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Report of the individual review of the greenhouse gas inventories of Canada submitted in 2007 and 2008*

* In the symbol for this document, 2008 refers to the year in which the inventory was submitted, and not to the year of publication.

CONTENTS

I. Overview

A. Introduction

1. This report covers the centralized review of the 2007 and 2008 greenhouse gas (GHG) inventory submissions of Canada, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. In accordance with the conclusions of the Subsidiary Body for Implementation at its twenty-seventh session,[1] the focus of the review is on the most recent (2008) submission. The review took place from 8 to 13 September 2008 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalist – Ms. Hongmin Dong (China) and Ms. Lisa Hanle (United States of America); energy – Mr. Dario Gomez (Argentina) and Mr. Pavel Fott (Czech Republic); industrial processes – Mr. Domenico Gaudioso (Italy) and Mr. Kiyoto Tanabe (Japan); agriculture – Mr. Donald Kamdonyo (Malawi) and Mr. Rob Sturgiss (Australia); land use, land-use change and forestry (LULUCF) – Mr. Harry Vreuls (Netherlands) and Mr. Xiaoquan Zhang (China); and waste – Mr. Seungdo Kim (Korea) and Mr. Takashi Morimoto (Japan). Mr. Gomez and Mr. Tanabe were the lead reviewers. The review was coordinated by Mr. Javier Hanna and Mr. Tomoyuki Aizawa (UNFCCC secretariat).

2. In accordance with the "Guidelines for review under Article 8 of the Kyoto Protocol" (decision 22/CMP.1), a draft version of this report was communicated to the Government of Canada, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

B. Inventory submission and other sources of information

3. The 2008 annual inventory was submitted on 22 May 2008; it contains a complete set of common reporting format (CRF) tables for the period 1990–2006 and a national inventory report (NIR). This is in line with decision 15/CMP.1. Canada indicated that the 2008 submission is also its voluntary submission under the Kyoto Protocol.[2] In its 2007 submission, which was submitted on 25 May 2007, Canada included a complete set of CRF tables for the period 1990–2005 and an NIR. The expert review team (ERT) encourages Canada to submit its next annual inventory by 15 April 2009 as required by decision 15/CMP.1. The full list of materials used during the review is provided in the annex to this report.

C. Emission profiles and trends

4. In 2006 (as reported in the 2008 annual submission), the main GHG in Canada was carbon dioxide (CO_2), accounting for 77.8 per cent of total GHG emissions[3] expressed in CO_2 eq, followed by methane (CH_4) (14.1 per cent) and nitrous oxide (N_2O) (6.6 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 1.5 per cent of the total GHG emissions in the country. The energy sector accounted for 80.9 per cent of the total GHG emissions, followed by agriculture (8.6 per cent), industrial processes (7.6 per cent), waste (2.9 per cent) and solvent and other product use (0.04 per cent). Total GHG emissions amounted to 720,631.73 Gg

[1] FCCC/SBI/2007/34, paragraph 104.

[2] Parties may start reporting information under Article 7, paragraph 1, of the Kyoto Protocol from the year following the submission of the initial report, on a voluntary basis (decision 15/CMP.1).

[3] In this report, the term "total GHG emissions" refers to the aggregated national GHG emissions expressed in terms of CO_2 eq excluding LULUCF, unless otherwise specified.

CO_2 eq and increased by 21.7 per cent between the base year[4] and 2006. In 2005 (as reported in the 2007 annual inventory submission), total GHG emissions amounted to 746,888.77 Gg CO_2 eq. However, in the 2008 annual inventory submission, the total GHG emissions in 2005 has been recalculated and reported to be 734,490.78 Gg CO_2 eq. This difference results mainly from recalculations undertaken for the energy sector. The shares of gases and sectors in 2006 (2008 annual inventory submission) were similar to those in 2005 (2007 annual inventory submission).

5. Tables 1 and 2 show GHG emissions by gas and by sector, respectively.

D. Key categories

6. Canada has reported a key category tier 1 analysis, both level and trend assessment, and also applied a qualitative approach in determining the key categories, as part of its 2008 submission. The key category analysis performed by Canada and that performed by the secretariat[5] produced similar results. Canada has included the LULUCF sector in its key category analysis, which was performed in accordance with the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF). The same key categories were identified in the 2007 annual submission.

7. The key category analysis is one of the driving factors for the preparation of the inventory. Canada uses the analysis to prioritize the development and improvement of its inventory. For most of the key categories, emissions are estimated using higher-tier methods.

8. In the previous review report, it was recommended that Canada develop a tier 2 approach based on quantitative uncertainty analysis. In its 2008 NIR, Canada explained that, since uncertainty estimates are currently not available for all sectors, a tier 1 approach has been used for this analysis. The ERT recommends, as did the ERT in the previous report, that Canada implement a tier 2 key category approach based on quantitative uncertainty.

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[4] Base year refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions do not include any possible emissions from deforestation; however, if applicable, these are taken into account when the assigned amount is calculated.

[5] The secretariat identified, for each Party, the categories that are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Key categories according to the tier 1 trend assessment were also identified for Parties that provided a full set of CRF tables for the base year. Where the Party performed a key category analysis, the key categories presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

Table 1. Greenhouse gas emissions by gas, 1990–2006

Greenhouse gas	Gg CO_2 eq								Change base year–2006 (%)
	Base year[a]	1990	1995	2000	2003	2004	2005	2006	
CO_2	455 999.45	455 999.45	488 393.48	559 997.43	581 597.70	579 635.26	572 234.70	560 389.43	22.9
CH_4	74 339.31	74 339.31	89 233.32	98 162.90	100 389.34	102 001.28	102 159.15	101 862.95	37.0
N_2O	49 932.69	49 932.69	54 371.89	47 908.02	47 468.92	50 357.15	49 293.52	47 730.26	–4.4
HFCs	767.25	767.25	479.41	2 985.39	4 384.76	4 702.32	5 194.04	5 274.05	587.4
PFCs	6 538.83	6 538.83	5 489.50	4 308.23	3 034.53	3 056.24	3 090.88	2 639.69	–59.6
SF_6	4 703.93	4 703.93	3 707.28	4 341.47	4 159.80	3 034.33	2 518.49	2 735.35	–41.8

Abbreviation: NA = not applicable.

[a] "Base year" refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions do not include any possible emissions from deforestation; however, if applicable, these are taken into account when the assigned amount is calculated.

Table 2. Greenhouse gas emissions by sector, 1990–2006

Sector	Gg CO_2 eq								Change base year–2006 (%)
	Base year[a]	1990	1995	2000	2003	2004	2005	2006	
Energy	469 636.24	469 636.24	509 930.08	587 048.56	608 801.86	604 264.55	596 307.21	583 099.57	24.2
Industrial processes	54 816.01	54 816.01	56 625.96	51 128.97	51 201.23	55 342.23	54 797.13	54 439.56	–0.7
Solvent and other product use	174.92	174.92	208.03	241.87	220.94	210.88	179.03	322.36	84.3
Agriculture	49 491.09	49 491.09	55 748.97	59 626.25	60 694.58	62 569.47	62 543.61	61 842.95	25.0
LULUCF	NA	–106 453.62	163 539.84	–97,653.36	11 509.59	41 225.10	–8 442.71	31 342.17	NA
Waste	18 163.20	18 163.20	19 161.85	19 657.80	20 116.43	20 399.45	20 663.81	20 927.30	15.2
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	NA	485 827.85	805 214.73	620 050.09	752 544.63	784 011.67	726 048.07	751 973.90	NA
Total (without LULUCF)	592 281.47	592 281.47	641 674.89	717 703.45	741 035.04	742 786.58	734 490.78	720 631.73	21.7

Abbreviations: LULUCF = land use, land-use change and forestry; NA = not applicable.

[a] "Base year" refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions do not include any possible emissions from deforestation; however, if applicable, these are taken into account when the assigned amount is calculated.

E. Main findings

9. The inventory is generally in line with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. However, the ERT did identify some instances where the inventory is not in line with these guidelines (see paras. 29 and 36 below).

10. The 2008 annual inventory submission shows significant improvement in terms of the implementation of the quality assurance/quality control (QA/QC) plan and the readability of the chapter on the industrial processes sector in the NIR. Other improvements made include: the inclusion of a description of the results of a detailed study on fugitive emissions from the non-conventional oil extraction industry; the use of revised estimation methods for the waste sector; and better LULUCF estimates based on new activity data (AD) and estimation parameters.

11. The ERT noted that the national registry was still being established at the time of submission of the 2008 NIR and that Canada therefore could not provide in that NIR the information requested by the previous ERT. The requested information included complete and detailed information on its national registry and the results of the technical assessment of the national registry. The ERT notes that Canada provided this information on 5 June 2008 in Canada's Written Submission to the Enforcement Branch of the Compliance Committee (CC-2008-1-5/Canada/EB). The current ERT recommends that Canada provide this information, including the results of standardized testing, as reported in the independent assessment report of the national registry of Canada published on 12 June 2008,[6] in its next annual inventory submission.

F. Cross-cutting issues

1. Completeness

12. Canada's inventory is generally complete in terms of the years covered. However, the ERT identified gaps in or a lack of data for some minor categories in the 2008 submission (see paras. 28, 51, 57, 75, 76, 77, 81 and 82 below). During the review, Canada provided the ERT with additional information concerning the categories that have been reported as not estimated ("NE"), including how it plans to address these categories in future submissions. The ERT acknowledges this information and encourages Canada to implement its plans in a timely manner in order to improve the completeness of its inventory by 2010 at the latest.

2. Transparency

13. Canada's inventory is generally transparent and the NIR includes information on key categories, methods, data sources, uncertainty estimates, QA/QC procedures and verification activities, which provides a good basis for reviewing the inventory. However, some additional information could improve transparency, such as information on the type of waste incineration with or without energy recovery and more consolidated information in one place on the waste sector.

3. Recalculations and time-series consistency

14. The ERT noted that recalculations have been undertaken, to take into account the recommendations made in previous reviews, both in the 2007 submission (for the time series 1990–2004) and in the 2008 submission (for the time series 1990–2005). The availability of updated statistics from Statistics Canada resulted in the recalculation of the emission estimates for stationary combustion,

[6] see <http://unfccc.int/resource/docs/2008/iar/can01.pdf>.

transport and refining/storage. The CO_2 emission factors (EFs) for cement production, national lime production and national hydrated lime production were revised. More accurate plant-specific data on ammonia production were provided. The EF for steel production, annual nitrogen (N) excretion rates and decay rates of dead organic matter in forest land were revised. Major changes were made to the estimates of CO_2 emissions from energy industries and N_2O emissions from soil. The recalculations in the LULUCF sector were of the greatest magnitude. The rationale for these recalculations is provided in the NIR.

15. The ERT compared the 2008 submission with the revised 2006 submission. As a result of recalculations undertaken in the 2007 and 2008 submissions, total GHG emissions (excluding LULUCF) were overall revised downwards by less than 1.0 per cent, except for in 2003 and 2004, where the downward revisions amounted to 1.2 per cent and 1.4 per cent, respectively. These recalculations had a moderate effect on the long-term trend in total GHG emissions (excluding LULUCF), which increased by 25.4 per cent between 1990 and 2004, as reported in the 2008 submission, compared with an increase of 26.8 per cent over the same period, as reported in the revised 2006 submission.

4. Uncertainties

16. During the review, Canada informed the ERT that a tier 2 quantitative uncertainty study was performed on Canada's GHG inventory throughout 2003 and 2004. (The 2008 NIR explains that it was performed throughout 2004 and 2005, but this is incorrect.) The results of the study were provided in Canada's 2005 NIR, including information on the overall trend in inventory uncertainty for 1990–2001 and the sensitivity of overall inventory uncertainty to uncertainties identified at the category level. Canada has continued to make use of this study as the primary source of reports on quantitative uncertainty for its 2008 NIR. The 2008 NIR states that Canada is aiming to update its uncertainty assessment for its 2009 NIR and that Canada plans to include, in its improvements on uncertainty, the development of a programme that will ensure the country's ability to provide incremental improvements to its uncertainty assessment on an annual basis. The ERT encourages Canada to make efforts to implement this plan to update its uncertainty analyses annually.

17. The uncertainty analysis was updated in the 2007 submission because significant changes in methodology and updates to parameters were made for the agriculture sector, and the quantitative uncertainty analysis on the LULUCF sector was included. According to the 2003 NIR, the overall level of uncertainty of the national inventory (without LULUCF), as at 2001, falls within a range of −3 to +6 per cent for all GHGs combined. N_2O exhibits the highest range of uncertainty in the national inventory, with a range of −8 to +80 per cent. The largest contributor to the inventory, CO_2, exhibits an uncertainty of −4 to 0 per cent.

5. Verification and quality assurance/quality control approaches

18. The implementation of the QA/QC plan was a key focus for the 2007 submission. The emphasis of this implementation was on the transition from an informal approach of QA/QC to an approach that is formally defined and consistent across sectors. A series of measures was taken in preparation for the implementation of the QA/QC plan, including hiring a new project manager to manage inventory timelines; developing an inventory schedule; conducting an internal audit on the completeness and transparency of the QC checklists; implementing a new electronic archiving structure and creating a hardcopy reference library; establishing a tier 1 QC working group, which resulted in revised tier 1 checklists and a new guidance manual; formalizing tier 2 QA/QC activities in the industrial processes and energy sectors and initiating the establishment of tier 2 QA/QC guidance documents; and developing a new process for the documentation required prior to the implementation of methodological changes. The ERT encourages Canada to complete the implementation of tier 2 QC procedures, at least for the key categories.

6. Follow-up to previous reviews

19. Major improvements have been made to Canada's inventory as a result of its consideration of previous recommendations made by the ERT, such as improving QA/QC implementation with emphasis placed on the transition from an informal to a formal approach, including CRF tables 2(II).F and 9(b), and improving consistency between the NIR and the CRF tables.

20. The ERT concluded, however, that Canada has still not yet implemented some of the recommendations made in the previous review, such as:

(a) Defining its fuel categories following the headings and sub-headings given in the Revised 1996 IPCC Guidelines;

(b) Making an effort to allocate the fuels used in navigation to domestic and international navigation in accordance with the IPCC good practice guidance;

(c) Reviewing and updating the properties of fossil fuels periodically.

21. According to the initial review report under the Kyoto Protocol published on 11 April 2008 (FCCC/IRR/2007/CAN), the status of Canada's national registry was not in accordance with the provisions of the modalities for the accounting of assigned amounts under Article 7, paragraph 4, of the Kyoto Protocol, and Canada had also not provided information on the national registry as required by the guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol. Consequently, the previous ERT raised a question of implementation with regard to Canada's national registry. The 2008 ERT noted, however, that the independent assessment report had concluded that Canada's registry had fulfilled sufficient obligations in terms of conformity with the Data Exchange Standards. The latter ERT also noted that the enforcement branch of the Compliance Committee under the Kyoto Protocol had taken, on 15 June 2008, the decision not to proceed further with the question of implementation mentioned above (CC-2008-1-6/Canada/EB).

22. According to the independent assessment report of the national registry of Canada published on 12 June 2008 [7], four limitations in the state of readiness of the registry had been identified:

(a) The Disaster Recovery Plan for Canada is still evolving and should be available when the registry moves into full production;

(b) Evidence of the Version Change Management procedure being executed is not available;

(c) The evidence provided of time management, as part of the Time Validation Plan, is limited and does not show time rectification actually being performed;

(d) Within the Change Management section of the Operational Plan ("Ops Plan"), the explanation of how operational changes to the registry environment are documented and controlled is limited, particularly in relation to communication of such changes to a third party, such as the international transaction log (ITL).

23. These limitations were to be rectified prior to the registry commencing live operations. During the centralized review, Canada provided the ERT with information on how the rectification of the limitations was progressing. The ERT recommends that Canada explain how these limitations have been rectified in the NIR of its next annual submission.

[7] see <http://unfccc.int/resource/docs/2008/iar/can01.pdf>.

G. Areas for further improvement

1. Identified by the Party

24. The 2008 NIR identifies several areas for improvement, including:

(a) Further development of the mandatory facility reporting programme in order to improve and expand the use of emission data from the industry;

(b) Continued implementation of the QA/QC plan, with a focus on performing more comprehensive assessments using category-specific QA, QC and verification;

(c) The development of a programme that will ensure Canada's ability to provide an uncertainty assessment on an annual basis;

(d) The development of an IPCC good practice guidance tier 2 key category analysis model based on the uncertainty analysis results;

(e) A review of the methodology and an update of the AD for the wood waste landfills of the Canadian saw mills and the pulp and paper industry.

2. Identified by the expert review team

25. The ERT identifies the following cross-cutting issues for improvement:

(a) The provision of more precise descriptions of methodologies that differ from those provided/recommended by the IPCC;

(b) The full implementation of the QA/QC plan;

(c) The development of formal and documented uncertainty estimates in all LULUCF categories;

(d) The provision of a more complete inventory by including all identified categories for which emissions occur in the country, such as emissions from the use of waste fuels in manufacturing industries and construction, and emissions from the field burning of agricultural residues.

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

II. Energy

A. Sector overview

27. The energy sector is the main sector in the GHG inventory of Canada. In 2006, the energy sector accounted for 583,099.57 Gg CO_2 eq, or 80.9 per cent of total GHG emissions. Since 1990, emissions in this sector have increased by 24.2 per cent. The key driver for this rise in emissions is stationary combustion in the energy industries. Within the sector, in 2006, 32.9 per cent of the emissions were from transport, followed by 31.7 per cent from energy industries and 12.9 per cent from other sectors. Oil and natural gas accounted for 11.3 per cent of emissions and manufacturing industries and construction accounted for 11.0 per cent. The remaining 0.1 per cent was from solid fuels.

28. In terms of the GHGs and categories covered, the CRF tables and the NIR are almost complete. Emissions for some minor categories have been reported as "NE". These include the use of waste as fuel in manufacturing industries and construction, the use of biodiesel in transport, CO_2 emissions from coal

mining and fugitive emissions from the distribution of oil products and from leakage in residential and commercial sectors. During the review, Canada confirmed its intention to include the use of waste as fuel and biodiesel in its reporting. Also, Canada plans to correct its reporting of the distribution of oil products to included elsewhere ("IE"), instead of "NE" as currently reported. In 2006, emissions from the use of ethanol in fuel mixtures were estimated and reported for the first time. The ERT commends the effort made by Canada to improve the completeness of its inventory.

29. Canada's decision to define fuel categories for the purposes of its GHG inventory on the basis of physical state is not in line with the Revised 1996 IPCC Guidelines. Canada's view is that fuels of the same physical state should be placed together as, firstly, this follows the gas, liquid or solid headings and, secondly, they have similar densities and heat contents and can therefore be analysed more conveniently and appropriately when grouped together. The ERT recommends that, for consistency with the Revised 1996 IPCC Guidelines, Canada report the fuel categories following the headings and sub-headings in Chapter 1.2, Vol. 1, which specify the liquid category as crude oil and petroleum products, the solid category as coal and coal products, and the gas category as natural gas.

30. Canada has provided recalculations of the 1990–2004 estimates for the energy sector in its 2008 submission. The ERT compared these recalculated estimates with those in the revised 2006 submission. Recalculations of the estimates in the 2004 inventory implied an overall decrease in estimated emissions by 1.7 per cent (from 614,728.48 Gg CO_2 eq to 604,264.55 Gg CO_2 eq). As a consequence, the emission trend over the period 1990–2004 was changed from an increase of 30.3 per cent to an increase of 28.7 per cent. The largest decrease in emissions, of 4.4 per cent (from 208,938.38 Gg CO_2 eq to 199,701.53 Gg CO_2 eq), was observed in energy industries. This change is due mainly to the decrease in CO_2 emissions associated with the application of a new methodology, and new EFs for fuels used in the bitumen-upgrading and the petroleum-refining industries. Decreases in emissions also occurred in manufacturing industries and construction, by 0.8 per cent (from 67,738.84 Gg CO_2 eq to 67,172.39 Gg CO_2 eq); in transport, by 0.2 per cent (from 188,824.09 Gg CO_2 eq to 188,352.97 Gg CO_2 eq), which was dominated by the decrease in N_2O emissions associated with a major revision of EFs; and in coal mining, by 33.4 per cent (from 990.22 Gg CO_2 eq to 659.26 Gg CO_2 eq), for which the figures were recalculated for 2002–2004 with the availability of AD from Statistics Canada.

31. Tier 1 and tier 2 uncertainty analyses were performed for all categories. Full coverage and a thorough discussion of the uncertainties associated with each GHG in each category are provided in the NIR.

32. Tier 1 QC checks were carried out for all categories and for specific models and studies used in the sector, such as the mobile greenhouse gas emission model and the upstream oil and gas industry study.

33. There are no major differences between the 2007 and the 2008 submission concerning the methods and the type and quality of AD used. The description in the NIR of methods and cross-cutting issues is also similar in both submissions. The 2007 submission contains an upgrade to a relational database of the model used to estimate emissions from stationary combustion. Historical AD and the set of EFs, including the underlying reasons for choosing them, were reviewed during the upgrading process, which was continued for the 2008 submission, accompanied by the continuous upgrading of the transportation model. CO_2 EFs for refined petroleum products and for coal and coal products for the period 1998–2006 differ in both submissions. The data set provided by Jaques (1992) was used in the 2007 submission, while that provided by McCann (2000) was used in the 2008 submission. CO_2 EFs for other fuels and non-CO_2 EFs used in both submissions were essentially the same (the update of CH_4 and N_2O EFs for road transport is discussed in para. 40 below).

B. Reference and sectoral approaches

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

34. The difference in the estimates for CO_2 emissions between the sectoral and reference approaches is 6.8 per cent for both 2005 and 2006. The main reasons for this discrepancy, as explained in the NIR, are that a significant amount of fossil fuel is used in Canada as feedstock for industrial processes and that CO_2 is emitted from flaring from oil and gas production. Canada provided adjusted estimates for the reference approach using energy consumption data corrected to exclude the non-energy use of fuels, which does not imply carbon stored but CO_2 emissions that are accounted for under the industrial processes sector. The difference in the estimated CO_2 emissions resulting from these adjusted estimates is –0.32 per cent for 2005 and –0.78 per cent for 2006. Previous reviews detected two errors in CRF table 1.A(b) concerning the value given for the carbon content of sub-bituminous coal used from 1990 to 1997 and the import data values used for several liquid fuels. The latter has been corrected, but the first error remains. The ERT recommends that Canada correct the value given for the carbon content of sub-bituminous coal used from 1990 to 1997 in CRF table 1.A(b) in its next submission.

2. International bunker fuels

35. The use of jet kerosene is reported by Statistics Canada (2008) for domestic airlines (73.6 per cent in 2006), foreign airlines (14.4 per cent), public administration (4.3 per cent) and commercial and other institutional (7.7 per cent). In accordance with the IPCC good practice guidance, the amount of fuel used by domestic airlines for international flights is estimated using a model that considers the tonne-kilometre AD reported by Canadian airlines for both domestic and international flights. The NIR indicates Canada's plans to develop an aviation model based on origin-destination data. The ERT welcomes these planned improvements and recommends their timely implementation.

36. AD for international navigation is taken as the value of fuels sold to foreign marine vessels as reported by Statistics Canada (2008). This allocation is done according to the flag of the vessel and is not in line with the IPCC good practice guidance, as some Canadian vessels are involved in international navigation. The ERT reiterates previous recommendations that Canada make an effort to allocate these fuels to domestic and international navigation in accordance with the IPCC good practice guidance.

3. Feedstocks and non-energy use of fuels

37. In the sectoral approach, the non-energy use of fuels is accounted for in the industrial processes sector in line with the IPCC good practice guidance. Emissions from the non-energy use of hydrocarbons are reported under other (industrial processes) and, except for ammonia production, are estimated using IPCC default values for the amount of carbon stored. Emissions from the use of fuels as reductants are estimated and reported under metal production. In iron and steel production, the use of natural gas, coal or coke as reductants is assumed as 100 per cent for metallurgical coke. In the NIR, it is indicated that Canada is planning to rectify this assumption and that it will try to identify the amounts of the different fuels used as reductants. Canada also plans to allocate emissions from the production of petroleum products under the chemical industry. The ERT welcomes these plans, as they would improve the accuracy and transparency of the inventory.

C. Key categories

1. Stationary combustion: liquid and gaseous fuels – CO_2

38. Except for petroleum coke and still gas, the carbon content and density of oil products and of marketable and non-marketable natural gas are based on the report by McCann (2000) that provides data measured in 1998. The ERT reiterates previous recommendations that Canada periodically review and update the properties of these fuels.

2. Stationary combustion: solid fuels – CO_2

39. EFs for coal for public electricity and heat production are reported for each Canadian province for the entire time series 1990–2006. They are based on the measured physical properties of samples of coal used by thermal power plants and a fuel combustion efficiency of 99.0 per cent. The 1990 EF is based on data from 1988 (Jaques, 1992). For the entire period 1998–2006 the same EF value has been used, which is based on measurements done in 1998 (McCann, 2000). A linear interpolation between the values from 1990 and 1998 has been used to estimate annual EFs for the period 1991–1997. In the NIR, it is reported that, in order to improve accuracy, Canada is planning a major review of the carbon content of coal used by thermal power plants for the entire time series. The ERT welcomes this project, which is in line with previous recommendations, and encourages its timely implementation.

3. Road transportation: CH_4 and N_2O

40. In its 2007 submission, Canada has used a new set of CH_4 and N_2O EFs for road transportation for the first time. These EFs were selected on the basis of a technical review (Gallant, 2006) which assessed what the most appropriate factors would be for the Canadian conditions. The ERT commends Canada on its implementation of previous recommendations from the 2003 and 2007 in-country reviews. However, in order to improve transparency, the ERT recommends that, in its next annual submission, Canada include a summary of the underlying reasons for selecting this new set of EFs, particularly explaining the choice of N_2O EFs for new and aged vehicles provided with catalytic converters.

D. Non-key categories

Fugitive emissions: oil and natural gas – CO_2

41. CO_2 storage occurring at the International Energy Agency (IEA) Weyburn-Midale monitoring and storage project is not specifically discussed in the NIR since the research project is still ongoing with a 2011 completion date. The NIR indicates that combustion and fugitive emissions including the fraction of CO_2 that is not collected and re-injected but instead released to the atmosphere from enhanced oil recovery (EOR) producing wells such as Weyburn is accounted for in the inventory. However, the Weyburn project is not a standard EOR process; rather an international undertaking aimed at investigating the storage of CO_2 in geological formations during large-scale EOR operations. To improve transparency, the ERT recommends that Canada provide more information in future NIRs, indicating how the methodology applied to estimate fugitive emissions from oil and gas covers EOR. The ERT notes that Canada intends to include in a future NIR a specific discussion on the IEA Weyburn-Midale CO_2 monitoring and storage project.

III. Industrial processes and solvent and other product use

A. Sector overview

42. In 2006, the industrial processes sector accounted for 54,439.56 Gg CO_2 eq, or 7.6 per cent of total GHG emissions, and the solvent and other product use sector accounted for 322.36 Gg CO_2 eq, or 0.04 per cent of total GHG emissions. Emissions in the industrial processes sector decreased by

0.7 per cent between 1990 and 2006, while in the solvent and other product use sector emissions increased by 84.3 per cent over that same period. Between 2005 and 2006, emissions in the industrial processes sector decreased by 0.7 per cent and emissions in the solvents and other product use sector increased by 80.1 per cent.

43. Canada has reported CO_2 emissions from asphalt roofing and road paving with asphalt, as well as those from solvent and other product use, as "NE". No explanation on asphalt roofing and road paving with asphalt is provided in the NIR, while the section concerning solvent and other product use considers only N_2O emissions. In response to questions from the ERT, Canada used information provided in some IPCC publications to explain its assumptions. For example, in Table 2-1 of the Revised IPCC 1996 Guidelines (Volume 3), CO_2 is not shown as a predominant GHG emitted from asphalt roofing and, according to recognized international scientific literature, "direct greenhouse gas emissions from asphalt roofing products are negligible compared to emissions such as non-methane volatile organic compounds (NMVOC), carbon monoxide (CO) and particulate matter (PM)". Emission estimates for the NMVOC, CO and PM can be found in Annex 14 of the NIR. This is in line with the current "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories" (hereinafter referred to as the UNFCCC reporting guidelines), which only request Parties to indicate whether indirect CO_2 emissions from the atmospheric oxidation of NMVOCs are included in the inventory or not, and do not require reporting on direct emissions.

44. The CO_2 emissions from glass production have also been reported as "NE", but should in fact be indicated as "IE", since CO_2 emissions from the use of limestone and soda ash in the glass production process are reported under limestone and dolomite use and soda ash production and use. For the category consumption of halocarbons and SF_6, actual and potential SF_6 emissions have been reported for the entire time series, but actual and potential emissions of HFCs and PFCs have only been reported for 1995 to 2006.

45. Canada estimates emissions in the industrial processes sector in accordance with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. Higher-tier methods are used for most key categories; however, data provided by production plants are often incomplete and lower-tier approaches with default IPCC EFs still have to be used for some plants. This corresponds, for some categories, to using a mixture of tier 1, tier 2 and tier 3 methods. The ERT encourages Canada to apply more consistently tier 2 approaches for cement production, lime production, iron and steel production and consumption of halocarbons and SF_6, by collecting plant-specific emission estimates, or developing plant or country-specific EFs.

46. Following a recommendation contained in the initial review report, in its 2008 submission Canada has improved the readability and transparency of the inventory for the industrial processes sector compared with the previous submission, by combining the information available in the NIR on each of the sub-categories into a single section. Canada has also started to review technical literature and to have discussions with relevant industries, in order to develop country-specific EFs for cement production, lime production and consumption of halocarbons and SF_6. Although only some preliminary findings have been included in the 2008 NIR, more complete results will be presented in future annual submissions.

B. Key categories

1. Cement production – CO_2

47. Canada uses the IPCC tier 2 approach and default EFs to estimate CO_2 emissions from cement production. A tier 2 QC check has shown that the availability of country-specific information for cement kiln dust (CKD) and the calcium oxide content of clinker would improve the estimates. Canada is

encouraged to validate recent assessments which show that the CKD factor may even be lower than the IPCC default value of 1.02, and to update these assessments with information obtained in more recent years.

2. Ammonia production – CO_2

48. Canada uses the methodology recommended by the Revised 1996 IPCC Guidelines and a country-specific EF to estimate CO_2 emissions from ammonia production. Since natural gas consumption for ammonia production is recorded as non-energy use of fuels and the relevant emissions are included in the inventory, CO_2 emissions from ammonia production are subtracted from the total CO_2 emissions of non-energy fossil fuel use, in order to avoid double counting. This is in line with the IPCC good practice guidance; however, the ERT encourages Canada to continue collecting natural gas consumption data from ammonia producers and to review the estimation of the EF with a view to detecting possible changes over time.

3. Iron and steel production – CO_2

49. Canada uses the tier 2 method reported in the IPCC good practice guidance to estimate CO_2 emissions from iron and steel production. Default IPCC values are used for the carbon content of the ore and of pig iron, and for the EF for carbon released by electric arc furnace electrodes. The GHG emissions associated with the use of reductants, other than metallurgical coke, are estimated in the category other (2.G) and reported undifferentiated from other sources. These methodologies are appropriate and in line with the IPCC good practice guidance. In order to improve the accuracy of the estimate for CO_2 emissions from iron and steel production, the ERT encourages Canada to develop country-specific values for the carbon content of the ore and of pig iron, and to report emissions from reducing agents other than coke under this category.

4. Aluminium production – CO_2 and PFCs

50. A mixture of tier 1, tier 2 and tier 3 methodologies has been used to estimate both CO_2 and PFC emissions from aluminium production, depending on data availability. Most EFs are drawn from the "Aluminium Sector Greenhouse Gas Protocol" published by the International Aluminium Institute. One plant relied on plant-specific information to estimate CO_2 emissions. The ERT recommends that Canada continue to review the available information in order to ensure the accuracy of the estimates.

5. Consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6

51. Canada has reported both actual and potential emissions of HFCs from 1995 onwards. The estimates of actual emissions are based on a modified tier 1 approach for 1995, owing to the lack of detailed data on HFCs, and on a tier 2a (bottom-up) approach for the years 1996–2006. With regard to AD, surveys were conducted for 1995, 1996–2000 and 2004 (with the addition of personal communications for the period 2004–2006). Gaps in the time series have been filled using the closest reported values. Leakage rates are based on the values provided by the Revised 1996 IPCC Guidelines. In order to improve the consistency of the time series, Canada is encouraged to replace missing activity values using linear interpolation, as recommended by the IPCC good practice guidance, rather than using the AD for one specific year. One of the recommendations made in the previous review was that Canada should use country-specific EFs for selected activities under this category. In response to a question raised by the ERT on the implementation of this recommendation, Canada explained that a request would be sent to importers, exporters and manufacturers of items containing HFCs to obtain information on EFs for major HFC applications, such as mobile air conditioning and refrigeration. Canada also explained that it would ask these respondents to comment on the applicability of the IPCC default EFs and to provide country-specific values. The ERT recommends that Canada follow up this survey and take into account its results in future submissions.

52. To estimate SF_6 emissions from electrical equipment, Canada assumes that all SF_6 purchased from gas distributors replaces SF_6 released into the atmosphere through leakage. This method, which corresponds to a modified tier 1 approach, may be acceptable for the time being, since neither manufacturing nor disposal of equipment take place in Canada, but will not be acceptable in the future when disposal of this equipment will take place. Since this is a key category, Canada is recommended to use a higher-tier method.

53. SF_6 (as well as PFC) emissions from semiconductor manufacturing have been estimated using a tier 2b method, with country-specific and IPCC default EFs. SF_6 consumption data have been provided by major Canadian gas suppliers and gaps in the time series have been filled using import data, or the closest reported values. In order to improve the consistency of the time series, Canada is encouraged to replace missing activity values using linear interpolation, rather than using the AD for one specific year, as recommended by the IPCC good practice guidance.

C. Non-key categories

Nitric acid production – N_2O

54. A mixture of tier 1, tier 2 and tier 3 methods, depending on data availability, has been used to estimate N_2O emissions from nitric acid production. In order to improve the completeness of the inventory and take into account possible changes in the performance of abatement systems, Canada is encouraged to provide more thorough information on these systems, including information on those systems possibly used for "dual pressure" plants.

IV. Agriculture

A. Sector overview

55. In 2006, the agriculture sector accounted for 61,842.95 Gg CO_2 eq, or 8.6 per cent of total GHG emissions. Emissions in the sector increased by 25.0 per cent between 1990 and 2006. The key drivers for this rise in emissions were the increases in the size of non-dairy cattle herds, in milk production and in the use of synthetic fertilizers.

56. Within the agriculture sector, 47.9 per cent of the emissions in 2006 were from agricultural soils, followed by 39.1 per cent from enteric fermentation and 13.0 per cent from manure management.

57. The inventory can be considered to be complete, as only the following minor categories have been reported as "NE": methane from anaerobic lagoons; emissions from the field burning of agricultural residues for cereals; and pulses and tubers. The following categories have also been reported as "NE": enteric fermentation (CH_4) from mules, asses and poultry; manure management (CH_4) from mules and asses; and direct and indirect CH_4 emissions from agricultural soils. However, the Revised 1996 IPCC Guidelines and IPCC good practice guidance do not provide any methods for estimating GHG emissions for these categories. In response to the request made by the ERT, Canada provided the ERT with background information on these categories and indicated that research is under way in order to collect historical and current information on the burning of agricultural residues so that these sources can be reported in the future. Prescribed burning of savannas and rice cultivation does not occur in Canada.

58. Some emission estimates have been recalculated as a result of new census data for animal populations, new live weight data for non-dairy cattle, revised animal manure N excretion rates and revised climate data. The recalculations had a relatively minor effect on the emission estimates and made little impact on the long-term trend.

B. Key categories

1. Enteric fermentation – CH_4

59. In accordance with the IPCC good practice guidance, Canada uses tier 2 methods for estimating emissions from dairy and non-dairy cattle and tier 1 methods for all other categories of livestock. Strong increases in milk production per animal caused an average increase of 15 per cent in the energy requirement of each cow, which was reflected in a 15 per cent increase in CH_4 emissions per animal between 1990 and 2006. Over the same period, increases in animal size led to an increase of 5.9 per cent in emissions per head of non-dairy cattle.

2. Manure management – N_2O

60. In accordance with the IPCC good practice guidance, Canada estimates N_2O emissions from manure management for other cattle, which is the most important sub-category, using a representation of livestock characteristics consistent with that used for enteric fermentation. However, such data have not been used to estimate emissions from dairy cattle. In particular, the time series of estimates of N excreted does not reflect the time series of the estimates of energy required used in the enteric fermentation calculations. During the review, Canada informed the ERT that a technical committee had been established to consider the methods used for this category. The ERT encourages Canada to pursue its review of these estimation methods and, in particular, to review the estimates of N excretion from dairy cattle used in the emission calculations. The ERT also encourages Canada to provide information on the results of the technical committee's reviews in the next or future NIRs.

3. Direct emissions from agricultural soils – N_2O

61. Canada utilizes a country-specific method to estimate direct emissions from agricultural soils. This method provides for variations in the EFs according to climate, topography and soil texture. In 2006, the implied emission factors (IEFs) for synthetic fertilizer use (0.0094 kg N_2O-N/kg N) and for the application of manure (0.011 kg N_2O-N/kg N) were, nonetheless, quite close to the IPCC default value (0.0125 kg N_2O-N/kg N). Over the 1990–2006 period, the IEFs for synthetic fertilizer use and manure application declined by 6.5 per cent and 7.1 per cent, respectively.

62. Canada also estimates the effect of changes in tillage practices on emissions, with opposing impacts modelled depending on the region. The average EF is adjusted according to the relative importance of direct seeding and reduced tillage management practice in each region. For eastern Canada, where soils are more moist, the average EF is increased by 10 per cent, while for the drier prairie soils the average EF is reduced by 20 per cent. The overall effect of including a variable representing tillage management practice into the emissions estimation procedure is that the level of emissions is lower than would otherwise be the case. This reduction in emissions increased by 1.75 Gg of N_2O between 1990 and 2006. An additional activity is also included in the estimation procedure which allows for the estimation of emissions from fields under summer fallow, where it is assumed that one hectare of field under summer fallow will generate the same amount of emissions as one hectare of field under summer cropping, and this is then adjusted by an estimate of background emissions. The area of field under summer fallow dropped by 54.9 per cent between 1990 and 2006. Given that this source of emissions is not identified in the IPCC good practice guidance, the ERT recommends that Canada include additional information that provides the empirical basis for the estimation of these emissions in the NIR of its next annual submission.

63. The model used to estimate emissions in this category is described in a research paper that has not yet been published. The ERT encourages Canada to improve the documentation of its methods by ensuring publication of the relevant research and providing this information in the NIR of its next annual submission. Canada should ensure that the methods are reviewed in accordance with good practice

QA/QC procedures. In addition, given the innovative nature of two of the categories, the ERT believes it is important for Canada to ensure that the sources of data required to support these methods are maintained in the future.

4. Indirect emissions from agricultural soils – N_2O

64. The IPCC tier 1 methodology has been used to calculate indirect emissions from agricultural soils from atmospheric deposition. A modified tier 1 method has been used to estimate emissions from leaching, in which the fraction of N leached is assumed to depend on climatic conditions. Indirect emissions increased by 19.3 per cent between 1990 and 2006.

C. Non-key categories

Manure management – CH_4

65. Canada estimates CH_4 emissions from manure management using a representation of livestock characteristics consistent with that used for enteric fermentation, in accordance with the IPCC good practice guidance. Consequently, consistent with the trends in emissions from enteric fermentation, estimated CH_4 emissions from manure management rose by 24.9 per cent between 1990 and 2006.

V. Land use, land-use change and forestry

A. Sector overview

66. In 2006, the LULUCF sector in Canada was a net source of 31,342.17 Gg CO_2 eq, increasing national net emissions by about 4.3 per cent between 1990 and 2006. GHG net emissions by sources and removals by sinks in the LULUCF sector displayed high inter-annual variability and GHG net emissions by sources and removals by sinks in the LULUCF sector shifted between being a net sink and a net source throughout the time series. The key driver for this high variability is associated with the immediate impact of forest wildfires.

67. Within the LULUCF sector, forest land remaining forest land was the dominant land category, contributing 23,794.67 Gg CO_2 eq of net emissions, followed by land converted to cropland (8,155.02 Gg CO_2 eq) and land converted to settlement (8,055.39 Gg CO_2 eq).

68. Except for emissions from grassland and other land, which have been reported as "NE" or not occurring, CO_2 emissions/removals from living biomass, soil (mineral and organic) and dead organic matter for all categories, CO_2 emissions from agricultural liming, N_2O emissions from disturbance associated with land-use conversion to cropland, as well as N_2O and CH_4 emissions from wildfire and control burning, have been estimated and reported. Concerning the categories land-use conversion from cropland, and wetlands and other land converted to settlements, which have been reported as "NE", Canada provided the ERT with additional information during the review and indicated that research programmes and efforts are under way with a view to improving current knowledge on these categories.

69. The ERT notes that Canada is continuing with its multi-year effort to substantially improve its estimates for the LULUCF sector, within the framework of the monitoring, accounting and reporting system (MARS) for LULUCF. IPCC tier 2 and 3 methods and country-specific parameters have been applied when preparing the estimates for the LULUCF sector. For example, CO_2 emissions and removals for forest land were estimated on the basis of a carbon budget model CBM-CFS3, while the CENTURY model was used to derive factors for CO_2 emissions and removals from cropland. The ERT also notes that work within MARS for LULUCF is expected to continue for several years to come.

70. On the whole, the uncertainty analysis has been improved, although uncertainties for forest land and wetlands were not assessed. Tier 1 and tier 2 QA/QC procedures have been implemented for the

land-use categories and emissions by sources or removals by sinks reported. The ERT notes that, in terms of planned improvements, improving the uncertainty analysis is one of Canada's priorities.

71. There is a significant difference between the 2007 and 2008 submissions, mainly in forest land remaining forest land, owing to the improvement of AD and EFs. Corrections and improvements made to AD, for example, included revisions in the area of managed forests and expanded coverage of deforestation samples. The enhanced harmonization of multi-source data also led to corrections, as well as updates to and the recalibration of estimation parameters.

B. Key categories

1. Forest land remaining forest land – CO_2, CH_4 and N_2O

72. Canada applies a tier 3 method (carbon budget model CBM-CFS3) to estimate GHG emissions and removals for forest land remaining forest land. The carbon budget model (CBM) is a semi-empirical model, with forest inventory and disturbance data as the empirical inputs and modelled values of dead organic matter decay. It generates estimates of tree growth, litter fall, tree mortality, emissions from decomposition and immediate emissions from forest conversion. EFs and parameters are country-specific and model-derived. AD come from multiple national sources, disaggregated into 18 ecological zones.

73. The ERT notes that not all Canadian forests are under the direct influence of human activities and can therefore be considered as managed forests. For the purpose of the GHG inventory, managed forests are defined as those which are potentially subject to harvesting or to measures of fire protection, which is consistent with the IPCC good practice guidance for LULUCF. The ERT notes that, although the identification of land use has been improving over time, it has not been adequately and transparently documented in the NIR, particularly in terms of identification procedures (e.g. decision trees), changes made in the current submission owing to improved methods, and previous errors identified and the corrections made. The ERT recommends that Canada improve its documentation concerning the identification of managed forests in its future submissions.

2. Land converted to cropland – CO_2

74. In 2008, land converted to cropland amounted to a net source of 7,874.29 Gg CO_2, mainly from forest land converted to cropland. CO_2 emissions/removals for land-use conversion from wetlands and for settlements converted to cropland have been reported as "NE". A tier 2 method was applied for the estimation of CO_2 emissions from forest land converted to cropland and grassland converted to cropland. No loss of soil organic carbon was assumed for forest land converted to cropland in western Canada; however, net gain of soil organic carbon was used for the opposite conversion of cropland converted to forest land. In response to the request made by the ERT for clarification, Canada explained that the limited data in western Canada suggest that, on average, the long-term effect on soil carbon is close to neutral. Most converted forest land in western Canada is marginal for agriculture and is used for pasture and forage, which reduces the potential for loss of soil carbon. Canada reports the conversion of cropland to intensively managed plantation forests only; ecosystems in such forests are very different from those in natural forests. This intensive management results in enhanced rates of carbon uptake and translocation to soils. The ERT recommends that Canada reconsider this issue and provide adequate and transparent documentation in the NIR of its next annual submission.

3. Land converted to wetlands – CO_2

75. In 2006, land converted to wetlands was a net source of 850.52 Gg CO_2, mainly from forest land converted to wetland. A tier 2 method and country-specific EFs have been used to estimate CO_2 emissions/removals owing to peat extraction and flooding. Emissions from cropland converted to

wetlands and grassland converted to wetlands have not been estimated. The ERT recommends that Canada estimate emissions for these two land-use conversions in its future submissions.

4. Settlements – CO_2

76. In 2006, settlements were a net source of 7,743.74 Gg CO_2, 86.9 per cent of which was from forest land converted to settlements. A tier 2 method and country-specific EFs have been used to estimate CO_2 emissions/removals for land converted to settlements. Data sets from global information systems (GIS), the Land-Use Change Mapping System for Canada's North, as well as satellite images, were used to detect land-use conversion. EFs are derived from above-ground biomass maps prepared using above-ground biomass data and remote-sensing data, and they are cross-checked with ground measurements. Emissions from cropland converted to settlements and other land converted to settlements have not been estimated, although in the NIR it is indicated that the conversion of cropland to settlements is known to occur. The ERT recommends that Canada estimate emissions for these two land-use conversions in its future submissions.

C. Non-key categories

Biomass burning – CH_4 and N_2O

77. CH_4 and N_2O emissions from wildfire for grassland remaining grassland have been reported as "NE". Given that grassland is extensively managed, as described in the NIR, and GHG emissions from wildfires may occur even if no net carbon gain or loss occurs, the ERT recommends that Canada include the estimates of CH_4 and N_2O emissions from managed grassland wildfire in its future submissions.

VI. Waste

A. Sector overview

78. In 2006, the waste sector accounted for 20,927.30 Gg CO_2 eq, or 2.9 per cent of total GHG emissions. Solid waste disposal on land was the largest category, accounting for 94.4 per cent of the GHG emissions in this sector, while wastewater handling and waste incineration accounted for 4.4 per cent and 1.2 per cent of emissions, respectively.

79. Over the period 1990–2006, GHG emissions in the waste sector increased by 15.2 per cent, relative to a 21.7 per cent increase in total national GHG emissions. Solid waste disposal on land and wastewater handling exhibited increases in emissions by 16.3 per cent and 19.1 per cent, respectively, while emissions from waste incineration decreased by 39.4 per cent over the same period. An increasing trend in GHG emissions is less significant in this sector than in terms of the national total, owing to a decrease in the per capita generation rate of solid waste and a steady increase in the recovery rate of CH_4 from landfills.

80. In the 2008 NIR, GHG emissions in the waste sector show a decrease of more than 20 per cent in the period 1990–2005 as compared with those reported in the 2007 NIR. Solid waste disposal on land is mainly responsible for this decrease. In line with the IPCC good practice guidance, Canada has adopted a degradable organic carbon (DOC) value of 0.6 in the 2008 NIR, which is lower than the value of 0.77 adopted in the 2007 NIR.

B. Key categories

1. Solid waste disposal on land – CH_4

81. Canada applied the IPCC tier 2 methodology with country-specific CH_4 generation potential (L_0) and methane generation constant (k). Two noticeable issues were identified in this category. Firstly,

Canada used a constant value for DOC over the period 1990–2006, which was derived from the waste composition results of a one-year survey carried out in 2002. Secondly, Canada assumed no emissions from construction and demolition landfills, which may actually contain a relatively high fraction of organic wastes, such as waste wood. The ERT recommends that Canada check the possibility of CH_4 being emitted from construction and demolition landfills. The ERT, while recognizing the difficulties for the central inventory agency to obtain current DOC values on a regular basis and over short intervals, encourages Canada to pursue arrangements which would see these updates made at more reasonable time intervals.

2. Wastewater handling – N_2O

82. Canada used the IPCC default method to estimate N_2O emissions from human sewage, using data for per capita protein intake obtained from Canadian statistics publications. Emissions occurring during the processes of industrial wastewater treatment have not been reported. The ERT recommends Canada make efforts to estimate and report emissions generated during the industrial wastewater treatment processes.

3. Waste incineration – CO_2

83. Canada estimated the GHG emissions for this category in accordance with the IPCC good practice guidance. The ERT noted that the NIR and the CRF tables did not distinguish between CO_2 emissions from incinerators with and without energy recovery. The ERT recommends that Canada separate these CO_2 emissions and allocate the emissions with energy recovery to the energy sector, as already noted by the previous ERT.

C. Non-key categories

Wastewater handling – CH_4

84. Canada applied a country-specific EF (4.015 kg CH_4/person/day) to estimate CH_4 emissions from domestic and commercial wastewater handling. Canada assumed two key parameter values (CH_4 generation rate from the anaerobic decomposition of organic matter in wastewater and daily per capita biochemical oxygen demand (BOD) loading). CH_4 emissions from industrial wastewater handling have been reported as "NE". The ERT encourages Canada to review the most recent data and methods in order to verify the suitability of the parameter values and to reflect this review in its next annual submission. The ERT also recommends that Canada estimate and report CH_4 emissions from industrial wastewater handling in its next annual submission.

VII. Other issues

1. Changes to the national system

85. Canada has not reported on any changes to its national system in either the 2007 or the 2008 submission. In response to questions raised by the ERT during the review, Canada confirmed that no changes to the national system have taken place.

2. Changes to the national registry

86. Canada has reported on changes to its national registry in the 2008 submission. These changes include entering into a contract with Perrin Quarles Associates to establish the national registry on 14 February 2008 and successfully completing virtual private network connectivity testing on 23 January 2008. The ERT considers these changes to be broadly in accordance with the requirements of national registries as defined in decision 13/CMP.1. However, at the time of the centralized review, the national registry of Canada was not yet in operation. Relevant information and the recommendations of

the ERT are provided in paragraphs 11, 21 and 22 above. Canada needs to improve its national registry following these recommendations and report on these improvements in its next annual submission under the Kyoto Protocol.

3. Commitment period reserve

87. Canada has not reported its commitment period reserve (CPR) in the 2008 submission. In response to questions raised by the ERT during the review, Canada reported its CPR to be 2,512,613,494 t CO_2 eq based on the assigned amount specified in the initial review report (FCCC/IRR/2007/CAN). The ERT agrees with this figure. Canada stated that it would include information on its CPR in its future annual submissions.

VIII. Conclusions and recommendations

88. Canada has submitted a GHG inventory that is generally complete in terms of the years, sectors and gases covered. Canada has also submitted an NIR based on the structure set out in the UNFCCC reporting guidelines and CRF tables for the entire time series 1990–2006. The ERT noted that Canada's inventory has been improved in the 2008 annual submission by the implementation of the QA/QC plan, inclusion of a description of fugitive emissions from the non-conventional oil extraction industry, the revision of estimation parameters for the waste sector, and the revision of LULUCF estimates based on new AD and estimation parameters. However, the ERT concluded that the completeness of the inventory could be further improved by reporting emission estimates for activities that are known to occur in Canada, but for which emissions have not yet been estimated.

89. In general terms, with regard to its completeness, consistency and comparability, the 2008 submission conforms with the UNFCCC reporting guidelines. Its transparency could be improved by describing the data and methods used to calculate GHG emissions more thoroughly in the NIR.

90. The ERT has identified some areas for improvement; these include:

(a) Providing, in the NIR, more precise descriptions of methodologies that differ from those provided/recommended by the IPCC;

(b) Improving and implementing the plan to update the uncertainty analysis on an annual basis;

(c) Developing formal and documented uncertainty estimates in all LULUCF categories;

(d) Establishing definitions for its fuel categories following the headings and sub-headings provided in the Revised 1996 IPCC guidelines;

(e) Reviewing and periodically updating the properties of fossil fuels;

(f) Applying the results of reviews on inconsistent data of N excretion from dairy cattle;

(g) Improving the documentation concerning the identification of managed forests;

(h) Reconsidering and documenting the issue related to CO_2 emissions/removal for land converted to cropland;

(i) Checking for the possibility of CH_4 emissions from construction and demolition landfills;

(j) Estimating N_2O emission from industrial wastewater handling;

(k) Providing a more complete inventory by including all identified categories for which emissions occur in the country, such as emissions from the use of waste fuels in manufacturing industries and construction, and emissions from the field burning of agricultural residues.

91. The ERT recommends that Canada report annually, in the NIR, the calculation of the CPR. The ERT also recommends that Canada provide complete and detailed information on its national registry and the results of the technical assessment of the national registry in its next inventory submission under the Kyoto Protocol.

IX. Questions of implementation

92. No questions of implementation were identified by the ERT during the review.

Annex

Documents and information used during the review

A. Reference documents

Intergovernmental Panel on Climate Change. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gp/english/>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

"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/SBSTA/2006/9. Available at <http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf>.

"Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention". FCCC/CP/2002/8. Available at <http://unfccc.int/resource/docs/cop8/08.pdf>.

"Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol". Decision 19/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=14>.

"Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol". Decision 15/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=54>.

"Guidelines for review under Article 8 of the Kyoto Protocol". Decision 22/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=51>.

Status report for Canada 2007. FCCC/ASR/2007/CAN. Available at <http://unfccc.int/resource/docs/2007/asr/can.pdf>.

Status report for Canada 2008. FCCC/ASR/2008/CAN. Available at <http://unfccc.int/resource/docs/2008/asr/can.pdf>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2007. Available at <http://unfccc.int/resource/webdocs/sai_2007.pdf>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2008. Available at <http://unfccc.int/resource/webdocs/sai_2008.pdf>.

FCCC/ARR/2006/CAN. Report of the individual review of the greenhouse gas inventory of Canada submitted in 2006. Available at <http://unfccc.int/resource/docs/2008/arr/can.pdf>.

FCCC/IRR/2007/CAN. Report of the review of the initial report of Canada. Available at <http://unfccc.int/resource/docs/2008/irr/can.pdf>.

B. Additional information provided by the Party

Responses to questions during the review were received from Ms. Nicole Folliet (Environment Canada), including additional material on the methodology and assumptions used. The following documents were also provided by Canada:

American Society of Agricultural Engineers. 2003. *Manure Production and Characteristics*. ASAE D384.1.

Gallant R. 2006. *Nitrous Oxide and Methane Emission Factor Review for On-Highway Vehicles*. (draft). Ottawa: Environment Canada.

Jaques AP. 1992. *Canada's Greenhouse Gas Emission Estimates for 1990*. Report EPS 5/AP/4, ISBN 0-662-20187-6. Ottawa: Environment Canada.

McCann TJ. 2000. *1998 Fossil Fuel and Derivative Factors: CO_2 per Unit of Fuel, Heating Values*. Prepared for Pollution Data Branch, Environment Canada. T. J. McCann and Associates Ltd, Clearstone Engineering Ltd.

Rochette P, Worth DE, Lemke RL, McConkey BG, Pennock DJ, Wagner-Riddle C and Desjardins RL. *Estimation of N_2O Emissions from Agricultural Soils in Canada.* (unpublished).

Statistics Canada. 2008. *Report on Energy Supply-demand in Canada 2006*. Catalogue no. 57-003-X, ISSN 1708-1580. Ottawa.

Wilson M and Monea M (eds). 2004. IEA GHG Weyburn CO_2 Monitoring and Storage Project Summary Report 2000–2004. *In*: *Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies*. Vancouver. p.273.

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