 and the draft 2002 synthesis and assessment (S&A) report, together with the previous status reports and S&A reports and the reports of the desk and in-country review of Finland's 2001 GHG inventory,[5] were made available to the review team. The country provided additional information and clarification during the review upon request from the ERT. The Party's responses are taken into consideration in this report. The full list of materials used during the review is provided in annex I to this report.

C. Emission profile, trends and key sources

6. In the year 2000, the most important GHG in Finland was carbon dioxide (CO_2), which accounts for 84.2 per cent of total[6] national GHG emissions expressed in CO_2 equivalent, followed by nitrous oxide (N_2O), 9.7 per cent, and methane (CH_4), 5.3 per cent. Emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) were quite small and contributed 0.7 per cent in 2000 of the overall GHG emissions in the country. By source, energy accounted for 82.1 per cent of the total emissions, agriculture 10.4 per cent, industrial processes 4.0 per cent, waste 2.4 per cent, solvent and other product use 0.1 per cent, and "other" 1 per cent.

7. Over the period 1990–2000, CO_2 emissions without land-use change and forestry (LUCF) were just below the 1990 level (–0.3 per cent). CO_2 emissions from other sectors in energy use decreased by 23.4 per cent, whereas emissions from manufacturing industries (+11.1 per cent) and energy industries (+7 per cent) increased between 1990 and 2000. CH_4 emissions have decreased significantly, 36 per cent, driven mainly by the reduction of emissions from solid waste disposal on land (–54.7 per cent) and enteric fermentation (–15.4 per cent). N_2O emissions were below the 1990 level by 14.6 per cent, mainly as a result of the significant decrease of emissions from agricultural soils (–20.1 per cent) and chemical industry (–17.3 per cent). The overall trend for PFCs and HFCs was upwards with an increase of 4,064.5 per cent for PFCs and 164,263.6 per cent for HFCs, while the SF_6 emissions decreased by 76.5 per cent. Total GHG emissions (without CO_2 from LUCF) decreased by 4.1 per cent between 1990 and 2000.

8. Finland did not update the key source analysis in its 2002 submission, but referred to the key source analysis provided in the 2001 submission. In the NIR 2001, Finland provided a tier 1 and tier 2 key source analysis for 1999, which differs slightly from the preliminary key source analysis[7] undertaken by the secretariat. N_2O emissions from mobile combustion have been identified in the secretariat's key source analysis, but not in the Party's tier 1 approach. However, in the Party's tier 2 approach, this source has been identified as a key source. The provision of the quantitative results of the key source analysis might have been helpful. In addition, the ERT encourages the Party to further elaborate on its conclusions in terms of future improvements from the findings of the key source analysis.

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[5] See documents FCCC/WEB/IRI(1)/2001/FIN and FCCC/WEB/IRI(2)/2001/FIN.

[6] Total national GHG emissions refer to aggregate emissions of CO_2, CH_4, N_2O, PFCs, HFCs and SF_6, all expressed in terms of CO_2 equivalent, excluding CO_2 emissions/removals from LUCF.

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

D. General assessment of inventory

9. The national inventory submitted by Finland is generally in conformity with the UNFCCC reporting guidelines. The methodology used to estimate GHG emissions was broadly consistent with the IPCC Guidelines and the IPCC good practice guidance. Areas for further improvements are identified in paragraphs 16 and 17 below and in sections II–VI for sector-specific aspects.

1. Completeness

10. Finland submitted inventory data for the years 1990–2000 using the CRF including all gases requested (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, as well as precursor gases nitrogen oxide (NO_X), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2)) and almost all tables requested (except tables 5.A to 5.C, where the documentation box was used for providing information) of the UNFCCC reporting guidelines. The CRF was accompanied by an NIR. Notation keys were widely used in the CRF.

2. Transparency

11. The NIR for Finland includes annual information from the base year 1990 to the 2000 inventory year, which is consistent with the CRF. The NIR provides information on the institutional arrangements for compiling the GHG inventory, activity data sources, methods and emission factors used. The NIR also refers to a methodological report, *Greenhouse gas emissions and removals in Finland*,[8] where methodologies and calculation models, including information on uncertainty estimation and key sources (for 1999), are described more in detail. The transparency of the Finnish submission could be improved by integrating the NIR with the more detailed methodological report.

3. Recalculations

12. Recalculations have been identified and clearly explained. Finland recalculated the emissions from mineral products for the years 1997 (0.10 per cent with LUCF and –0.09 per cent without LUCF) and 1999 (–0.17 per cent with LUCF and –0.15 per cent without LUCF) resulting from activity data corrections. It was also noted that tables 8(a) and 8(b) were provided for recalculated years in the 2000 CRF. Only the recalculated source categories are provided. The ERT encourages Finland to provide tables 8(a) and 8(b) for all years in the CRF for that year in its next submission. The ERT also encourages Finland to complete the whole tables for transparency reasons. In its response to this draft report, Finland states that a number of new data sources and emission factors have become available during the last years. In particular for the energy sector, and Finland is planning to finish the recalculations due to these changes during 2004.

4. Uncertainties

13. The tier 1 uncertainty estimate provided in the 2001 NIR has not been updated in the 2002 NIR. The approach to estimating the uncertainties of the Finnish inventory has up to now been based entirely on expert judgement. The procedures for eliciting expert and methods for encoding expert judgement described in the IPCC good practice guidance have not been implemented yet. The current level of disaggregation in estimating the uncertainties and methods used in combining them may need further consideration and improvement. The uncertainty estimates given in the CRF should therefore be considered as preliminary. The quality of the estimates is considered to be high if the uncertainty is less than 10 per cent, low if the uncertainty is more than 40 per cent and medium for values in-between. The uncertainty estimates are based on the combined uncertainty of activity data and emission factors. In table 7 of the CRF qualitative estimates of the uncertainty are reported for GHG source and sink categories.

[8] The report can be found at http://www.vyh.fi/eng/environ/state/air/emis/ghg/ghg.htm.

5. Quality assurance/quality control

14. Finland has not yet developed a quality assurance/quality control (QA/QC) plan or implemented a formal QA/QC system across its inventory. However, the quality management for the national GHG inventory is currently under development and will be implemented in the 2004 submission. Finland does not currently conduct a third party review or a public review. Verification is done through UNFCCC inventory reviews.

6. Issues related to previous reviews

15. Finland addresses only partially the issues and problems identified during previous reviews. Not addressed are the problems identified concerning the following:

(a) More detailed information, for example, in the form of basic calculation sheets or detailed activity data, was not incorporated into the NIR to improve its transparency;

(b) A key source analysis at the same level of category disaggregation as the IPCC good practice guidance was not performed for the 2000 inventory.

7. Areas for further improvement

16. Finland has noted the following areas for further improvement:

(a) The creation of a QA/QC management system by 2004;

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

(c) Integrating qualitative criteria in addition to quantitative tests for key sources identification;

(d) Establishing an integrated, comprehensive and easily accessible archiving system; performing some minor updates for the years 1992–1999 for the energy sector;

(e) Revising some activity data and emissions factors for energy and waste sectors;

(f) Emissions from some subsectors for industrial processes sector will be estimated in future inventories;

(g) A change of methodology will be under review for agriculture and waste sectors.

17. The ERT noted the following with regard to future inventories:

(a) Finland may wish to continue to implement the IPCC good practice guidance, in particular QA/QC, including third party reviews;

(b) The Party may wish to consider also including in its NIR sections summarizing emissions trends, any major developments since the last report (including responses to previous reviews) and areas for further improvements;

(c) The Party may wish to provide the quantitative results of the key source analysis and elaborate conclusions in terms of future improvements from the findings of the key source analysis.

II. ENERGY

A. Sector overview

18. The energy sector in 2000 accounted for 82.1 per cent of total GHG emissions in Finland (without LUCF). Fuel combustion is responsible for 94.2 per cent of emissions in the energy sector. Emissions

from energy industries are the largest source within the energy sector (33.2 per cent), followed by manufacturing industries and construction (27.2 per cent) and transport (21.6 per cent). Finland uses considerable amounts of biomass and peat for energy supply. About 27 per cent of the overall energy supply is based on biomass and about 7 per cent on peat. Between 1990 and 2000, fuel combustion and GHG emissions in the energy industries varied considerably with changes in electricity exchange in the Nordic electricity market. GHG emissions from energy industries were at their lowest in 1992 and highest in 1996, they were 49 per cent above the 1990 level. Between 1996 and 2000, the GHG emissions decreased significantly, in 2000 being only 1 per cent above the 1990 level, while fuel consumption increased by 15.4 per cent over the same period. Finland is one of the few countries that have managed to stabilize emissions from transport over the past decade.

19. The CRF tables provided by Finland are largely complete. Several sources for fugitive emissions (e.g., transmission and distribution of natural gas) have not been estimated, although these activities occur. The NIR contains a well-structured description of methodologies, models, references, recalculations and future needs. The ERT notes that, according to the NIR, in some cases new emission factors or methodologies have only been applied to some years of the whole time series or only to the most recent year (2000). The ERT recommends that revisions of methodologies, emission factors or underlying assumptions are applied to all years of an inventory submission in order to improve the transparency and comparability of the inventory.

B. Key sources

1. Stationary combustion

20. According to the NIR, emissions from coke and residual fuels used in blast furnaces in the iron and steel industry are allocated under category 1.A.2.a in the energy sector. The IPCC Guidelines recommend Parties to make efforts to report these emissions under iron and steel production. For Finland this is an important allocation matter since emissions in blast furnaces are estimated to be very significant for Finland (about 7 per cent of total GHG emissions). Therefore the ERT encourages Finland to investigate the possibility of splitting the fuels used in the iron and steel industry between those that belong to the energy sector (used for combustion purposes) and those that are process emissions, and to stick to the IPCC recommendations. The NIR also states that non-energy-based emissions have been allocated to the category 2.G. However, no emission estimates are reported under category 2.G. In its response to the draft report Finland states that in the future it is planned to separate process emissions from iron and steel industry, although, as it is a resource demanding task, it will take some time. Finland further states that due to a misprint in the NIR "category 2.G" should be read in fact "category 2".

21. The time series of the CO_2 implied emission factor (IEF) for solid fuels under the category 1.A.1.c (Manufacture of solid fuels and other energy industries) appears to be inconsistent. In 1990 the IEF amount to 40 t/TJ, in the period 1991–1993 to approximately 10 t/TJ, in 1994 to approximately 7 t/TJ, in the period 1995–1997 to approximately 30 t/TJ and in the period 1998–2000 to approximately 40 t/TJ. Generally, emission factors appear to be relatively low for solid fuels. The time series of CO_2 IEF for solid fuels also varies considerably in the category 1.A.2 (Manufacturing industries and construction), in particular in the subcategories 1.A.2.a (Iron and steel) and 1.A.2.b (Non-ferrous metals). The ERT recommends to check emission estimates and activity data and correct these inconsistencies. In its response to the draft report, Finland, states it is planning to finish the recalculations of the energy sector during the year 2004.

22. The allocation of fuel consumption (and emissions) appeared not to be consistent over time under the category 1.A.4 (Other sectors). This is also reflected as a problem by Finland in the NIR: In the commercial/institutional sector fuel consumption amounts to approximately 3,000–4,000 TJ annually in the period 1990–1995 and it increased sharply thereafter to a level of approximately 20,000–25,000 TJ

annually. At the same time fuel consumption decreases significantly in the residential sector from 1995 to 1996. Possibly as a result, some CO_2 IEF also appears to be inconsistent, for example, the time series of the CO_2 IEF for solid fuels and biomass in the commercial/institutional sector and the CO_2 IEF for other fuels in the agriculture/forestry/fisheries sector. Wrong allocation of fuel consumption may also affect the accuracy of emission estimates for CH_4 and N_2O, since emission factors for these gases vary considerably between sectors. The inconsistency may partly be caused by increased use of district heating systems. The ERT encourages Finland to check and improve the allocation of fuel consumption and emissions between the different sectors. In its response to this draft report, Finland states it is planning to finish the recalculations of the energy sector during the year 2004.

2. Mobile combustion

23. According to the NIR and the CRF tables, emissions from combustion of natural gas in road transportation have been included in the inventory for the years 1999 and 2000. It remains unclear whether in previous years emissions were not occurring (no cars using natural gas were in place), or whether consumption of natural gas has not been allocated to the transport sector. The ERT recommends that Finland provide clarifications in the NIR and estimate relevant data for the period 1990–1998, if the activity is occurring; otherwise the emissions should be reported as "NO"(not occurring) in the CRF. In its response to this draft report Finland states that the use of natural gas in road transport started in 1996; the data for years 1996–1998 are available and will be reported in the future in recalculated CRF tables; "NO" will be reported for 1990–1995.

3. Fugitive emissions

24. Fugitive CO_2 emissions from peat production are estimated to be a significant source of GHG (3,500 Gg, or 4.7 per cent of overall GHG emissions without LUCF in 2000). Fugitive CH_4 emissions from peat production are estimated to be rather small. The same emission estimate for CO_2 has been applied to all inventory years, although the annual quantity of peat productions varies considerably. References for CO_2 emission factors and underlying activity data are partly provided in the NIR, but references for CH_4 estimates are lacking. It remains unclear how the estimate of 3,500 Gg has been calculated, since multiplying the underlying activity data with the emission factors documented in the NIR results in emissions between 2,200 and 3,100 Gg of CO_2. As fugitive emissions from peat production are a key source, the ERT recommends that Finland improve the methodologies for estimating these emissions and to document underlying assumptions in a transparent manner. Finland recognizes the need to do so in its NIR.

C. Non-key sources

1. Fuel combustion

25. The ERT recommends that Finland check and, if applicable, revise its emission factors for CH_4 and N_2O for a number of combustion processes. The draft 2002 S&A report revealed that there are a number of cases where time series of IEFs appear inconsistent or values are out of the range reported by other Parties. Particular emphasis may be put on CH_4 emission factors for liquid fuels in public electricity and heat production and manufacturing industries and construction, as well as the time series consistency of CH_4 IEF for other fuels and biomass, and natural gas in road transportation. The N_2O IEF appears to be inconsistent for domestic navigation, for fuel combustion regarding biomass and for other fuels, and in many cases in the manufacturing industries and construction sector, where values change, in particular between 1999 and 2000.[9] In its response to the draft report, Finland states it is planning to finish the recalculations of the energy sector during 2004.

[9] Finland states in the NIR that "results from new measurements on CH_4 and N_2O emission factors of certain boiler types have been used in the year 2000 inventory. (…). The time series will be updated in the future inventories". If

2. Fugitive emissions

26. Finland does not provide estimates for certain fugitive emissions which may not be negligible as stated in the NIR. These include fugitive emissions from post-mining activities,[10] CH_4 emissions from venting and flaring in oil refineries, and CH_4 emissions from transmission and distribution of natural gas. The ERT recommends that Finland estimate these fugitive emissions in accordance with the IPCC Guidelines, at least by applying tier1 approaches. In its response to the draft report the Party states that this will be done in the next inventory submission. As part of the research programme "Greenhouse gas effects of peat use and peatlands in Finland 2002-2005", jointly funded by the Ministry of Trade and Industry, the Ministry of Agriculture and Forestry and the Ministry of Environment, under the coordination of Prof. Jukka K. Laine, University of Helsinki, field measurements of GHG fluxes on peat production areas contribute to the improvement of the accuracy of current estimates of fugitive emissions from peat production areas.

D. Reference and sectoral approaches

27. CO_2 emissions from fuel combustion were calculated using the reference approach and the sectoral approach. The difference between the two approaches is 1.49 per cent in 2000. The difference has been larger in previous years, amounting to 9.3 per cent in 1994.

28. Differences in fuel combustion reported in the CRF and to the International Energy Agency (IEA) were relatively small in 2000, but larger for 1990. Apparent consumption using the reference approach in 2000 was 0.7 per cent higher than that reported to IEA. However, there are some more significant differences in the allocation of fuels; for example, peat production reported to IEA was 18 per cent lower than in the CRF data. In the response to the draft report, Finland states that according to the latest 'Energy Statistics 2001' both figures (IEA and CRF) for peat production must be revised as well as stock changes, and these will be checked.

E. Bunker fuels

29. Finland does not provide in the NIR methodological information on how emissions from international bunkers have been separated from those of domestic origin. The ERT encourages Finland to provide information on the methodology applied in the NIR. However, in its response to the draft report, the Party states that there is a short note in the documentation box and some more information is included in the NIR 2003.

30. The time series of the IEFs for CH_4 and N_2O for jet kerosene are inconsistent. IEFs amount to approximately 88 kg/TJ and 32 kg/TJ respectively from 1990 to 1998 and drop thereafter to approximately 3 kg/TJ for both, CH_4 and N_2O emissions. Also, IEFs for CO_2, CH_4 and N_2O for gas/diesel oil and residual oil for international navigation in the years 1991 and 2000 appear partly inconsistent with the values reported in other years. The N_2O IEF for gas/diesel oil is the highest of all reporting Parties. The ERT recommends that Finland check the inconsistency and improve the estimates. In its response to this draft report, Finland, states it is planning to finish the recalculations of the energy sector during the year 2004.

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this is the main source for the inconsistencies observed, the ERT recommends that Finland apply new emission factors in the future only to the whole time series and that it provide more detailed background information on the measurement results. The application of new measurements to one inventory year reduces the transparency, time series consistency and comparability of the inventory.

[10] Coal mining does not occur in Finland. However, CH_4 emissions during storage and transportation may not be negligible.

F. Country specific issues

31. Finland also estimates N_2O emissions which result indirectly from NO_X emissions in the energy sector, which is not part of the IPCC Guidelines. The methodology is taken from the agricultural sector where oxidation of deposited nitrogen and subsequent conversion to N_2O are estimated. These indirect N_2O emissions are estimated to amount to 1.13 Gg N_2O or 350 Gg CO_2 equivalent in 2000, which corresponds to 0.47 per cent of overall GHG emissions (without LUCF). For the year 1990, emissions are estimated at 1.49 Gg N_2O or 463 Gg CO_2 equivalent, which corresponds to 0.60 per cent of overall GHG emissions (without LUCF). The ERT considers that accounting for this indirect emission source should be consistent between countries in order to get comparable and transparent inventories. All countries have NO_X emissions from energy, but – as far as known – only Finland accounts for this emission source. In order to improve the comparability of Finland's GHG inventory with other inventories, and since the estimation of these emissions is not suggested in the IPCC Guidelines, the ERT recommends that Finland do not account for these emissions in the national inventory.[11] However, these estimates may be provided as additional information in the NIR. In its response to this draft report the Party states that in the future the reporting will be changed as suggested.

III. INDUSTRIAL PROCESSES AND SOLVENTS USE

A. Sector overview

32. In 2000, industrial processes emissions accounted for 3.7 per cent of the total CO_2 equivalent (without LUCF), the same as in 1990. Nitric acid was the largest emission source (N_2O) in the industrial processes sector, and represented 44.8 per cent of the sector's emissions in 2000. Emissions of CO_2 were 36.4 per cent of the CO_2 equivalent emissions in industrial processes in 2000, with cement production being responsible for 62.5 per cent of this CO_2. In the period 1990–2000, the increase in industrial processes CO_2 equivalent emissions was 3.4 per cent, mainly as a result of an increase of 652 per cent of emissions of fluorinated gases (emissions due to cement production decreased by 13.8 per cent in the same period).

B. Key sources

1. Cement production – CO_2

33. The IEF for cement production is lower than the IPCC default value, 0.47 t/t compared to 0.499. In its comments on the 2001 S&A report, Finland explained that the emission factor used is a national emission factor, but the Party reports using IPCC defaults both for methodology and for emission factor, according to the NIR. The Party could clarify this matter in its future submissions. In the response to the draft report, Finland states that in the CRF table 'Summary 3', the notation key 'D' is used for method and 'PS/D' for emission factor, where 'PS' refers to plant specific CaO content of cement (60 % instead of default 63,5 %); the information was not reported in the NIR, however the data will be checked and revised in future submissions.

2. Nitric acid production – N_2O

34. The IEF for nitric acid production is higher than the IPCC value range and the second highest among the reporting Parties. It is based on measurements made in the factories of the fertilizer company, Kemira Agro Ltd. However, the Party reports "NO" about the methodology and emission factor in table

[11] Since emissions were reduced from 1990 to 2000, and may be further reduced up to 2010, accounting for these emissions in national inventories under the Kyoto Protocol would likely lead to a reduction of emissions during the commitment period compared with the base year. This may also apply for other countries, since generally NO_X emissions are expected to decrease as the use of catalytic converters increases. However, accounting for these indirect emissions should be treated in the same way by all Parties.

Summary 3. This information should be changed to "CS" (country specific) and "PS" (point source) to reflect the information for nitric acid production in the NIR. However, in its response to the draft report, the Party states that in the CRF table 'Summary 3' the notation key 'D' is used for method and 'CS' for emission factor, while the method is default and the EF is plant specific. The information in the NIR will be corrected in future submission.

3. Consumption of halocarbons and SF_6 – HFCs and SF_6 emissions

35. Finland reports an unusual trend in SF_6 emissions which it has not sufficiently explained in either the NIR or subsequent communications with the ERT. Specifically, Finland reports a 75 per cent drop in SF_6 emissions from electrical equipment between 1990 and 2000, most of which occurred between 1990 and 1995. Although the overall decrease is reasonably consistent with declines reported elsewhere, it is unusual in having occurred during the first, rather than the second, half of the decade. (Both the emission factors in the IPCC good practice guidance and reported world sales of SF_6 for use in electrical equipment indicate that emissions were probably steady during the early 1990s, declining after 1995). Finland does not explain this decline in the NIR. In its response to questions from the ERT, Finland states that the declines in SF_6 emissions from electrical equipment are attributable to very sharp declines in installed new nameplate capacity between 1990 and 1993 and between 1994 and 1995. However, an analysis of SF_6 bank information submitted by Finland at the request of the ERT shows that this cannot explain all of the declines. In fact, this analysis (using the emission factors given by Finland in its NIR) results in estimates significantly different from the Finnish estimates, ranging from 0.82 to 4.3 times the Finnish estimates, and averaging 1.5 times the Finnish estimates. Finland states that it is checking its time series for possible errors that may have occurred when data were transferred from spreadsheets, but that this work is not complete yet. The ERT recommends that Finland complete this check, make any necessary corrections, and explain the reasons for any trends more clearly in future NIRs.

36. In addition to clarifying the reasons for the trend in SF_6 emissions, Finland could increase the transparency of its inventory by presenting emission factors for air-conditioning and refrigeration equipment, the largest source in the "Consumption of Halocarbons and SF_6" category. At a minimum, Finland should clearly indicate in the NIR where this information can be found in previous NIRs. Quite late in the review process, the ERT found emission factors for air conditioning and refrigeration equipment in annex C of Finland's 2001 submission, but this discovery was purely accidental. Nowhere in Finland's 2002 NIR was this resource mentioned. Finland could also increase the transparency of its inventory by presenting its estimates of the HFC and SF_6 banks in air conditioning and refrigeration equipment and electrical equipment, including its assumption that none of this equipment is yet being disposed of. This is a far more reasonable assumption than assuming that the equipment is being disposed of with zero emissions, which is what is implied by the emission factors in the NIR.

37. It appears that Finland may not be including SF_6 emissions from magnesium and semiconductor manufacturing in its actual emission estimates. These sources are not individually discussed in the NIR, and the CRF inconsistently uses "C" (confidential) and "0" to denote emissions from them. From documentation boxes in the CRF, it appears that emissions from these sources may be aggregated with emissions elsewhere, but in some cases this appears to be on a potential rather than an actual level. The ERT recommends that Finland include emissions from these sources in its aggregate actual emissions and that it clarify where and how it has done so.

C. Non-key sources

1. Lime production – CO_2

38. Table 8 of the CRF in the 2002 submission states that 1997 and 1998 activity data were changed. In fact activity data for 1999 have been reviewed, but for 1997 it was the emission factor that was corrected. The ERT recommends that Finland correct its description of the changes accordingly.

However, in its response to this draft report the Party states that in the recalculation tables years 1997 and 1999 were mentioned; for 1997 it was the emission figure that was corrected (the original figure was taken from the wrong cell); thus it looks like the EF had been changed although there were no changes in the actual calculation; also, the description in table 8(b) was not correct for 1997.

2. Ammonia production

39. Ammonia production was reported as "NO". However, United Nations statistics note a small amount (5 kt) of ammonia produced in 1999. The ERT recommends that this information be checked. In the response to this draft report Finland states that this information will be checked in future inventory submissions.

3. Iron and steel production

40. CO_2 emissions from iron and steel production are reported as "IE" (included elsewhere). The NIR provides the explanation that the emissions are included in the energy sector. CH_4 emissions are reported from coke. CH_4 emissions from pig iron and sinter production are reported as "NZ" (nearly zero). According to the IPCC guidelines Parties should make every effort to report the process emissions from iron and steel in the industrial processes sector. The ERT encourages Finland to investigate the possibility of splitting the fuels used in the iron and steel industry between those that belong to the energy sector (used for combustion purposes) and those that are process emissions, and to stick to the IPCC recommendations. If it is impossible to split the emissions, Finland should continue to clearly state that the emissions are included in the energy sector, both in the CRF and in the NIR. The ERT recommends Finland to use the standard notation keys instead of "NZ". Finland should either report an estimate of CH_4 emissions or use the notation key "NE" (not estimated). In its response to this draft report the Party states that in the 2003 submission the "NZ" has been replaced with other notation keys and as mentioned in the energy sector, Finland is working on splitting emissions from iron and steel production between energy and industrial processes.

D. Solvent and other product use

41. No activity data or emissions of N_2O were provided for the use of N_2O in fire extinguishers, aerosol cans or other uses. In table 3.A-D, the notation key "IE" was used and an explanation of where these emissions were included was provided in the documentation box, but this information was not carried back to table 9. The ERT recommends that the Party list these sources in table 9 under "Sources and sinks reported elsewhere" and that it explain in table 9 where these sources are included. In its response to this draft report Finland states that this has been done in the 2003 submission.

IV. AGRICULTURE

A. Sector overview

42. The agriculture sector accounted for 12.4 per cent of total national GHG emissions in 2000, reaching 7,696 Gg equivalent. Over the period 1990–2000, emissions decreased by 32 per cent. A consistent emission time series from 1990 to 2000 is reported. Finland reported a complete agricultural inventory using the relevant tables (4.A, 4.B(a), 4.B(b) and 4.D). The source categories 4.C Rice cultivation and 4.E Prescribed burning of savannas were reported as "NO". The emission from 4.F Field burning of agricultural residues were reported as NE/0 in the CRF and assumed to be negligible. GHGs reported in the agricultural sector are CO_2, CH_4 and N_2O. The NIR provides methodology, activity data and references for every source; footnotes and additional information boxes in the CFR were used for additional information. The activity data are based on information from Statistics Finland, Information Center of the Ministry of Agriculture and Forestry, published literature and national experts. The methodology used is a combination of country-specific methodology and the IPCC good practice guidance

(tier 1 and tier 2). No uncertainty estimates according to the IPCC good practice guidance were provided for the agricultural sector. No QA/QC check according to the IPCC good practice guidance was performed in the sector. Qualitative uncertainty estimates were included in table 7. However, in its response to the draft report, Finland states that the uncertainty in agricultural emissions was estimated similarly as in all other sectors.

B. Key sources

1. Enteric fermentation – CH_4

43. A combination of tier 2 (for cattle) and tier 1(other animals) was used in calculations. The country-specific emission factor for dairy cattle is high compared to other Parties' values, while for non-dairy cattle the IEF is low. The reason for this could be that the average daily feed intake has been calculated from data on animal weight, daily weight gain etc. obtained from agricultural experts. Finland will examine the possibility of developing a country-specific method based on direct estimation of feed consumption of cattle. The ERT encourages the Party to continue this work. Some changes in the IEF trends were noticed. These differences should be due to annual recalculations of emission factors according to tier 2 methodology and connected to a change in feeding practices. The ERT suggests that Finland include the explanations of the change in feeding practice in future NIRs. The Party may wish to use an enhanced characterization of sheep and develop country-specific emission factors for them.

2. Agricultural soils – direct N_2O

44. Some differences of fraction values were noted with the default, which the Party reported using. In its comments to the 2001 S&A report, the Party explained the reason for low value for the $Frac_{GASF}$ (FCCC/WEB/SAI/2001). However, these comments were not included in the 2002 NIR. The value of $Frac_{GASM}$ is high compared to that of other Parties. There seems to be confusion in the additional information box of table 4.D for $Frac_{NCRBF}$ and $Frac_{NCRO}$, for which the descriptions were replaced in column I and data in column J. The reported value for N-content in N-fixing crops (0.0415) is higher than the default (0.03). The values of $Frac_{GASF}$ varied over the period 1990–2000 (+12.5 per cent). The ERT recommends that the Party include information on the fraction values used and how they are derived in future NIRs. Finland is encouraged to reflect the methodologies and fraction values used in the CRF tables correctly. In the response to this draft report Finland states that the value of $Frac_{GASM}$ is country-specific, being based on the research made in Technical Research Centre of Finland (VTT); also, there has been confusion in terms in the "Additional information box" of table 4.D. Finland further states that the descriptions for $Frac_{NCRO}$ and $Frac_{NCRBF}$ will be corrected in future inventory submissions. The value for N-content in N-fixing crops is an average of two plant species: pea and clover seed, both values being national and were obtained from MTT Agrifood Research Finland; while the value $Frac_{GASF}$ used in the inventory has been 0.006 over the time period 1990-2000, so there seems to be some confusion in this regard.

3. Agricultural soils – CO_2

45. Summary emissions were presented under the agriculture sector. However, additional information was provided in the LUCF sector (table 5.D). See also comments in the LUCF sector.

C. Non-key sources

1. Manure management – CH_4

46. The information on waste treatment is based on surveys from 1993 and 1998. In the NIR the need for the development of annual or periodic data collection is emphasised. The ERT encourages the Party to carry out this work. Trends in IEF for non-dairy cattle increased by 21.1 per cent over the period 1990–2000. Emission trends from cattle did not follow the trend in population size. This should be due to

the use of the tier 2 methodology for calculating annual emission factors, and to changes of typical animal mass and N excretion rates as a consequence of changes in feeding practice in the country. The ERT suggests that Finland include the explanations of the change in feeding practice in future NIRs. In its response to this draft report the Party states that the increase in trends in IEF for non-dairy cattle (21.1%) seems to be higher that was calculated by national experts (18.7 %), however, the change, indeed, is due to differences in feeding practices.

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

47. In Finland, LUCF constituted a net sink in 2000 with an uptake of 11,953 Gg CO_2. Total gross emissions in Finland in 2000 were 73,958 Gg CO_2 while net emissions were 62,005 Gg CO_2. LUCF represented a net CO_2 removal equivalent to 16.2 per cent of total 2000 GHG gross emissions. The trend in LUCF CO_2 net removal between 1990 and 2000 shows a sharp decrease of almost 50 per cent. According to the reported information, this was due to a steady increase in forest biomass stocks of 8 per cent over the period, while total biomass removed for commercial harvest, fuel wood and other wood use and from natural losses increased by more than 27 per cent in the same period.

48. The ERT noted also that only changes in forest and other woody biomass stocks were reported in 2002 CRF table 5, since the 202 NIR states that emissions and removals for tables 5.B and 5.C, representing afforestation, reforestation and deforestation, are indirectly included in the tree biomass change figures given by the Finnish Forest Research Institute (FFRI). Emissions or removals from forest soils were not reported on the grounds that changes in the carbon content of forest soils are slow, and that a method to estimate them is under development at the FFRI. Non-CO_2 GHG emissions were not reported in table 5.B, nor were estimates for non-forest trees provided. Table 5.D, considering the cultivation of mineral and organic soils and liming of agricultural soils, was documented but reported in the agriculture sector. The standing stock of stem wood was obtained from the National Forest Inventory (NFI) of Finland, from which most of the reliable information on land use and forestry could be obtained, in order to fill in CRF sectoral tables 5.A to 5.C. This was noted by the previous in-country review report in 2001, and the ERT recommends that Finland include these tables in future submissions.

49. The LUCF methodology was not included in the 2002 NIR, although it was described in annex E of the NIR 2001. It is recommended that a description of LUCF methodology be included in every future NIR. The volume increment of the growing stock of trees was estimated from the Finnish National Forest Inventory, which covers CO_2 removals from the increase in the forest biomass of 22,943 kha of managed forests, representing 88 per cent of the total forest land reported for Finland. This indirectly includes CO_2 uptake from afforestation and reforestation activities. In turn, total annual CO_2 release (drain) is based on forest harvest statistics reported by forest industry companies and collected by the FFRI, as are the estimates of cutting waste and natural losses. The LUCF methodology establishes country-specific factors for wood carbon content, dry matter per stem wood cubic meter, expansion factor from stem volume to total tree biomass, and conversion factor from stem volume to total biomass carbon content, all of them for pine, spruce and broadleaf species.

50. The average CO_2 contents per cubic meter are 1.52 t for broadleaf and 1.25 t for coniferous, with a national average of 1.3 t CO_2/m^3 for all species. These are lower than the IPCC default factors of 2.26 t CO_2/m^3 for broadleaf and 1.57 t CO_2/m^3 for coniferous. Considering that broadleaf forests make up 26 per cent of total managed woodlands and coniferous forests account for the remaining 74 per cent, it seems that the calculations were conservative and did not include soil carbon.

51. CO_2 uptake by managed forests was calculated by a national forest inventory carried out eight times between 1921 and 1994. A ninth inventory began in 1996 and is expected to be finalized by 2003. The annual total standing volume over bark (stem wood) was calculated using the average of five-year

periods, where the annual increment in volume of stem wood was estimated at 73.4 Mm^3 in 1990, rising to 79.3 Mm^3 in 2000. Annual drain, which comprises mainly forest harvest, was 55.1 Mm^3 in 1990 and 70.1 Mm^3 in 2000, with some yearly fluctuations due to timber market demand.

52. In CRF table 5.D it is noted that the same CO_2 emission factor for cultivation of mineral soils under high and low activity was reported. It is noted that also CO_2 emission factor for cultivation of organic soils under pasture/forest conditions is more than four times the IPCC default value. In its response to the draft report, Finland states that the utilisation of the same emission factor for CO_2 from high activity soils and low activity soils is due to the fact that the net change in carbon stock in mineral soils has been calculated on a basis of reference carbon stock for each soil type; the reference soil carbon stocks used was 56 Mg C/ha in both high activity and low activity soils; the values were received from MTT Agrifood Research Finland; the emission factors for organic soils were national values and are also received from MTT Agrifood Research Finland.

B. Sink and source categories

1. Changes in forest and other woody biomass stocks

53. CRF table 5.A was not filled in, although the CO_2 removals in forests were calculated applying country-specific factors that are adequately explained in the LUCF methodology in the NIR 2001. The ERT recommends that Finland incorporate in CRF and NIR more detailed information based on available data from the National Forest Inventory and the Finnish Forest Research Institute in its future submissions.

2. Forest and grassland conversion

54. Information on land conversion, burned biomass and non-CO_2 GHG emissions was not provided, although is reported as being indirectly included in the forest tree biomass change. The ERT recommends that the Party report it in order to improve the whole estimation of GHG sources and removals in the LUCF sector.

3. Abandonment of managed lands

55. No information was reported, although it was stated that this information is indirectly included in the forest tree biomass change. The ERT recommends that Finland estimate CO_2 emissions and removals in this category in order to ensure accuracy and transparency in the national GHG inventory.

4. CO_2 emissions and removals from soil

56. Estimates of changes in the carbon stock from cultivation of mineral and organic soils and liming of agricultural soils were included in CRF table 5.D, but the emissions are reported under agriculture, as allowed by the IPCC Guidelines. It is noted that CO_2 emissions and removals from forest soils were not reported.

VI. WASTE

A. Sector overview

57. Emissions from the waste sector represented approximately 2.4 per cent of total GHG emissions in 2000, and there has been a 54 per cent decline in emission figures since 1990. The NIR covers emissions from solid waste disposal on land, waste-water handling and human sewage. Emissions from waste incineration are reported in the energy sector. The IPCC default methodology with country-specific parameters was used for estimating CH_4 emission from solid waste disposal sites (SWDS). Emissions from other sources were estimated using the IPCC methodology and country-specific parameters. Assumptions and methodologies used for estimating emissions are described in the NIR. Most of the activity data, IEFs and additional information in the CRF were presented. The methodology and emission

factors given in the CRF and the NIR are comparable to those reported by other Parties. All the CRF tables from 1990–2000 were submitted. Methodologies used for estimating emissions in the period 1990–2000 are consistent with the IPCC Guidelines. However, the IPCC Guidelines recommend the First Order Decay (FOD) model for countries like Finland. Quantitative uncertainty assessments were not performed in the waste sector, but qualitative uncertainty indicators were reported in CRF table 7. Recalculations were not done for the 2002 submission.

B. Key sources

1. Solid waste disposal on land

58. It is assumed that 50 per cent of solid waste is landfilled on managed SWDS and 50 per cent on unmanaged shallow SWDS according to the IPCC's SWDS classification. In cases when the amount of waste being landfilled is decreasing over time, as is the case with Finland, the default method could underestimate total emissions. Data on the composition and amount of solid waste landfilled are partly (20 per cent) based on estimates. The report of the individual review of the GHG inventory of Finland submitted in the year 2001 (in-country review) identified these issues. The draft 2002 S&A report pointed out that no additional information was provided on degradable organic carbon (DOC) value. In response, Finland provided the required information in its NIR, Annex F Methodology for estimating GHG emissions from the waste sector. The ERT recommends that Finland use the more advanced FOD model (tier 2) for estimating emissions of CH_4 from SWDS and review historical data on the composition and amount of solid waste, and the portion going to unmanaged landfills. Finland has stated that the FOD model will be used from the 2003 inventory. All IEFs and additional data should be presented and justified where required in that inventory.

C. Non-key sources

1. Waste-water handling

59. Emissions from waste-water handling sources included municipal and industrial waste water. Uncollected domestic waste waters were not included in the NIR. The IPCC good practice guidance default value for maximum CH_4-producing capacity from domestic waste water equals 0.25 kg CH_4/kg chemical oxygen demand (COD). In the NIR, this value is, probably by mistake, changed to 0.25 kg CH_4/kg biochemical oxygen demand (BOD). The report of the individual review of the GHG inventory of Finland submitted in the year 2001 (desk review) stated that emissions from waste-water handling are rather low in comparison to other Parties. It was noted by Finland that emissions from treatment facilities are insignificant because CH_4 is completely recovered. The draft 2002 S&A report found an irregular trend of CH_4 emissions from waste-water handling, which is not further explained in that document. This emissions trend is a result of changes in the annual amount of DOC in waste water and CH_4 recovered/flared from waste-water handling in that period.

2. Waste incineration

60. Emissions from waste incineration have been reported in energy sector. ERT recommends that Finland provide additional information on incinerated waste, particularly quantities and amounts.

ANNEX I: MATERIALS USED DURING THE REVIEW

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

Sources of information used during the review include:

2000, 2001 and 2002 Inventory submissions of Finland. 2002 submissions including CRF for years 1990–2000 and an NIR.

UNFCCC secretariat (2002). *Report of the individual review of the greenhouse gas inventory of Finland submitted in the year 2001 (Desk review)* FCCC/WEB/IRI(1)/2001/FIN [available at http://unfccc.int/program/mis/ghg/countrep/findeskrev.pdf].

UNFCCC secretariat (2002). *Report of the individual review of the greenhouse gas inventory of Finland submitted in the year 2001 (In-country review)* FCCC/WEB/IRI(2)/2001/FIN [available at http://unfccc.int/program/mis/ghg/countrep/finincountrep.pdf].

UNFCCC secretariat. *2000 Status report for Finland* [available at http://unfccc.int/program/mis/ghg/statrep00/fin00.pdf].

UNFCCC secretariat. *2001 Status report for Finland* [available at http://unfccc.int/program/mis/ghg/statrep01/fin01.pdf].

UNFCCC secretariat. *2002 Status report for Finland* [available at http://unfccc.int/program/mis/ghg/statrep02/fin02.pdf].

UNFCCC secretariat. *Synthesis and assessment report of the greenhouse gas inventories submitted in 2000*. FCCC/WEB/SAI/2000 [available at http://unfccc.int/program/mis/ghg/sai2000.pdf].

UNFCCC secretariat. *Synthesis and assessment report of the greenhouse gas inventories submitted in 2001*. FCCC/WEB/SAI/2001 [available at http://unfccc.int/program/mis/ghg/sai2001.pdf].

UNFCCC secretariat. *Draft synthesis and assessment report of the greenhouse gas inventories submitted in 2002* (Part I and Part II – the section on Finland) [unpublished].

Finland's comments on the Draft synthesis and assessment report of the greenhouse gas inventories submitted in 2002 [unpublished].

UNFCCC secretariat. *Key source analysis for the year 2000*. [unpublished].

UNFCCC secretariat. *Handbook for review of national GHG inventories*. Draft 2002, [unpublished].

UNFCCC secretariat. *UNFCCC guidelines on reporting and review*. FCCC/CP/1999/7, [available at http://www.unfccc.int/resource/docs/cop5/07.pdf].

UNFCCC secretariat. Database search tool – *Locator* [unpublished].

IPCC. *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000* [available at http://www.ipcc-nggip.iges.or.jp/public/gp/gpgaum.htm]

IPCC/OECD/IEA. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, volumes 1–3, 1997*. [available at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm].

Riita Pipatti, VTT Energy, Technical Research Centre of Finland. *Greenhouse Gas Emissions and Removals in Finland.* [available at http://www.vyh.fi/eng/environ/state/air/emis/ghg/ghg.htm].

B. Additional materials provided by the Party

Responses to questions within the sectors industrial processes and solvents use and agriculture during the review were received from Mr. Jaakko Ojala (Ministry of Environment – Finland) including additional material on the methodology and assumptions used. Responses to questions within the waste sector during the review were received from Mr. Jouko Petäjä (Finnish Environment Institute) including additional material on the methodology and assumptions used.

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