



CANADA

**REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY
SUBMITTED IN THE YEAR 2004¹**

I. OVERVIEW

A. Introduction

1. This report covers the desk review of the 2004 greenhouse gas (GHG) inventory submission of Canada, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8 of the Conference of the Parties. The review took place from 8 to 26 November 2004, and was conducted by the following team of nominated experts from the roster of experts: Generalists – Mrs. Inga Konstantinaviciute (Lithuania) and Mrs. Anke Herold (European Community), Energy – Mr. Eilev Gjerald (Norway) and Mr. Yannis Sarafidis (Greece), Industrial Processes – Mr. Riccardo De Lauretis (Italy) and Mr. Marius Taranu (Moldova), Agriculture – Mr. Erda Lin (China) and Mr. Samuel Adeoye Adejuwon (Nigeria), Land-use Change and Forestry (LUCF) – Mr. Justin Ford-Robertson (New Zealand) and Ms. Thelma Krug (Brazil), Waste – Mr. Takashi Morimoto (Japan) and Mr. Davor Vesligaj (Croatia). Mr. Samuel Adeoye Adejuwon and Ms. Anke Herold were the lead reviewers. The review was coordinated by Mr. Javier Hanna (UNFCCC secretariat).

2. In accordance with the UNFCCC “Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention” a draft version of this report was communicated to the Government of Canada, which provided comments that were considered and incorporated, as appropriate, in this final version of the report.

B. Inventory submission and other sources of information

3. In its 2004 submission, Canada has submitted a complete set of common reporting format (CRF) tables for the years 1990–2002 and a national inventory report (NIR) containing background information on methods, key sources and data sources. The NIR also includes information on uncertainty estimates, and a description of quality assurance/quality control (QA/QC) procedures and verification activities. Where needed the expert review team (ERT) also used the previous year’s submission, additional information provided during the review and other information. The full list of materials used during the review is provided in annex 1 to this report.

C. Emission profiles and trends

4. In the year 2002, the most important GHG in Canada was carbon dioxide (CO₂), contributing 79.4 per cent to total² national GHG emissions expressed in CO₂ equivalent, followed by methane (CH₄) – 12.6 per cent – and nitrous oxide (N₂O) – 6.8 per cent. Perfluorocarbons (PFCs), hydrofluorocarbons

¹ In the symbol for this document, 2004 refers to the year in which the inventory was submitted, and not to the year of publication.

² In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO₂ equivalent excluding LUCF, unless otherwise specified.

(HFCs) and sulphur hexafluoride (SF₆) taken together contributed 1.2 per cent of total GHG emissions in the country. The Energy sector accounted for 81.7 per cent of total GHG emissions, followed by Agriculture (8.1 per cent), Industrial Processes and Solvent and Other Product Use (6.9 per cent) and Waste (3.3 per cent). Total national GHG emissions amounted to 725,188.71 Gg CO₂ equivalent and increased by 19.7 per cent from 1990 to 2002. Excluding LUCF, CO₂ emissions increased by 22.2 per cent over the period 1990–2002, while CH₄ emissions increased by 26.5 per cent; and N₂O emissions decreased by 4.8 per cent. Emissions from HFCs increased by 91.4 per cent from 1995 to 2002, while emissions of PFCs and SF₆ decreased by 34.1 per cent and 6.7 per cent, respectively, over the period 1990–2002.

5. The Party has reported a complete time series for all direct GHGs for the years 1990–2002 (CRF tables 10). The emission trend is unstable and fluctuates for many source categories identified in the 2004 previous review stages. Some fluctuations are explained in the NIR or in the responses of the Party to the 2004 previous review stages.

D. Key sources

6. Canada has provided a key source analysis based on tier 1 using both level and trend assessment, and a qualitative analysis. The key source analyses performed by the Party and the secretariat³ produced similar results. Differences appear to be due to the use of different levels of disaggregation. Canada identified 32 key sources and the secretariat 22.

E. Main findings

7. The ERT acknowledges the considerable number of improvements made in the 2004 inventory submission, such as the shift to tier 2 methods for Cement Production and Iron and Steel Production, a revised country-specific emission factor (EF) for PFC emissions from Aluminium Production, the incorporation of new activity data (AD) in the LUCF sector and the provision of an annex describing methodologies in the LUCF sector. Some recommendations from previous reviews have not yet been implemented, but the NIR clearly describes how future improvements will address them. Country-specific approaches and/or tier 2 Intergovernmental Panel on Climate Change (IPCC) methodologies are used to estimate emissions for most identified key source categories with except for CH₄ emissions from Manure Management and N₂O emissions from Agricultural Soils, for which IPCC tier 1 methods have been used.

F. Cross-cutting topics

Completeness

8. Canada has provided inventory data for the years 1990–2002; CRF tables 2(II).F have not been provided. Tables 10 have not been included in the CRF for the years 1990–2001. Tables 5.A have been modified for the reporting of non-CO₂ gases. The inventory does not include CO₂ emissions from Coal Mining and Handling, CO₂ emissions from Distribution of natural gas, and N₂O emissions from Flaring that are all considered as insignificant sources. HFC emissions from Fire Extinguishers are only provided for the years 1995, 1996 and 1997. Emissions before 1995 are considered as negligible, and for the years after 1997 emissions were estimated to be zero. The estimation for the years 1998 onwards will be revised in the subsequent inventory submission utilizing the results of a more recent survey. The estimates for LUCF do not include soil organic carbon, below-ground biomass, and dead organic material. CH₄ and N₂O emissions from Forest and Grassland Conversion have not been estimated. An explanation is provided in the NIR (Annex 5) and Canada informed in its response to the draft review report that it will be elaborated in the 2005 inventory submission. Also, CH₄ and N₂O emissions from

³ The secretariat had identified, for each individual Party, those source categories which are key sources in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC good practice guidance. Key sources according to the tier 1 trend assessment were also identified for those Parties providing a full CRF for the year 1990. Where the Party has performed a key source analysis, the key sources presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key source assessment conducted by the secretariat.

Industrial Waste-water, and CH₄ emissions from sludge of Domestic and Commercial Waste-water have not been estimated. The ERT recommends Canada to include the missing estimates that may be significant in its inventory.

Transparency

9. The information provided in the NIR is generally transparent and well documented. The NIR follows the recommended structure of the UNFCCC reporting guidelines, and provides information on methodologies with references to background data and detailed information on planned improvements and completeness. However, in some cases additional information on background data would help the reviewers to understand the estimates fully: instances are indicated in the sector sections of this report, for example, in source categories in the Agriculture sector. In the Energy sector the presentation of the reference approach data in net calorific values (NCVs) and the sectoral approach data in gross calorific values (GCVs) reduces the transparency of the inventory. In its response to the draft review report, Canada indicated that it revised the method by which the reference approach is compiled and will submit the subsequent inventory with this new method. The new method utilizes Canadian energy conversion factors and presents the results in GCV to harmonize with and provide corroboration of the sectoral approach, which also reports in GCV.

Recalculations and time-series consistency

10. Canada has provided recalculations for the period 1990–2001 (in CRF tables 8(a)) and justifications for the recalculations (in CRF tables 8(b)) and in the NIR. The major changes include the recalculation of CO₂ emissions from the LUCF sector for 1990–2001, non-CO₂ emissions from the LUCF sector in 1994, and all emissions from Energy Industries in 2001. The recalculations result in increases in the estimates of total national GHG emissions of 0.2 per cent in 1990, 3.0 per cent in 1994 and 5.0 per cent in 2001. By gas, the recalculations for the year 1990 result in a decrease in the figures for CO₂ emissions of 13.2 per cent, an increase in CH₄ emissions of 0.2 per cent and an increase in N₂O emissions of 0.9 per cent. Recalculations have been undertaken to take into account updates to the underlying AD or the availability of new information on sources of emissions or in response to previous review reports. The recalculations reported in CRF tables 8(b) are consistent with the descriptions of recalculations in the NIR. Inconsistencies in the time series of AD are reported transparently, together with the methodological approaches taken to estimate the entire time series.

Uncertainties

11. The uncertainty assessment reported in the 2004 submission was performed using the Monte Carlo method in 1994 for the 1990 inventory data, and there have been no subsequent updates. The NIR states that a new study on uncertainties was launched in 2003 and its results will be reflected in the 2005 submission. The qualitative estimation of uncertainty is provided in CRF table 7. The ERT recommends Canada to provide an updated quantitative uncertainty analysis, including recent years, in its next inventory submission.

Verification and quality assurance/quality control approaches

12. The Party has not yet implemented a formal QA/QC plan. The NIR states that Canada has started scoping out its QA/QC plan. QA/QC procedures at sectoral level are described in the NIR. The ERT recommends Canada to finalize the QA/QC plan as soon as possible and include the key elements of the plan in its next inventory submission.

13. Before it is submitted, the GHG inventory is reviewed by the Emissions and Projections Working Group (EPWG) and other selected government experts. In addition the inventory estimates and methodologies are published on a regular basis, providing an additional opportunity for public and expert review. To improve the accuracy of the inventory, Environment Canada has established a formal agreement with Statistics Canada to provide Environment Canada with detailed energy data and to work together to improve the quality and accuracy of the energy balance.

14. The NIR states that AD, methodologies and changes to methodologies are documented and archived in both paper and electronic format. The NIR reports that Canada has begun building its data archive.

G. Areas for further improvement

Identified by the Party

15. Canada identifies several areas for improvements:

- (a) Development of a formal QA/QC plan;
- (b) Improvement of documentation and establishment of an archive;
- (c) Development of an uncertainty analysis;
- (d) Implementation of tier 2 QC procedures for key sources.

Identified by the ERT

16. The ERT welcomes the Party's intention to update the quantified uncertainty analysis because of changes in the quality of data sources and in the methods used to estimate emissions since the last uncertainty analysis, which was performed in 1994.

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

II. ENERGY

A. Sector overview

18. In 2002, the Energy sector contributed 81.7 per cent of total GHG emissions in Canada. The increase in overall GHG emissions in Canada from 1990 to 2002 was due entirely to the increase of emissions from the Energy sector. They increased by 25.3 per cent from 1990 to 2002 and by 1.8 per cent from 2001 to 2002. In 2002, emissions from Energy Industries accounted for 34.2 per cent of the sector's total GHG emissions, Transport for 32.1 per cent, Manufacturing Industries and Construction for 10.6 per cent, Other Sectors for 13.9 per cent and Fugitive Emissions from Fuels for 9.2 per cent. GHG emissions from all source categories increased between 1990 and 2002. Fugitive Emissions increased by 43.8 per cent and emissions from Energy Industries by 37.9 per cent.

19. The CRF for the Energy sector includes emissions estimates for most of the relevant emission sources. The following sources are considered as negligible and therefore were not included in the inventory: CO₂ emissions from Coal Mining and Handling, CO₂ emissions from Distribution of natural gas and N₂O emissions from Flaring. Emissions from biodiesel and ethanol are not included in the Transport source category. In its response to the draft review report, Canada announced that it is completing a time series of biodiesel and ethanol data to be introduced in the Transportation model during 2005.

20. The Party gives detailed information about methodological topics in the NIR. Most methods used in the calculation of key sources are equivalent to tier 2 or higher-tier methods and the EFs used are country-specific. Although the Canadian inventory uses advanced methods, some of the Party's implied emission factors (IEFs) were defined as outliers in the 2004 previous review stages, taking into account that the secretariat made the necessary conversions of the Canadian IEFs for comparison purposes. The ERT recommends the Party to investigate why these IEFs are defined as outliers, and in particular whether the units are used correctly.

21. According to the national energy balance, the energy density for gasoline increased by 0.99 per cent and the density for diesel oil decreased by 0.98 per cent from 1997 to 1998. In its response to the draft review report Canada explained that for some petroleum fuels, Canada's National Energy

Balance reports a step-change in energy density between 1997 and 1998. This step-change has been retained in the inventory to ensure consistency with historic energy quantities and allocations. The inventory agency has made requests to the National Statistical Agency for clarification on annual variations of energy densities. The ERT recommends to further clarify these changes in the energy balances in the next inventory submission.

B. Reference and sectoral approaches

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

22. The Party provides a detailed description of the complex reference approach calculations. In the sectoral approach the Party uses GCVs. In the reference approach AD in GCVs are converted and reported as NCVs. With some exceptions the Party uses IPCC default emissions factors in the reference approach calculations and country-specific EFs and GCVs in the sectoral approach. Consistent use of GCVs for both the sectoral approach and the reference approach, combined with the use of consistent EFs, might have made it easier for the reviewer to compare the reference and sectoral approach calculations. The possibility is in fact provided in table 1.A(b), where either NCVs or GCVs can be selected and where country-specific EFs can be introduced. The ERT emphasizes the additional requirement for Parties reporting GCVs to provide the necessary information in the documentation box of table 1.A(a) to enable the calculation of the AD based on NCVs. In its response to the draft review report Canada announced that it has revised the method by which the Reference Approach is compiled and will use the new method for the 2005 inventory submission. . The new method utilizes Canadian energy conversion factors and presents the results in GCV to harmonize with and provide corroboration of the sectoral approach, which also reports in GCV.

23. Canada, like many other Parties, has had difficulty reviewing the discrepancies between the energy data presented in the CRF and the International Energy Agency (IEA) data. This is a recurring problem that ought to be solved before the next review process.

International bunker fuels and non-energy use of fuels

24. According to the NIR, Canada uses a modified tier 1 approach for estimating emissions from domestic and international aviation and navigation. AD are based on quarterly statistics on fuel sold to Canadian airlines and foreign airlines, and shipping companies/vessels. This definition of “domestic” (Canadian airlines or vessels) and “international” (foreign airlines or vessels) is not consistent with the IPCC definitions. Canada should try to develop methods that are clearly in line with the IPCC definitions of domestic and international for both marine and air transport. In its response to the draft review report, Canada announced that the 2005 submission will include an additional method to allocate aviation fuels based on passenger and freight traffic using publicly reported activity data from Canadian airlines operating both domestically and internationally. However, due to confidentiality and domestic reporting procedures, military fuel use (aviation and navigation) will be combined with non-military uses and reported together and fuel use by fishing vessels will be included in domestic Navigation.

C. Key sources

Stationary fuel combustion: oil, gas, coal – CO₂

25. Questions were raised in the 2004 previous review stages about the inter-annual changes in the IEFs. The Party has responded to some of the questions but the ERT recommends that it give further explanations in its future submissions. This concerns in particular the IEFs for liquid fuels, which are usually fairly stable (e.g., for Energy Industries and Manufacturing Industries and Construction).

26. The uncertainty in the Energy Industries category is mainly connected to the procedure used for collecting AD and the question how representative the EFs are, particularly for non-market fuels (e.g., field uses of natural gas and refinery fuel gas). It is not clear how important this uncertainty is to the sector's overall emissions. The ERT recommends the Party to quantify the uncertainty and provide more details of its importance in the NIR. In its response to the draft review report Canada informed that an

IPCC tier 2 uncertainty analysis has been conducted for the AD and EFs associated with non-marketable fuels and results will be presented in the 2005 inventory submission.

Civil aviation: oil – CO₂

27. Emissions from Civil Aviation, including aviation for military purposes, are estimated using a modified tier 1 method and based on a definition which is not consistent with the *IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC Guidelines). Since this is a key source the ERT recommends Canada to use the tier 2 method and use a consistent definition of domestic aviation.

28. Military aviation is reported as a part of Civil Aviation. The ERT recommends the Party to report emissions from military aviation separately in the appropriate place (under 1.A.5) and in as disaggregated a form as possible, bearing in mind that some information may be confidential. This recommendation also applies to military navigation. Canada in its response to the draft review report informed that has instituted an additional method to allocate aviation fuels based on passenger and freight traffic using publicly reported activity data from Canadian Airlines operating both domestically and internationally. This reporting will be introduced in the 2005 submission and the allocations of fuels to domestic and international aviation will be better aligned with IPCC guidelines. However, due to confidentiality and domestic reporting procedures, military fuel use (aviation and navigation) is combined with non-military uses and reported together. Similarly, use of fuel by fishing vessels is included within the domestic Navigation, however some work has been initiated to provide increased resolution on fuel use for this source category.

Fugitive emissions from fuels: oil and gas – CO₂, CH₄

29. Chapter 3.1.1.2 of the NIR explains that the amount of fuels flared is reported from fossil fuel producers in the Quarterly Report on Energy Supply–Demand in Canada (QRES). However, it does not explain how the volume flared is metered and collected. The ERT recommends Canada to provide further details on how the amount of fuels flared is accounted for. In its response to the draft review report Canada explained that the total volume of fuel consumed by fossil fuel producers as reported in the QRES includes the volume of fuel flared. However, flaring emissions are estimated using the approach described in the Fugitive Emissions from Oil and Natural Gas category. To ensure that the flaring emission is not double counted, it is subtracted from the total estimated using the fuel volume from the QRES. The ERT encourages Canada to include this information in the next NIR.

30. Fugitive emissions from oil and natural gas activities (conventional oil and natural gas production, and natural gas distribution) in the Canadian GHG inventory are estimated using the tier 3 method. The estimates of emissions from non-conventional oil production have been kept constant since 1996. The ERT encourages the Party to justify the reason for keeping these data constant. In its response to the draft review report Canada reported that a bitumen study was initiated in 2004 to update the complete time series of the inventory for the unconventional oil production. Results from the study will be assessed and where appropriate used to update the approach in future years. The ERT encourages Canada to update the approach as soon as possible.

D. Non-key sources

Stationary fuel combustion: biomass – CO₂

31. As the previous 2003 in-country review reported, the CO₂ IEF for biomass shows unusual variations from year to year. It is also at the low end of the range of reporting Parties. The reason for this should be explained in the NIR. The biomass AD for subcategories and categories within Stationary Combustion are reported as “not applicable” (“NA”). According to the Party’s response to the 2004 previous review stages, corrections will be made in the 2005 NIR and CRF submission.

Stationary fuel combustion: coal – CH₄, N₂O

32. The CH₄ and N₂O EFs for different coals expressed in mass units are considered as not fuel-specific. The ERT considers that they should be fuel-specific.

Stationary fuel combustion: oil – CO₂, CH₄, N₂O

33. The ERT repeats the remark of the previous 2003 in-country review that consumption of fuel in the fishing fleet should be reported in sector 1.A.4c Agriculture/Forestry/Fisheries in accordance with the *1996 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and not in the category 1.A.3d Navigation as it is reported now.

III. INDUSTRIAL PROCESSES AND SOLVENT USE

A. Sector overview

34. In 2002, the Industrial Processes and Solvent and Other Product Use sectors accounted for 6.9 per cent of total national GHG emissions, or 50,245.65 Gg CO₂ equivalent. Total emissions from the two sectors decreased by 6.7 per cent over the period 1990–2002. The main reason for this reduction was the introduction of abatement technology in the adipic acid production process, leading to a 49.7 per cent reduction in emissions in the Chemical Industry source category in this period. Emissions from Other Production increased by 38.7 per cent over the period 1990–2002; this trend will be revised if Canada implements the recommendations of the 2003 review report that the allocation of emissions to this subsector be reassessed. According to the Party's response to the draft review report, studies are underway to disaggregate the activity data (i.e., the non-energy use of fuel) in this source category into industry-specific fuel consumption data and to acquire representative EF values for each category. The ERT encourages Canada to complete these studies and implement as soon as possible its results.

35. The CRF and the NIR include estimates of and information on most sources of GHG emissions from the Industrial Processes sector. Sources not included are SF₆ emissions from Electrical Equipment, which could be significant, SF₆ emissions from Aluminium Foundries, SF₆ emissions from Semiconductor Manufacture, and CH₄ emissions from the production of petrochemicals such as carbon black, ethylene, dichloroethylene, styrene and methanol, and CH₄ emissions from Iron and Steel Production. SF₆ potential emissions are also not reported. Sectoral background data tables on Consumption of Halocarbons and SF₆ (2(II).F) have not been reported, but detailed information on methodologies and EFs is given in the NIR. HFC emissions from Fire Extinguishers are only provided for the years 1995, 1996 and 1997. CO₂ emissions attributed to limestone use in the pulp and paper industry are not included. Emissions from Asphalt Roofing, Road Paving with Asphalt, and Glass Production are not estimated and considered to be negligible. Canada is encouraged to estimate emissions that are reported as "not estimated" ("NE"), particularly those that are likely to be significant. In its response to the draft review report, Canada indicated that SF₆ emissions from Electrical Equipment for the years 1990–2003 will be included in the 2005 submission, as well as HFC emissions from Fire Extinguishers for 1995–2003 and that further efforts will be made to include, in future inventories, all the other sources mentioned.

36. Emissions from indirect sources are not included. Emissions from non-methane volatile organic compounds (NMVOCs) are usually important in the Industrial Processes sector, particularly in the Food and Drink category and the Solvent and Other Product Use sector. Efforts should be made to report them in future inventories.

37. Recalculations are reported for the whole time series 1990–2001. They are transparently documented and are justified. The estimates of CO₂ emissions from Cement Production, Lime Production and Iron and Steel Production have been recalculated as the method used has changed from tier 1 to tier 2. The estimates of PFC emissions have been recalculated because the PFC EFs from industry and the AD have been revised. For the Industrial Processes sector, the recalculations result in decreases in estimated

emissions of 494.91 Gg and 1,648.79 Gg CO₂ equivalent for the years 1990 and 2001, respectively. These represent decreases of 0.1 and 0.3 per cent, respectively, in total national GHG emissions.

38. Specific QA/QC procedures are reported for the different source categories of the sector.

B. Key sources

Cement production – CO₂

39. Since its 2003 inventory submission, Canada has implemented an IPCC tier 2 method for estimating emissions from Cement Production following the recommendations of the 2003 review report. The revision has led to higher emissions estimates for all years (the greatest increase being that for 1995, by 9.3 per cent), except for the base year (1990), for which estimated emissions decreased by 4.8 per cent. In its response to the draft review report, the Party clarified that this decrease is related to lower activity data (clinker production) from a different data source used for the tier 2 method in the 2004 submission.

Adipic acid production – N₂O

40. AD for Adipic Acid Production are confidential for the entire time series because there is only one production facility. The ERT considers that the Party should assess whether these data could be reported for earlier years, as the industry may no longer consider production data from five or ten years ago as confidential.

Iron and steel production – CO₂

41. Since the 2003 inventory submission, Canada has implemented an IPCC tier 2 method for the Iron and Steel Production source category and followed the recommendations of the 2003 review process. This methodological improvement has resulted in a decrease in the estimates of CO₂ emissions from this source of approximately 7–9 per cent over the period 1990–2002.

Aluminium production – PFCs

42. The EFs for this sector depend both on the technology employed and on the procedures adopted to reduce the frequency of the anodic effect. Canada has estimated emissions on the basis of a tier 2 method based on information collected from individual plants. The time series of EFs used is reported in the NIR and the EFs are specific to the cell technology type. On the basis of a recent study, the whole time series of EFs and emissions have been recalculated. The recalculations result in higher estimates of emissions for the years 1990–1997 (+23 per cent in 1990), and lower estimates for 1998–2001 (–23 per cent in 2001). The ERT considers that the Party should provide more information on the reasons why the revision of the EFs produced higher estimates for the base year and lower estimates in the more recent years. In its response to the draft review report Canada explained that the estimates in the 2005 submission will be further revised based on audited data directly obtained from the Aluminium Association of Canada.

Magnesium production – SF₆

43. For magnesium foundries a tier 3 method based on facility-specific emissions data is used. Since 1999, data have been reported on a mandatory basis from each magnesium producer; for earlier years data were provided by the industry on a voluntary basis.

Other – CO₂

44. The emissions reported in this source category are based on data for non-energy use of fuels from the publications of Statistics Canada. In the Canadian national energy balance, the use of non-energy products is allocated to several subsectors besides industry, including mining, transportation, agriculture, public administration, commercial and other institutional. The emissions associated with combustion of fuels should be kept in the Energy sector instead of being included in Other, as suggested by the 2003 review report. In its response to the draft review report, Canada explained that studies are underway to obtain breakdowns for non-energy fuel use, and to research more representative CO₂ EFs.

45. Within the Industrial Processes sector, only the consumption that can be associated with industrial processes should be included. To increase transparency as much as possible, emissions should be reported in the individual subcategories (Iron and Steel Production, Ferroalloy Production), as is currently done for the ammonia production and aluminium production processes.
46. Since the 2003 submission, the 2001 emissions have been recalculated on the basis of a revision of the non-energy fossil fuel use data. Canada plans to make efforts to improve its allocation of emissions to the sub-sources, as the NIR reports.

C. Non-key sources

Consumption of halocarbons and SF₆ – HFCs, PFCs and SF₆

47. HFC emissions from Fire Extinguishers are only provided for the years 1995, 1996 and 1997. The NIR, however, seems to indicate that there were HFC emissions from this source in previous years as well. In its response to the draft review report, Canada informed that the 2005 inventory submission will include updated data for the years 1998–2000 using the results of a more recent survey and that the emissions from HFC consumption were considered negligible for the period 1990–1994.
48. For the years 1998–2002, emissions of HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, perfluoromethane (CF₄) and hexafluoroethane (C₂F₆) are reported as constant. Canada has conducted a survey of HFC and PFC consumption for 1999 and 2000 and will use the resulting data to update its estimates of HFC and PFC emissions from 1998 to 2003 in its 2005 inventory submission. SF₆ emissions from Electrical Equipment are also currently being studied and these emissions will be added to Canada's submission in 2005.

Soda ash production and use – CO₂

49. Emissions of CO₂ from soda ash use are reported as constant from 1992 onwards. The reason for this is that the information provided in a Statistics Canada report on the consumption of soda ash in the glass industry was discontinued in 1992. Canada is encouraged to obtain basic AD and to report the related emissions for the entire time series. In its response to the draft review report, Canada announced that this is part of the planned improvements.

IV. AGRICULTURE

A. Sector overview

50. In 2002, the Agriculture sector was the second-largest source of emissions, accounting for 8.1 per cent of total national GHG emissions, or 58,738.21 Gg CO₂ equivalent. Emissions from most sources in the sector, with the exception of CO₂ emissions and removals for Agricultural Soils, increased between 1990 and 2002 – by 17.8 per cent for CH₄ from Enteric Fermentation, 22.4 per cent for CH₄ from Manure Management, 25.8 per cent for N₂O from Manure Management and 10.3 per cent for N₂O from Agricultural Soils. CO₂ emissions from Agricultural Soils decreased by 107 per cent between 1990 and 2002, and in 2001 Agricultural Soils became a removal.
51. The CRF includes estimates of all major gases and sources of emissions from the Agriculture sector, as recommended by the IPCC Guidelines. As there is only a small amount of rice cultivation in Canada, CH₄ emissions from this source are considered to be negligible. Field burning of agricultural residues and prescribed burning of savannas are not considered common practices in Canadian agriculture and are therefore not inventoried. CO₂ emissions and removals from Agricultural Soils are reported under 4.D Agricultural Soils instead of under the LUCF sector. Canada's CO₂ inventory for Agricultural Soils currently includes agricultural soils managed for crop production, but does not include grassland management, which accounts for about 30 per cent of the agricultural land area. The previous 2003 review recommended Canada to report emissions from Rice Cultivation and Field Burning of Agricultural Residues as "NE" instead of "not occurring" ("NO"). In the 2002 inventory "NE" is used for 1990, and "NO" for later years. The ERT still recommends Canada to use "NE" in a consistent manner. Emissions

from Buffalo, Mules and Asses, and Poultry are reported as “NE”. In its response to the 2004 previous review stages Canada explained that no population data are available for mules and asses, but that poultry population and buffalo population data in 1996 and 2001 are available. It plans to include emissions from Poultry and Buffalo in its future inventory submissions.

52. The NIR provides information on the methodologies used, EFs and references for every source. The more detailed methodologies are provided in annex 3 to the NIR. Some more disaggregated AD should be provided in several areas, however, as indicated in the following sections.

53. Some IEFs are different from the IPCC default values. The previous 2003 review recommended that Canada include a comparison and explanation of the differences between the EFs and the IPCC defaults in the NIR, but these have not yet been provided.

B. Key sources

Enteric fermentation – CH₄

54. During the previous 2003 review, Canada reported plans to implement the IPCC tier 2 methodology for the inventory year 2003. The ERT expects Canada to use tier 2 for its next inventory submission.

55. The population data for Sheep (and lambs), Swine and Poultry in table 4.A for 2002 are inconsistent with the population data in table 4.B. In table 4.A Canada reports the same data for 2002 as for 2001; only table 4.B seems to contain AD for 2002. This difference should be explained or corrected.

56. For the year 2002, the IEF for Horses in the CRF is 18.0 kg CH₄/head/year, while in table A.3-1 of the NIR the EF is reported as 13.0 kg CH₄/head/year. For Goats, the IEF reported in the CRF is 5.0 kg CH₄/head/year, while in table A.3-1 the EF is 8.0 kg CH₄/head/year. These inconsistencies should be explained or corrected.

57. In order to avoid large inter-annual changes in the figures for horse and goat populations, and in response to the recommendations of the previous 2003 review, the horse and goat populations have been recalculated based on interpolation. However, the jump in the figures for the goat population between 1995 and 1996 is even higher than it was before (it rises from 21,900 in 1995 to 125,819 in 1996; in the 2003 inventory submission it was 73,300 in 1996). The ERT recommends the Party to explain why the goat population can have increased by a factor of almost 6 in one year when the interpolation method was used.

Manure management – CH₄

58. During the 2003 review, Canada reported plans to implement the IPCC tier 2 methodology for the inventory year 2003. The ERT expects Canada to use tier 2 for its next inventory submission.

59. The IEF for Swine given in the CRF is 10.48 kg CH₄/head/year for 2002, while according to table A.3-3 of the NIR it is 10 kg CH₄/head/year. For all other years, the CRF reports consistently 10 kg CH₄/head/year as the IEF. The difference should be explained or corrected.

Agricultural soils – CO₂

60. In the NIR, Canada provided more information on the Century model for the estimation of CO₂ emissions and removals from Agricultural soils. However, the AD and other parameters were not provided, for example, at a level of disaggregation comparable to that in CRF table 5.D. It is not clear why Agricultural Soils were a source of CO₂ from 1990 to 2000 and became a sink in 2001. There is also no transparent explanation as to why more intensive cropping systems and reduced use of summer fallow appears to have increased the crop residues returned to the soil and the content of carbon (C) in soils. The ERT recommends Canada to further increase the transparency of its reporting in the areas highlighted.

61. Canada reports on work currently being done to assess alternative methodologies for soil C that may be suitable to replace the Century model, which would make it possible to produce a consistent time series and enable comparability with previous estimates. The ERT suggests that Canada include the results of this assessment in its future submissions.

62. CO₂ emissions from liming have been recalculated for the years 1997–2002. However, the new data source is not indicated exactly in the NIR and there is no clear explanation of how a consistent time series was achieved. The ERT recommends Canada to provide additional information with its next inventory submission.

Agricultural soils – N₂O

63. The IEF for Direct Soil Emissions – Animal Wastes Applied to Soils (0.0092 kg N₂O-N/kg N) is lower than the IPCC default (0.0125 kg N₂O-N/kg N). Canada indicated that an error in the database caused the discrepancy and that this will be corrected and recalculated for future submissions.

64. Frac_{GRAZ} is reported as 0.00 in the CRF but as 0.02 (equal to the IPCC default) in the NIR. Frac_{NCRO} (0.030 kg N/kg of dry biomass) and Frac_{NCRBF} (0.015 kg N/kg of dry biomass) are higher and lower, respectively, than the IPCC default values (0.015 kg N/kg of dry biomass and 0.030 kg N/kg of dry biomass, respectively). Canada explained that the defaults for Frac_{NCRO} and Frac_{NCRBF} were used but the values were switched by mistake, and that this error will be corrected in future submissions.

65. The IEF used for Cultivation of Histosols is 5 kg N₂O-N/ha. In the IPCC Guidelines this value was updated to 8 kg N₂O-N/ha. Canada should explain why it considers the old EF to be more accurate.

C. Non-key sources

Manure management – N₂O

66. The nitrogen (N) excretion rates for some livestock species are different from the IPCC default values. The NIR explains that the N excretion rates were taken from a report of the US-based American Society of Agricultural Engineering (ASAE, 1999); however, no information is provided on why these values are considered as more representative than the IPCC default values.

67. The survey on animal waste management system (AWMS) distributions for different animal categories announced in the previous 2003 review report and the NIR has not yet been included in Canada's submission. The ERT expects that this source category will be revised for Canada's next inventory submission.

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

68. In 2002, CO₂ removals by the LUCF sector represented 2.8 per cent of total GHG emissions reported, including CH₄ and N₂O emissions from LUCF (731,209.44 Gg of CO₂ equivalent). Changes in Forest and Other Woody Biomass Stocks dominates the LUCF sector, contributing 99.5 per cent of CO₂ removals and 90.8 per cent of emissions (including CH₄ and N₂O) in 2002. The contributions of Forest and Grassland Conversion and CO₂ Emissions and Removals from Soil to the sector's emissions are equal, at approximately 4.6 per cent each.

69. The ERT recognizes that the Canadian system for estimating and reporting GHG emissions and removals for the LUCF sector is in a transitional phase. The time-series estimates reported this year for managed forests have changed significantly compared to previous inventory reports. It is recognized this is a result of ongoing changes which may entail further significant recalculations over the coming years.

70. There has been high inter-annual variability in gross and net emissions largely because of variation in the incidence of forest fires. Those years in which LUCF is reported to be a net source all

coincide with years of extensive wildfires. The harvesting rate has remained on a gradually increasing trend since 1990, with apparent stabilization since 1999.

71. Net emissions in categories 5.B, 5.C and 5.D are reported to be constant throughout the years 1990–2002 since the area of land-use change has been averaged over the entire inventory period. This makes it difficult to identify trends. These values should be considered as indicative only until planned work to improve confidence in these estimates is completed.

72. The CRF includes estimates of all four LUCF sectors as recommended by the IPCC Guidelines. The estimates do not include forest soil organic carbon, below-ground biomass, or dead organic matter. The Party clarified in its response to the draft review report that it did not use IPCC default factors for belowground biomass, as these default values would grossly overestimate C sequestration. The inventory includes the notation key “NE” for CH₄ and N₂O emissions from Forest and Grassland Conversion. The ERT acknowledges that Canada has plans to include these sources in future, in accordance with the new IPCC Good Practice Guidance for Land Use, Land-use Change and Forestry (LULUCF) (hereinafter referred to as LULUCF good practice guidance).

73. The methodology is well described in the NIR (including annex 6) and the CRF. Changes to the inventory that have occurred recently and future plans are clearly outlined. The relationship between the values provided in CRF table 5 and their sources is not always immediately apparent. For example, it might be helpful to include additional information in table 5.D to make it possible to convert the estimates of C that are given to CO₂.

74. Significant recalculations have been conducted for the 2004 submission. These were more focused on AD than on methods. Extensive explanations of these recalculations are provided. New forest inventory data and changed definitional parameters have greatly increased the area of ‘managed forest’ reported. The average annual area of forest affected by wildfire has also increased.

75. Canada previously reported a net sink for the LUCF sector for all years 1990–2001, declining from 104,732.6 Gg CO₂ equivalent in 1990 to 34,295.83 Gg CO₂ equivalent in 2001. The current inventory reports a net sink in all years except 1994, 1995 and 1998, with 2002 removals estimated at 14,624.14 Gg CO₂ equivalent, which is only 19.1 per cent of the recalculated 2001 estimate (76,548.62 Gg CO₂ equivalent) and 9.7 per cent of the recalculated 1990 estimate (151,304.19 Gg CO₂ equivalent).

76. The main source of uncertainty is acknowledged to be the omission of important carbon pools, such as forest soils, harvested wood products and dead organic matter. The NIR states that it is not possible to undertake a quantitative uncertainty assessment. Fire plays a major role in LUCF and Canada is conducting assessments to reduce the level of uncertainty of areas affected and associated emissions estimates. Other main sources of uncertainties are the scarcity of quantitative information on the extent and geographical location of significant land-use changes, and the types and the characteristics of ecosystems that have changed; the lack of spatial definition for the managed forests and the temporary nature of the values given for the areas of managed forest; and the use of forest data which are highly aggregated and spatially coarse.

77. The NIR identifies a range of improvements which indicate that significant effort is being made to improve the quality of the inventory. The ERT supports the changes proposed. Improvements include the implementation of a formal procedure for the technical verification of the LUCF inventory and checks for consistency and transparency between the NIR and the CRF.

B. Sink and source categories

Changes in forest and other woody biomass stocks

78. Forest parks and reserves are excluded from this category. It is unclear whether there is not enough management involved for these areas to be included under managed forest. The Party should explain why forest parks and reserves are not considered under managed forests.

79. The documentation box contains a note with reference to “Traditional Fuelwood Consumed (cell E90)”, but nothing is reported in cell E90 of that sheet.

80. The ERT considers that it would be useful to clarify whether the non-CO₂ EFs given in the NIR for wildfires are also applied to prescribed burning, and explain any differences in the factors applied.

81. The estimates of removals by woodlots located on agricultural land and urban forests are acknowledged to be crude and an area of uncertainty for future improvement.

Forest and grassland conversion

82. The inventory does not include below-ground biomass, dead organic material above ground, CH₄ and N₂O emissions from Forest and Grassland Conversion, drainage of wetland or extraction of peat, but includes soil emissions upon land conversion. The ERT acknowledges that Canada has plans to include these sources in future, in accordance with the LULUCF good practice guidance.

VI. WASTE

A. Sector overview

83. In 2002, emissions from the Waste sector represented 3.3 per cent of total national GHG emissions, and had increased by 18.2 per cent since 1990. Emissions from Solid Waste Disposal on Land, which is a key source, contributed 3.0 per cent to total national GHG emissions, while emissions from Waste-water Handling and Waste Incineration contributed 0.2 and 0.05 per cent, respectively.

84. The CRF includes estimates of most gases and sources of emissions from the Waste sector, as recommended by the IPCC Guidelines. Only emissions from Industrial Waste-water have not been estimated due to a lack of data on the industrial facilities that treat their own waste water. In its response to the draft review report, Canada announced that such data is currently gathered.

85. In practice, the methodology and parameters are not completely transparent in the NIR and the CRF, and do not allow a complete reconstruction of the emissions estimation. The NIR does provide documentary references to the main sources of information on AD and EFs but, in the view of the ERT, to enhance transparency it could be useful to provide in the NIR not only the methodological description but also the quantitative values chosen (e.g., the CH₄ generation rate constant (*k*)). In its response to the draft review report Canada announced that an NIR annex is being considered to provide greater detail for this source.

86. According to information given in table 8(a) and 8(b) of the CRF, estimates in the Waste sector were recalculated for the period 1990–2001 because revised population and other data became available. The ERT noted differences in the estimates between previous submissions and the latest submission for the years 1998, 1999, 2000 and 2001. All the recalculations are associated with the acquisition of more accurate data and efforts to achieve time-series consistency.

87. According to the NIR and the CRF, the quality of the emissions estimates is considered to be low to medium in almost all source categories, mostly due to the lack of detailed data to support a higher-tier methodology. In future Canada plans to improve the accuracy and completeness of the AD and EFs in the Waste sector in order to improve the overall quality of the emissions inventory.

B. Key sources

Solid waste disposal on land – CH₄

88. The first order decay (FOD) method was applied to estimate CH₄ emissions from Solid Waste Disposal on Land, which is in accordance with the IPCC good practice guidance. The methodology and parameters used in the FOD model are described in the NIR and the NIR provides a list of reference documents in which additional information is provided.

89. There are two types of landfill for which CH₄ emissions have been estimated – managed solid waste disposal sites (SWDS) and wood waste landfills. The annual amount of municipal solid waste (MSW) landfilled on municipal SWDS is estimated on a per capita basis for each province and provincial population, as recorded by Statistics Canada. The amount of wood waste landfilled for the period 1970–1992 has been estimated using a national method. For the period 1993–2000 the amount of wood waste has been estimated on the basis of information provided in three reference documents. Historical data on amounts of waste landfilled are not presented in the NIR.

90. According to the CRF, the waste generation rate, which is 3.2 kg/capita/day, remained constant over the period 1990–2002, which is not very likely in the light of developments in other Annex I Parties. In its response to the draft review report Canada confirmed that the waste generation rate was incorrect and this will be revised to NA in the subsequent inventory submission since there are several province specific rates employed in the model used for Canada. The ERT encourages Canada to provide this information in the next NIR.

91. The constant k used to estimate CH₄ emissions from both types of landfill originates from a study that acknowledges the limitations of the available data. The NIR does not provide the ranges of the k values used in the FOD model. The k values are indicated as “NA” in the CRF additional information box. The ERT recommends Canada to provide the k values used in its next submission. In its response to the review Canada explained that the k values are province specific and therefore cannot be represented by one value in the CRF. However, the province specific k values will be provided in the Waste chapter of NIR.

92. Methane generation potential (Lo) has been estimated using an adjusted equation from the IPCC good practice guidance. It appears that this equation does not include the fraction of degradable organic carbon (DOC) ultimately dissimilated (DOC_F) which could lead to Lo being overestimated. The fraction for the volume of CH₄ in equation 8-2 presented in the NIR equals 0.5, while in the CRF this value is 0.46. In its response to the draft review report the Party explained that the CRF value for CH₄ fraction in landfill gas value reflects an average of the measured concentrations and that the NIR presents an assumed value that will be changed to NA, because the gas capture data and the model are province specific. The ERT encourages Canada to provide this province specific information in the next NIR.

93. Data on recovered CH₄ are based on estimates supplied by individual landfill operators, but these values are not provided in the NIR. Additional data in the CRF are not provided since these data are not used in the national waste model. In its response to the draft review report, the Party explained that an NIR annex is being considered to provide greater detail for this source.

94. Although the FOD model has been elaborated in the NIR, the ERT recommends Canada to present all parameters used in the FOD, particularly historical data on estimated quantities of MSW landfilled, waste composition and CH₄ generation potential over time. All EFs that are different from the IPCC Guidelines should be justified. Additional information should be provided in CRF table 6.A. In its response to the draft review report, the Party explained that an NIR annex is being considered to provide greater detail for this source.

C. Non-key sources

Waste-water handling – CH₄ and N₂O

95. CH₄ emissions from waste water of Domestic and Commercial Waste-water have been estimated using a country-specific method because the data needed in order to use the IPCC default method were not available. The parameters used in the estimation are partially described in the NIR. The ERT recommends Canada to present and elaborate the parameters used, particularly the amount of organic matter generated per capita and the CH₄ conversion factor. N₂O emissions have been calculated using the IPCC default method. In its response to the draft review report, the Party informed that will provide more transparent description of the methodology in the future, probably in an annex to the NIR.

96. Most of the AD, IEFs and additional information for Waste-water Handling in CRF table 6.B are indicated as “NA” and “NE”.

97. Emissions from Industrial Waste-water have not been estimated due to a lack of data on the industrial facilities that treat their own waste water. The ERT recommends Canada to make an effort to collect data on industrial waste water in order to estimate emissions from this source category. In its response to the draft review report, the Party explained that a waste water study is planned to update the emission estimates.

Waste incineration – CO₂, CH₄, N₂O

98. Emissions from both MSW and sewage sludge incineration are included in the NIR and the CRF. Canada has used a country-specific method to estimate emissions of CO₂ from waste incineration, which could be characterized as a simplified method compared to that described in the IPCC good practice guidance.

99. The amount of waste incinerated for the period 1990–2002 has been estimated by extrapolation from detailed data from the individual provinces collected in 1992. The amount of carbon in waste of fossil origin which oxidizes to CO₂ has been determined using a typical fraction of C content in waste. The ERT recommends Canada to update its data on amounts of waste incinerated and to apply the IPCC good practice guidance methodology. In its response to the draft review report, Canada informed that a study is presently being developed which will provide the quantitative data on the energy being recovered from the MSW, hazardous and medical waste incinerators and that the methodology will be reviewed as well.

100. Emissions of N₂O from MSW incineration have been estimated using the average IPCC default EF for a five-stoker incineration facility.

101. Emissions of CH₄ have been estimated only for sewage sludge incineration. The calculation is based on an amount of dried solids and EFs which equal 1.6 and 3.2 t CH₄/kt dried solids for fluidized beds and multiple heart incinerators, respectively. The NIR does not specify the reference documents used as a source for EFs. In its response to the draft review report, the Party provided this source and explained that the reference will be included in future NIRs.

102. Emissions from Waste Incineration are reported in the Waste sector despite the fact that energy is used in almost all waste incineration plants in Canada. The ERT recommends Canada to report emissions from waste incineration in the Energy sector under the correct source category when energy is recovered. In its response to the draft review report, the Party explained that a study on incinerators is underway that will allow correct allocation in the future.

ANNEX 1: MATERIALS USED DURING THE REVIEW

A. Support materials used during the review

- 2003 and 2004 Inventory submissions of Canada. 2004 submission including a set of CRF tables for 1990–2002 and an NIR.
- UNFCCC secretariat (2004). “Report of the individual review of the greenhouse gas inventory of Canada submitted in the year 2003 (In-country review)”. FCCC/WEB/IRI(2)/2003/ (available on the secretariat web site <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/canrep03.pdf>).
- UNFCCC secretariat. “2004 Status report for Canada” (available on the secretariat web site <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/can04.pdf>).
- UNFCCC secretariat. “Synthesis and assessment report of the greenhouse gas inventories submitted in 2004. Part I”: FCCC/WEB/SAI/2004 (available on the secretariat web site <<http://unfccc.int/resource/webdocs/sai/2004.pdf>>) and Part II – the section on *Canada* (unpublished).
- UNFCCC secretariat. Review findings for Canada (unpublished).
- Canada’s comments on the draft “Synthesis and assessment report of the greenhouse gas inventories submitted in 2004” (unpublished).
- UNFCCC secretariat. “Handbook for review of national GHG inventories.” Draft 2004 (unpublished).
- UNFCCC secretariat. “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories”, “Part II: UNFCCC reporting guidelines on national communications” and “Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention.” FCCC/CP/1999/7 (available on the secretariat web site <<http://unfccc.int/resource/docs/cop5/07.pdf>>).
- UNFCCC secretariat. “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories” and “Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention.” FCCC/CP/2002/8 (available on the secretariat web site <<http://unfccc.int/resource/docs/cop8/08.pdf>>).
- UNFCCC secretariat. Database search tool – *Locator* (unpublished).
- IPCC. *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000* (available on the following web site: <<http://www.ipcc-nggip.iges.or.jp/public/gp/english>>).
- IPCC/OECD/IEA. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, volumes 1–3, 1997* (available on the following web site: <<http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>>).

B. Additional materials

Responses to questions during the review were received from Mr. Art Jacques (Environment Canada) including additional material on the methodology and assumptions used.

McCann, T.J. (2000), 1998 Fossil Fuel and Derivative Factors, prepared for Environment Canada by T.J. McCann and Associates, March.

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