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Report of the individual review of the inventory submission of Canada submitted in 2013*

* In the symbol for this document, 2013 refers to the year in which the inventory was submitted, and not to the year of publication.

Contents

I. Introduction and summary

1. This report covers the review of the 2013 inventory submission of Canada, coordinated by the UNFCCC secretariat, in accordance with decision 19/CP.8. The review took place from 23 to 28 September 2013 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Mr. Paul Filliger (Switzerland) and Mr. Tomas Gustafsson (Sweden); energy – Ms. Kristien Aernouts (Belgium), Mr. Alexey Cherednichenko (Kazakhstan), Mr. Christo Christov (Bulgaria) and Ms. Lea Kai (Lebanon); industrial processes and solvent and other product use – Mr. David Kuntze (Germany) and Mr. Jacek Skoskiewicz (Poland); agriculture – Mr. Daniel Bretscher (Switzerland), Mr. Nguyen Mong Cuong (Viet Nam) and Mr. Tom Wirth (United States of America); land use, land-use change and forestry (LULUCF) – Mr. Agustin Inthamoussu (Uruguay) and Ms. Sekai Ngarize (United Kingdom of Great Britain and Northern Ireland); and waste – Ms. Juliana Bempah (Ghana) and Ms. Kaatje Jespers (Belgium). Ms. Bempah and Mr. Gustafsson were the lead reviewers. The review was coordinated by Mr. Tomoyuki Aizawa (UNFCCC secretariat).

2. In accordance with the "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention" (hereinafter referred to as the UNFCCC review guidelines), 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. All encouragements and recommendations in this report are for the next inventory submission, unless otherwise specified. The expert review team (ERT) notes that the 2012 annual review report (ARR) of Canada was published after the submission of the 2013 inventory submission.

3. In 2011, the main greenhouse gas (GHG) in Canada was carbon dioxide (CO_2), accounting for 79.2 per cent of total GHG emissions[1] expressed in CO_2 equivalent (CO_2 eq), followed by methane (CH_4) (12.9 per cent) and nitrous oxide (N_2O) (6.6 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 1.3 per cent of the overall GHG emissions in the country. The energy sector accounted for 81.4 per cent of total GHG emissions, followed by the industrial processes sector (7.7 per cent), the agriculture sector (7.7 per cent), the waste sector (3.1 per cent) and the solvent and other product use sector (0.04 per cent). Total GHG emissions amounted to 701,791.22 Gg CO_2 eq and increased by 18.7 per cent between the base year and 2011. The ERT concludes that the description in the national inventory report (NIR) of the trends for the different gases and sectors is reasonable.

4. Tables 1 and 2 show GHG emissions under the Convention, by gas and by sector, respectively. In table 1, CO_2, CH_4 and N_2O emissions do not include emissions and removals from the LULUCF sector.

5. Additional background data on recalculations by Canada in the 2013 inventory submission can be found in annex I to this report.

[1] 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.

Table 1
Greenhouse gas emissions by gas, 1990 to 2011

	Gg CO_2 eq								*(%)*
Greenhouse gas	*1990*	*1995*	*2000*	*2005*	*2008*	*2009*	*2010*	*2011*	*Change 1990–2011*
CO_2	459 313.03	491 116.15	564 642.46	578 955.01	576 528.04	542 049.92	554 019.16	555 613.97	21.0
CH_4	72 002.96	85 909.47	94 025.84	98 087.81	94 098.57	90 943.19	90 400.78	90 562.54	25.8
N_2O	49 065.08	53 749.55	48 613.73	50 308.15	51 802.20	47 165.70	47 287.06	46 221.70	–5.8
HFCs	767.25	479.41	2 936.12	5 296.47	5 550.65	6 306.34	7 072.55	7 526.83	881.0
PFCs	6 538.83	5 489.59	4 311.08	3 317.26	2 252.32	2 171.97	1 607.49	1 450.89	–77.8
SF_6	3 392.20	2 395.56	3 051.86	1 492.14	683.95	393.06	462.24	415.29	–87.8

Table 2
Greenhouse gas emissions by sector, 1990 to 2011

	Gg CO_2 eq								*(%)*
Sector	*1990*	*1995*	*2000*	*2005*	*2008*	*2009*	*2010*	*2011*	*Change 1990–2011*
Energy	469 186.20	508 788.47	589 473.78	597 336.61	592 195.74	560 441.65	570 137.09	571 601.41	21.8
Industrial processes	55 978.49	57 472.54	52 054.26	60 461.41	58 545.80	50 805.78	53 262.13	54 271.29	–3.0
Solvent and other product use	178.71	212.58	449.60	378.00	341.62	260.49	241.97	247.40	38.4
Agriculture	46 728.50	52 669.69	55 650.44	58 122.92	58 602.62	56 134.71	55 612.85	53 924.99	15.4
LULUCF	–61 628.06	193 807.01	–52 192.87	62 685.50	–11 062.19	–9 842.34	103 194.97	87 267.07	–241.6
Waste	19 007.45	19 996.44	19 953.02	21 157.90	21 229.94	21 387.55	21 595.25	21 746.13	14.4
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	529 451.29	832 946.73	665 388.23	800 142.33	719 853.55	679 187.83	804 044.25	789 058.29	49.0
Total (without LULUCF)	591 079.35	639 139.72	717 581.11	737 456.83	730 915.73	689 030.17	700 849.29	701 791.22	18.7

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

II. Technical assessment of the inventory submission

A. Overview

1. Inventory submission and other sources of information

6. The 2013 inventory submission was submitted on 15 April 2013; it contains a complete set of common reporting format (CRF) tables for the period 1990–2011 and an NIR. The inventory submission was submitted in accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories" (hereinafter referred to as the UNFCCC reporting guidelines).

7. The full list of materials used during the review is provided in annex II to this report.

2. Overall assessment of the inventory

8. Table 3 contains the ERT's overall assessment of the inventory submission of Canada. For recommendations for improvements related to cross-cutting issues for specific categories, please see the paragraphs cross-referenced in the table.

Table 3
The expert review team's overall assessment of the inventory submission

		General findings and recommendations (category-specific recommendations are cross-referenced)
The expert review team's (ERT's) findings on completeness of the 2013 inventory submission		
Non-land use, land-use change and forestry[a]	Complete	Mandatory: None
		Non-mandatory: CO_2 emissions from coal mining and handling, CO_2, CH_4 and N_2O emissions from solid fuel transformation, CO_2 emissions from natural gas–other leakage, CH_4 and N_2O emissions from ammonia production, CO_2 emissions from adipic acid production, CH_4 emissions from ferroalloys production, CH_4 emissions from aluminium production, potential PFC emissions from aerosols and metered dose inhalers, CH_4 and N_2O emissions from other (industrial processes), potential SF_6 emissions from import, export and destruction, CH_4 emissions from other livestock (manure management), CH_4 emissions from direct soil emissions, CH_4 emissions from indirect soil emissions, CO_2 emissions from solid waste disposal on land, N_2O emissions from industrial wastewater, CH_4 emissions from municipal waste burning.

Land use, land-use change and forestry[a]	Not complete	Mandatory: Carbon stock changes for grassland remaining grassland (in living biomass, and in soils); carbon stock changes for cropland converted to wetlands, grassland converted to wetlands, other land converted to wetlands (in living biomass, and in soils); carbon stock changes for cropland converted to settlements, wetland converted to settlements, and other land converted to settlements (in living biomass); carbon stock changes for grassland converted to other land, and wetland converted to other land (in living biomass, and in soils); and N_2O emissions from disturbance associated with land-use conversion to cropland for wetland converted to cropland.
		Non-mandatory: Carbon stock changes for grassland remaining grassland (in dead organic matter); carbon stock changes for cropland converted to wetlands, grassland converted to wetlands, other land converted to wetlands (in dead organic matter); carbon stock changes for cropland converted to settlements, wetland converted to settlements, and other land converted to settlements (in dead organic matter, and in soils); carbon stock changes for grassland converted to other land, and wetland converted to other land (in dead organic matter).
The ERT's findings on recalculations and time-series consistency in the 2013 inventory submission	Generally consistent	See paragraph 19
The ERT's findings on verification and quality assurance/quality control procedures in the 2013 inventory submission	Sufficient	See paragraphs 10, 11 and 25
The ERT's findings on the transparency of the 2013 inventory submission	Generally transparent	See paragraphs 23, 25, 28, 30, 34, 35, 40, 41, 42, 47, 49, 64, 67, 71, 74, 75, 76 and 80

[a] The assessment of completeness by the ERT considers only the completeness of reporting of mandatory categories (i.e. categories for which methods and default emission factors are provided in the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, or the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*).

9. In the previous review report, it was recommended that Canada improve the completeness of its reporting of CH_4 emissions from sludge of industrial wastewater and

sludge of domestic and commercial wastewater (in response to questions raised by the ERT during the previous review Canada had indicated that these emissions should be reported as "NO" (not occurring) as opposed to "NE" (not estimated)), and the information on land area and all carbon pools for wetlands and settlements converted to cropland, grassland remaining grassland, and grassland and cropland converted to wetlands. The ERT noted that the 2013 inventory submission did not contain any improvement based on these recommendations. Therefore, the ERT reiterates the recommendation made in the previous review report that Canada improve the completeness of its reporting on mandatory categories for the LULUCF and recommends that Canada improve the consistency between the CRF and NIR regarding the waste sectors in line with the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), the 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).

10. In the previous review report, the ERT recommended that Canada improve the quality control (QC) procedures to avoid inconsistencies in the information reported in different CRF tables and between the NIR and the CRF tables. The ERT noted that there are still discrepancies between the CRF tables and the NIR (e.g. CH_4 emissions from industrial wastewater sludge are reported as "NE" in the CRF tables but as "NO" in the NIR) (see para. 76 below). In response to a question raised by the ERT during the review, Canada provided information that it has implemented checks to ensure that the information presented in the CRF tables and in the NIR is consistent and that information across the CRF tables is consistent, for example, that common activity data (AD) for organic soil is reported consistently between the LULUCF and agriculture sectors. The ERT commends Canada for its continuous efforts to improve the quality assurance (QA)/QC system and reiterates the recommendation made in the previous review report that Canada further strengthen its QC procedures at the final stage of the inventory preparation to avoid inconsistencies between the CRF tables and the NIR.

11. In the 2013 NIR (page 38), Canada explained that internal and external review processes are carried out during February and March, prior to the submission to the UNFCCC secretariat. The NIR also states that comments from these reviews are documented and, where appropriate, incorporated in the inventory. The ERT commends Canada for its efforts. However, the ERT noticed that the Canadian NIR does not describe what changes are made due to these internal and external reviews and encourages Canada to improve the transparency of the NIR by including a summary of the results of those review processes.

3. Description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

Inventory planning

12. The NIR and additional information provided by the Party during the review described the institutional arrangements for the preparation of the inventory. The Pollutant Inventories and Reporting Division of Environment Canada has overall responsibility for the national inventory, on the basis of the Canadian Environmental Protection Act. The responsibilities of the Division are: inventory planning and prioritization; GHG emission estimation and analysis; NIR preparation; QA/QC and verification; and archiving. Environment Canada also collaborates with provincial and territorial governments.

13. Other organizations are also involved in the preparation of the inventory as data providers. Statistics Canada provides AD for the inventory, such as the energy balance, information on mining and electricity, data on urea and ammonia production and data on crop production and agricultural management practices.

14. Agriculture and Agri-Food Canada and the Canadian Forest Service of Natural Resources Canada are responsible for the development of key components of the LULUCF inventory, on the basis of a formal governance mechanism through a memorandum of understanding. In addition, Natural Resources Canada provides AD on mineral production, ethanol consumption and wood residues, as well as energy-related expertise and analysis. Transport Canada and Natural Resources Canada provide data on road vehicle fuel efficiency.

15. In accordance with a bilateral agreement with the Aluminium Association of Canada, estimates of CO_2, PFC and SF_6 emissions are provided annually to Environment Canada.

Inventory preparation

16. Table 4 contains the ERT's assessment of Canada's inventory preparation process. For improvements related to specific categories, please see the paragraphs cross-referenced in the table.

Table 4
Assessment of inventory preparation by Canada

		General findings and recommendations
Key category analysis		
Was the key category analysis 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)?	Yes	
Approach followed?	Tier 1	
Were additional key categories identified using a qualitative approach?	No	
Does the Party use the key category analysis to prioritize inventory improvements?	Yes	
Are there any changes to the key category analysis in the latest submission?	Yes	Two new key categories for trend: Emissions of SF_6 from magnesium production CO_2 emissions from land converted to settlements
Assessment of uncertainty analysis		
Approach followed?	Both tier 1	

		General findings and recommendations
	and tier 2	
Was the uncertainty analysis carried out consistent with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF?	No	No trend analyses including LULUCF See paragraph 17
Quantitative uncertainty (including LULUCF)	Level = 14.7%	
	Not reported	
Quantitative uncertainty (excluding LULUCF)	Level = 4.0%	
	Trend = 0.9%	

Abbreviation: *LULUCF = land use, land-use change and forestry.*

17. Canada has estimated uncertainties using the tier 1 level and trend assessment for the entire inventory and using a tier 2 method for specific categories. Canada has included the LULUCF sector in the uncertainty analysis but has not reported trend uncertainties, including LULUCF. In response to a question raised by the ERT during the review, Canada explained that trend uncertainties including LULUCF are not reported due to the high annual variability in the emissions and removals from the LULUCF sector, which is primarily driven by natural factors. Because of this, the Party explained that it has currently no plans to report trend uncertainties including LULUCF in future inventory submissions.

18. The ERT was informed that year to year variations in Canada's LULUCF estimates primarily reflect the effect of natural disturbances (fires) in managed forests and therefore Canada does not present trend uncertainties including LULUCF as part of the analysis for anthropogenic GHG emissions and removals trends uncertainties. However, the ERT reiterates the recommendation made in the previous review report that Canada carry out and report the results of a trend uncertainty analysis, including LULUCF.

Inventory management

19. Canada has a centralized archiving system, which includes the archiving of disaggregated emission factors (EFs) and AD, and documentation on how these factors and data have been generated and aggregated for the preparation of the inventory. The archived information also includes internal documentation on QA/QC procedures, external and internal reviews, and documentation on annual key categories and key category identification and planned inventory improvements. The Pollutant Inventories and Reporting Division of Environment Canada maintain the archive. During the review, the ERT was provided with the requested additional archived information.

4. Follow-up to previous reviews

20. Canada has reported recalculations and planned improvements in its NIR (section 9). The ERT noted that only one recalculation (CH_4 and N_2O emissions from other (manufacturing industries and construction (cement))) has been carried out in response to recommendations made in previous review reports. The ERT encourages Canada to include all recalculations made in response to recommendations made in the previous review reports in the NIR. The ERT noted a number of improvements made by Canada following recommendations made in the previous review report, including:

(a) Changes the categorization of fuels in accordance with the Revised 1996 IPCC guidelines (para. 23);

(b) Correcting CRF table 1.A.(d) maintaining consistency with the NIR (see para. 25);

(c) Extending part 2 of the NIR regarding the methodology for waste incineration, including composition of incinerated municipal solid waste (MSW), which is now better described (see para. 68).

5. Areas for further improvement identified by the expert review team

21. During the review, the ERT identified a number of areas for improvement, including some related to specific categories. These are listed in the relevant chapters of this report and in table 7.

B. Energy

1. Sector overview

22. The energy sector is the main sector in the GHG inventory of Canada. In 2011, emissions from the energy sector amounted to 571,601.41 Gg CO_2 eq, or 81.4 per cent of total GHG emissions. Since 1990, emissions have increased by 21.8 per cent. The key drivers for the rise in emissions are road transportation and manufacturing industries and construction. Within the sector, 34.7 per cent of the emissions were from transport, followed by 27.1 per cent from energy industries, 14.1 per cent from manufacturing industries and construction, 13.6 per cent from other sectors and 10.4 per cent from fugitive emissions from fuels. The remaining 0.01 per cent was emissions from the category other (fuel combustion).

23. Following the recommendation made in the previous review report, the Party has made changes in the categorization of fuels. Previously, Canada took into consideration the physical state of the fuel at the time of use. In the 2013 inventory submission, most fuels are categorized in accordance with the Revised 1996 IPCC Guidelines. The ERT commends Canada for its efforts to improve the accuracy and comparability of its reporting. The changes in fuel categorization have led to reallocation of emissions in the CRF tables. The ERT noted that the consequences of the reallocations are not transparently described in the NIR and recommends that Canada improve the transparency of its NIR by providing better documentation on any recalculation or reallocation of emissions.

24. The ERT noted that Canada reports some butane and propane as gaseous fuels and some as liquid fuels. According to the Revised 1996 IPCC Guidelines they should all be categorized as liquid fuels even though they do not all originate from crude oil.

25. Following the recommendation made in the previous review report on inconsistency in reporting between the CRF tables and the NIR (para. 60 of the 2012 annual review report), Canada made a correction in CRF table 1.A.(d). However, the ERT noted that the NIR does not contain any new information on implemented QA/QC procedures to prevent this type of error from occurring. The ERT recommends that Canada document the QA/QC procedures undertaken on the energy sector, including the outcomes of these procedures, to improve the transparency of its NIR.

2. Reference and sectoral approaches

26. Table 5 provides a review of the information reported under the reference approach and the sectoral approach, as well as comparisons with other sources of international data. Issues identified in table 5 are more fully elaborated in paragraph 32 below.

Table 5
Review of reference and sectoral approaches

		Include paragraph cross references to any recommendation
Difference between the reference approach and the sectoral approach	–318.07 PJ, –3.94% 3,340.48 Gg CO_2 eq, 0.67%	
Are differences between the reference approach and the sectoral approach adequately explained in the NIR and the CRF tables?	Yes	
Are differences with international statistics adequately explained?	No	See paragraph 28
Is reporting of bunker fuels in accordance with the UNFCCC reporting guidelines?	No	29
Is reporting of feedstocks and non-energy use of fuels in accordance with the UNFCCC reporting guidelines?	Yes	

Abbreviations: CRF = common reporting format, NIR = national inventory report, UNFCCC reporting guidelines = "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories".

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

27. The apparent fuel consumption reported in the CRF table is lower than that reported to the International Energy Agency (IEA) by up to 9 per cent for all years except 2002 (+1 per cent), 2005 (+9 per cent), 2006 (+10 per cent) and 2010 (0 per cent). The growth rate in 1990–2011 for the total apparent consumption is 24 per cent according to the CRF tables but 19 per cent according to IEA data. In response to questions raised by the ERT during the previous review, the Party explained that the National Inventory Group (at Environment Canada) is engaged in discussions with the agencies reporting to IEA, with a view to trying to reconcile any differences in data. The ERT reiterates the encouragement made in the previous review report that Canada continue its efforts to reconcile the differences between the data reported to IEA and report the progress in its NIR.

International bunker fuels

28. Canada estimates the amount of fuel used for international aviation bunkers based on the location of the origin and destination airports for reporting in the CRF tables. This is in line with the IPCC good practice guidance. Canada reports data to IEA based on the amount of fuel sold to domestic and international carriers. The difference in total jet kerosene and aviation gasoline use between the data reported to IEA and those reported in the CRF tables is –15.9 per cent for 2011. The difference in jet kerosene use for civil aviation is +57.2 per cent and the difference in jet kerosene use for aviation bunkers is –62.2 per cent. This issue was raised in the previous review report (para. 57 of the 2012

annual review report), but the ERT noted that the transparency of the 2013 inventory submission had not improved. The ERT reiterates the recommendation made in the previous review report that Canada provides a rationale for in its NIR in order to improve transparency.

29. Canada estimates the amount of fuel used for international marine bunkers based on information on fuel reported by Statistics Canada as having been sold to foreign-registered marine vessels. However, the ERT noted that Canada has not clearly described in its NIR whether all of the fuel sold to foreign-registered carriers in Canada is used for international transport. In addition, in response to a question raised by the ERT during the review, Canada indicated that not all of the fuels sold to domestically registered carriers are consumed within the country. The ERT noted that fuel allocation between domestic and international marine has not been conducted in line with the IPCC good practice guidance. The ERT reiterates the recommendation made in previous review reports that Canada make further efforts to allocate fuel to domestic and international navigation separately in accordance with the IPCC good practice guidance.

Feedstocks and non-energy use of fuels

30. In the sectoral approach, the non-energy use of fuels should be accounted for under the industrial processes sector, according to the Revised 1996 IPCC Guidelines. The ERT noted that the associated CO_2 emissions from the non-energy use of fuels allocated to the category other (industrial processes) in CRF table 1.A(d) (16,172.61 Gg CO_2 eq) is not equal to the emissions reported in the category other (industrial processes) in CRF table 2(I) (15,236.02 Gg CO_2 eq). The ERT reiterates the recommendation made in the previous review report (para. 59 of the 2012 annual review report) that the Party provide an explanation for the differences between the values in CRF table 1.A(d) and table 2(I) in the NIR in order to improve transparency.

31. The ERT noted that Canada has not resolved a recommendation made in the previous review report to report coke separately from coal oils and tar in CRF table 1.A(d) (para 40 of the 2011 annual review report). The ERT reiterates the recommendation made in the previous review report that the Party report coke separately from coal oils and tar and provide the explanation in the NIR to improve accuracy and transparency.

3. Key categories

Stationary combustion: liquid, gaseous and solid fuels – CO_2, CH_4 and N_2O[2]

32. Canada stated in the NIR (section 3.2.1.6) that future improvements in collecting AD for fuel use in public electricity and heat production are being investigated with the eventual goal of developing a bottom-up inventory. The ERT commends the Party for its efforts and recommends that Canada provide information on the progress in its NIR.

Road transportation: liquid fuels and biomass – CO_2 and CH_4

33. Canada stated in the NIR that the GHG emissions from road transportation are estimated with a tier 3 approach. The fuel consumption is calculated using both top-down and bottom-up approaches. Canada indicated in the CRF tables that all fuel sold (as provided in the energy statistics) is allocated to on-road and off-road transportation. During the review, the ERT noted that the AD reported in the CRF tables are lower than net fuel

[2] Not all emissions related to all gases under this category are key categories, particularly CH_4 and N_2O emissions. However, since the calculation procedures for issues related to this category are discussed as whole, the individual gases are not assessed in separate sections.

sales in the official energy statistics reported by Statistics Canada. In response to a question raised by the ERT during the review, Canada explained that the differences are partly due to the use of several data sources in the CRF tables and that data from Statistics Canada are one of the sources. The ERT recommends that Canada provide information on the data sources used and an analysis of the reasons for the differences compared with statistics on fuel sold in order to ensure that no omission or double counting of emissions occur in accordance with the IPCC good practice guidance.

Fugitive emissions from solid fuels – CH_4

34. During the review, the ERT identified that the production data for coal presented in CRF tables 1.A(b) (67.45 Mt) and 1.B.1 (88.57 Mt) differ by 21.12 Mt and no information on the difference is provided in the CRF tables or in the NIR. In response to questions raised by the ERT during the review, the Party explained that it reports information on gross coal production (88.57 Mt) and marketable coal (67.45 Mt) and that the difference stems from the mass of contaminants that are removed from the raw coal during processing. Gross coal production (raw coal) is the amount of coal produced from the various underground and surface coal mines before processing. The raw coal consists of coal, rocks, minerals and contamination, which is removed prior to use (in industry, power plants, etc.) in order to achieve a greater market value and reduce transportation costs. The coal processing plant washes the coal of soil and rock, crushes it into graded sized chunks and removes any other contamination. The use of gross production when estimating fugitive emissions is a conservative approach to ensure that all fugitive CH_4 is accounted. Marketable coal is the amount used for combustion activities as this is the amount actually burned since it has higher energy content value as compared with gross/non-marketable coal. The ERT recommends that the Party include this information in the NIR to improve transparency.

Fugitive emissions from oil and natural gas – CO_2, CH_4

35. In tCRF table 1.B.2, Canada has presented information about flaring oil and gas as "Flared Gas and Flare". In response to questions raised by the ERT during the review, Canada clarified that it appears to be an error in terminology that has been carried over from previous inventory submissions and it plans to rectify this in its next inventory submission. The Party explained that the AD descriptor for the category "1.B.2.c – Flaring" should just read "Flared Gas" as it is associated gas from oil-related activities that is flared. In addition, the Party provided detailed information on the underlying sources of flaring of gas. The ERT recommends that Canada correct the error in the CRF table and include information on the sources of its flared gases in the NIR to improve transparency.

C. Industrial processes and solvent and other product use

1. Sector overview

36. In 2011, emissions from the industrial processes sector amounted to 54,271.29 Gg CO_2 eq, or 7.7 per cent of total GHG emissions, and emissions from the solvent and other product use sector amounted to 247.40 Gg CO_2 eq, or 0.04 per cent of total GHG emissions. Since 1990, emissions have decreased by 3.0 per cent in the industrial processes sector and increased by 38.4 per cent in the solvent and other product use sector. The key drivers for the fall in emissions in the industrial processes sector are the chemical industry and the metal industry. These decreasing trends are contrary counterbalanced by an increasing trend in consumption of fluorinated gases (F-gases) and industrial processes (other). Within the industrial processes sector, 30.7 per cent of the emissions were from metal production, followed by 28.1 per cent from other (industrial processes), 14.3 per cent from mineral

products and 14.2 per cent from consumption of halocarbons and SF_6. Chemical industry accounted for 12.9 per cent.

37. The ERT commends the Party for addressing the following issues raised by recommendations made in the previous review report related to transparency: providing additional information on the use of metallurgical coke and other reductants for iron and steel production in the industrial processes and energy sectors, reporting the technologies used by Canada's four major integrated iron and steel plants and reporting in the NIR on the breakdown of limestone and dolomite use.

38. Canada has reported all emissions of carbon monoxide, nitrogen oxides, non-methane volatile organic compounds and sulphur oxides in the CRF tables as "IE" (included elsewhere) and noted in the comment box that all emissions are reported in annex 10 to the NIR. The ERT encourages Canada to report the indirect GHG emissions in the CRF tables in future inventory submissions in accordance with the UNFCCC reporting guidelines.

2. Key categories

Cement production – CO_2

39. Canada has estimated CO_2 emissions from cement production using a tier 2 approach in accordance with the IPCC good practice guidance, using the default EF from the Revised 1996 IPCC Guidelines (0.5071 kt CO_2/kt clinker produced) and a default cement kiln dust correction factor of 1.02. In the 2011 and 2012 annual review reports, it was noted that Canada planned to develop a country-specific EF based on the calcium oxide content in clinker; however, the development of that EF has yet to be realized. The ERT reiterates the recommendation made in the previous review reports that Canada pursue this improvement and report thereon in the NIR.

Aluminium production –PFCs and CH_4[3]

40. The ERT finds that the methodology description provided in the NIR in regards to aluminium process-related emissions – as applicable to the production technologies employed by companies and the years to which the methodologies apply – is not adequately transparent. The ERT recommends that Canada improve the transparency of its NIR by including more information on the plant-specific AD and EFs in its NIR.

41. Canada has reported the CH_4 emissions from aluminium production as "NE" in CRF table 2(I). In response to a question raised by the ERT during the review, Canada explained that "the high temperatures associated with the electrolysis pots keeps the CH_4 levels very low. The checks made with the facility data base provides information that around 0.2 per cent in CO_2 eq of the overall process emissions associated with non-energy use of fuels – relates to methane." Given that data are available to estimate CH_4 emissions from aluminium production, the ERT encourages Canada to improve the completeness of the inventory by including emissions of CH_4 from aluminium production based on these expert judgements in its inventory submission.

[3] Not all emissions related to all gases under this category are key categories, particularly CH_4 emissions. However, since the calculation procedures for issues related to this category are discussed as whole, the individual gases are not assessed in separate sections.

Consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6[4]

42. Canada has reported values for AD and implied emission factors (IEFs) in CRF table 2(II).F for all categories. However, the ERT noted that Canada has reported all emissions from this background table as "IE". The ERT recommends that Canada report the detailed emissions from manufacturing, from stocks and from disposal in CRF table 2(II).F for all F-gases to improve transparency and comparability in its next inventory submission.

43. Canada has reported HFC emissions from semiconductor manufacture as "IE" in CRF table 2(I) and stated in the comment box that the allocation used by the Party is under olvents and that only aggregated data were available. The ERT recommends that Canada collect disaggregated data and report them under semiconductor manufacture to improve transparency and comparability n.

44. In the previous review report, it was recommended that Canada increase the accuracy of its reporting of HFC emissions from consumption of halocarbons and SF_6 by developing country-specific EFs. In response to a question raised by the ERT during the review, Canada stated that a study had been undertaken to determine country-specific HFC EFs and indicated that the results of that study would be likely to be incorporated in its 2014 inventory submission. The ERT recommends that Canada report in its inventory submission the results of, and any recalculations due to, the study in a transparent way in line with the IPCC good practice guidance.

45. Canada has reported SF_6 emissions from other (consumption of halocarbons and SF_6) as "NO" in CRF table 2(II). In response to a question raised by the ERT during the review regarding, Canada explained that it intends to change the notation key from "NO" to "NE". The ERT recommends that Canada investigate whether such emissions occur, and if so, estimate and report them in its inventory submission to avoid a potential underestimation of emissions.

46. Canada has reported PFC emissions from electrical equipment as "NE" in CRF table 2(I) for 2011–2013. In response to a question raised by the ERT during the review, the Party acknowledged that small amounts of PFCs (perfluoromethane) are used in cold climate gas mixtures (mixed with SF_6) in high voltage grid switchgear. The ERT encourages Canada to report these emissions.

Other (industrial processes) – CO_2

47. Canada has reported CO_2 emissions of 15,236.02 Gg for 2011 in the category other (industrial processes). The NIR does not describe in detail this category and the method of calculation for emissions in this category but makes reference to a very detailed national study. In response to a question raised by the ERT during the review for clarification on this matter, Canada explained that emissions from this category include the non-energy uses of fossil fuels and that the use of fossil fuels for non-energy purposes are reported in an aggregate manner. The ERT commends Canada for the very detailed study about non-energy use in Canada and recommends that the Party improve the transparency of its inventory submission by including a short overview of methods and calculations of emissions for all subcategories and feedstocks included in the category other (industrial processes).

[4] Not all emissions related to all gases under this category are key categories, particularly PFCs and SF_6 emissions. However, since the calculation procedures for issues related to this category are discussed as whole, the individual gases are not assessed in separate sections.

3. Non-key categories

Lime production – CO_2

48. The previous ERT found that Canada corrected the estimate of total national lime production by using the proportion of hydrated lime production to total lime production and the water content in the hydrated lime but it was not clear to the previous ERT if the values in the CRF tables were the corrected or the original values. The current ERT noted that AD in the CRF tables are revised but no reference to this revision is reported in the NIR. The ERT recommends that Canada report information on any recalculations in the CRF tables and in the NIR, in accordance with the UNFCCC reporting guidelines.

49. The previous review report stated that Canada provided information explaining the large decline in the share of dolomitic lime during the periods 1999–2000 and 2008–2009. In response to a question raised by the ERT during the previous review, Canada indicated that it would consider incorporating the above-mentioned information in its 2013 NIR. However, the ERT noted that no additional information on this issue has been presented in the 2013 NIR. Therefore, the ERT reiterates the recommendations made in the previous review reports that Canada provide the information in its NIR.

Other (chemical industry) – CH_4

50. The ERT commends Canada for using plant-specific EFs for the emissions of CH_4 from carbon black production. The IEF (1.28 kg CH_4/t for 2011) of Canada is much lower than the default EF of the Revised 1996 IPCC Guidelines (p. 2.22, table 2-9) of 11 kg/t product, and there is no explanation for this in the NIR. In response to a question raised by the ERT during the review, Canada provided explanations for the low IEF based on the reference Cheminfo Services 2010. The ERT recommends that Canada include an explanation of why the country-specific EF is significantly lower than the default EF in the NIR.

Iron and steel production – CH_4

51. Canada has reported the CH_4 emissions from steel and coke production as "NE". In response to a question raised by the ERT during the review, Canada explained that the CH_4 emissions are minor due to high temperatures present inside both basic oxygen furnace and electric arc furnace vessels and that integrated steel industries do not emit more than 0.02 per cent of their overall process emissions in the form of CH_4 (on a CO_2 eq basis). Canada also reports its CH_4 emissions from coke production under the energy Sector. The ERT encourages Canada to report the CH_4 emissions from steel production based on this expert judgement to improve completeness and to change the notation from NE to IE for CH_4 from coke production in the CRF.

D. Agriculture

1. Sector overview

52. In 2011, emissions from the agriculture sector amounted to 53,924.99 Gg CO_2 eq, or 7.7 per cent of total GHG emissions. Since 1990, emissions have increased by 15.4 per cent. The key drivers for the rise in emissions are the increased populations of non-dairy cattle and swine, and increased applications of synthetic nitrogen (N) fertilizers to agricultural soils. Within the sector, 54.7 per cent of the emissions were from agricultural soils, followed by 33.3 per cent from enteric fermentation, 11.9 per cent from manure management and the remaining 0.1 per cent from field burning of agricultural residues.

Canada reported emissions from rice cultivation and prescribed burning of savannas as "NO".

53. The previous review report contained only one recommendation for improvement in the agriculture sector; this relates to the reporting of mules and asses. While Canada reported populations of mules and asses as "NO" in the 2012 inventory submission, the previous annual review report referenced the database of the Food and Agriculture Organization of the United Nations (FAO), which indicated there are significant populations of these animals. Canada has since resolved this issue by confirming that the FAO database is in error and has provided a footnote indicating that "these livestock are not raised for commercial purposes". However, in a subsequent follow-up on this issue, the 2013 ERT noted that while use of the notation key "NO" is correct, the footnote is misleading and that the issue is not that these animals are not raised for commercial purposes, but rather that the populations are insignificant and therefore it is not necessary to estimate their emissions. Canada responded to this by indicating that the footnote about commercial production was misleading and that it plans to remove the statement from future submissions. The ERT recommends that Canada provide further documentation that these animals are not occurring, and if they are occurring use default methods to estimate emissions, or report "NE".

2. Key categories

Enteric fermentation – CH_4

54. Canada uses a tier 2 method with country-specific EFs to estimate enteric emissions from dairy and non-dairy cattle, while a tier 1 method with default EFs is used for estimating emissions from the remaining livestock types, except for poultry, which are excluded due to the unavailability of EFs. AD are largely provided by Statistics Canada. The approach implemented is in line with the IPCC good practice guidance. The plans for inventory improvement are under way to improve the time series with respect to animal feed rations and improve the model that estimates emissions from non-dairy cattle, but these improvements are not expected to be implemented for several years. The ERT encourages Canada to improve this time series and looks forward to seeing the use of these updated data in future inventory submissions.

55. Canada disaggregates its cattle population into eight separate subcategories in order to estimate emissions. However, when reporting in the CRF tables, Canada has used option A for livestock reporting classification (subdivision: dairy and non-dairy cattle), and includes all young cattle in the non-dairy category. In order to improve the transparency of reporting, and take advantage of the subcategorization carried out in preparing the estimates, the ERT encourages Canada to consider reporting under option B for livestock reporting classification, which would allow separate reporting of mature dairy cattle, mature non-dairy cattle and young animals. This would make the IEFs shown in the CRF tables more representative of the subcategories used in developing the estimates. The ERT was informed that Canada thinks reporting option A is more comparable because most of Parties are reporting with option A.

Manure management – CH_4 and N_2O[5]

56. Canada has used a tier 2 method from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines) to estimate CH_4 emissions from manure management and a tier 1 method for N_2O emissions, both of which are consistent with the IPCC good practice guidance. A number of improvements are planned for this category:

(a) Canada currently holds animal waste management system (AWMS) usage constant through the time series as it previously had very little data available that would allow it to construct a variable time series. In response to a question raised by the ERT during the review, Canada indicated that four separate surveys (one in 1995, one in 2001, one in 2005 and one in 2006) have just been reviewed and will be used to develop a complete time series of AWMS usage. The methodology is to be reviewed in 2014 prior to integrating into the GHG inventory. The ERT commends Canada for working on improvements to the AWMS usage data and encourages it to integrate this new data into the inventory as soon as possible;

(b) Canada currently uses the IPCC default methane conversion factor (MCF) values for all AWMS systems. There is work under way, initiated in 2010 and with an expected completion date of 2015, that will provide new data on CH_4 and N_2O emissions from manure storage. Canada intends to integrate this information into its inventory when the research is completed. This may allow for use of country-specific MCFs in estimating CH_4 emissions from manure management. The ERT commends Canada for this ongoing work and encourages Canada to integrate into the inventory;

(c) Canada has used an approach from the 2006 IPCC Guidelines to estimate N excretion from mature dairy cows. The tier 1 estimation method is solely based on animal type. Consequently, N excretion is stable over the whole inventory time period, as is animal weight. However, reported estimates for gross energy intake increase together with increasing milk yield. Furthermore, N intake usually increases together with gross energy intake. Canada stated in section 6.2.6 of the NIR on the agriculture sector that it plans to integrate a tier 2 methodology based on calculating N excretion directly from feed data by the 2015 inventory submission. The ERT commends Canada for this planned improvement and encourages the Party to continue these efforts and progress in the NIR.

57. In CRF table 4.B(b), there are differences in total N excretion for sheep, goats, horses and poultry when comparing the results of multiplying animal population numbers with animal-specific nitrogen excretion rates (Nex) with an approach of adding up the N managed in individual ÀWMS for each of the specific animal types. In response to a question raised by the ERT during the review, Canada stated that the differences in total N excretion for sheep, goats and horses are due to rounding of annual average Nex values to two decimal places in CRF table 4.B(b). However, for poultry, Canada stated that there were two problems. The first was an error in calculating the weighted Nex, which was then input into CRF table 4.B(b). This alone explains the differences from 1990 to 2006. For these years, the actual amount of N that is reported for each AWMS system is correct. From 2007 to 2011, this error continues, but the Party also identified an error in the population data that was transferred to the N_2O model. The population of laying hens was not in fact updated to the new census values and laying hen populations remained constant from 2006 to 2011 at the 2006 population level. This resulted in a small overestimate of the quantity of N delivered to AWMS for the years 2007 to 2011. The ERT recommends that Canada correct these errors.

[5] Not all emissions related to all gases under this category are key categories, particularly CH_4 emissions. However, since the calculation procedures for issues related to this category are discussed as whole, the individual gases are not assessed in separate sections.

Agricultural soils – N_2O

58. Canada currently does not account for the N_2O emissions resulting from application of sewage sludge to agricultural soils. Based on a brief Internet search, the ERT determined that Canada does apply sewage sludge to agricultural soils. During the review, the ERT asked Canada if it had considered accounting for N_2O emissions from application of sewage sludge to agricultural soils. Canada responded that currently there are no data on the application of sewage sludge to agricultural soils in the country. The ERT encourages that Canada assemble the necessary AD to include the N from sewage sludge application to the soil and include this in estimating N_2O emissions from agricultural soils.

59. Canada currently provides uncertainty estimates for N_2O emissions from direct soil emissions at the level of the N inputs (e.g. synthetic fertilizer, manure additions, crop residue) and for N_2O emissions from the category indirect emissions by volatilization emissions and leaching/run-off emissions. The usefulness of these uncertainty estimates would be improved if the uncertainty were combined at the subcategory level for reporting purposes. In response to questions raised by the ERT during the review, Canada indicated that it has just completed a comprehensive analysis of N_2O uncertainty and has plans to provide the combined uncertainties for total direct and indirect emissions in a future inventory submission. The ERT commends Canada for this effort and recommends that the Party include this in the NIR of its future inventory submission.

E. Land use, land-use change and forestry

1. Sector overview

60. In 2011, net emissions from the LULUCF sector amounted to 87,267.07 Gg CO_2 eq. Since 1990, net removals have decreased from a net sink of 61,628.06 Gg CO_2 eq, which means a decrease of 241.6 per cent. Within the sector, emissions of 83,236.74 Gg CO_2 eq were from forest land, followed by 9,335.16 Gg CO_2 eq from settlements and 2,668.72 Gg from wetlands. Cropland accounted for a removal of 7,973.55 Gg CO_2 eq. Over the years, the sector has changed from a net sink to a net source. The shift in emissions and removals are primarily driven by forest fires and insect infestations on forest land. As a result, the LULUCF sector is a net sink for only 11 years of the 22-year time series.

61. The ERT noted that the 2011 annual review report (para. 104) recommended for the Party to provide evidence that the estimation method used for the LULUCF category land converted to wetlands provides unbiased estimates regarding the decay of submerged biomass, or to revert to a tier 1 approach for the category land converted to wetlands, or to use a longer conversion period than 10 years. The Party did not provide such information in the 2013 inventory submission. The ERT reiterates the recommendation made in the previous review report that Canada provide this documentation.

62. The ERT did note that Canada provided information on its choice not to report the reversion of managed grassland to unmanaged land in response to a recommendation in the 2011 annual review report (para 97). The ERT commends Canada's effort on this issue.

2. Key categories

Land converted to cropland – CO_2, N_2O

63. In most reporting areas in Canada as the notation key "NO" is used for the carbon stock change in grassland converted to cropland. As noted in the previous review report (para. 92), the Party neither provided empirical data nor cited publications supporting the assumption that the steady state biomass carbon stock in unimproved grassland is different

from that in improved pastures or arable crops. Based on the literature[6], it is evident that unimproved grassland could include tall grasses and woody biomass, which may be likely to represent a larger biomass pool at a steady state when compared with improved pastures and cropland. The ERT reiterates the recommendation made in the previous review report that the Party include an assessment of biomass carbon stock changes associated with grassland conversion to cropland using default biomass values, or provide some data supporting the assumption that these stock changes are negligible.

64. The Party has also reported as confidential AD and changes in carbon stocks in the reporting zone "Boreal Cordillera" under forest land converted to cropland and grassland converted to cropland in the 2013 inventory submission. In response to questions raised by the ERT during the review, the Party explained that there is an internal requirement to report all land conversion activity to cropland as confidential in this specific reporting zone. While this requirement was well implemented in previous submissions in the case of residual emissions after the 20-year transition period, emissions occurring before the 20-year period were still being reported (they have reported values in previous submissions). Despite the fact that the explanation is reasonable, the Party has not explained the reason that this area has become confidential. The ERT encourages the Party to improve the transparency of its reporting, for example, by explaining the reasons for data becoming confidential. The ERT noted that it is unclear whether carbon stock change in those area is reported, then recommends that Canada provide information on the carbon stock changes in those area in the NIR.

65. The ERT noted that N_2O emissions from disturbance associated with land-use conversion to cropland (in particular from wetlands converted to cropland) are reported as "NE", which is a mandatory reporting category. The Party indicates that N_2O emissions from cropland on organic soils, reported under cultivation of histosols in the agriculture Sector, include these emissions. Therefore the notation key should be "IE". The ERT encourages Canada to use appropriate notation keys in its next submission.

F. Waste

1. Sector overview

66. In 2011, emissions from the waste sector amounted to 21,746.13 Gg CO_2 eq, or 3.1 per cent of total GHG emissions. Since 1990, emissions have increased by 14.4 per cent. The key drivers for the rise in emissions are the CH_4 emissions from solid waste disposal on land and the N_2O emissions from human sewage. Within the waste sector, 92.2 per cent of the emissions were from solid waste disposal on land, followed by 4.6 per cent from wastewater handling and the remaining 3.2 per cent from waste incineration.

67. In the category solid waste disposal on land the emissions decreased by 2.6 per cent in 2010 due to improved AD. Four regions recalculated the amounts of waste for 2007–2010 and the NIR also mentions new provincial export data for the period 1998–2010. The corrections for 1998–2010 and 2007–2010 were both described in the NIR, but additional corrections for 1990–1997 (a constant minor difference (+0.0012 per cent) between the 2012 and 2013 inventory submissions) were not described in the NIR. In response to a question raised by the ERT during the review, Canada referred to the information in CRF table 8(b), explaining that the difference is due to updated waste export data from 1990 to 2011. The ERT recommends that Canada report consistent information in the CRF tables

[6] Shorthouse JD. 2010. Ecoregions with Grasslands in British Columbia, the Yukon, and Southern Ontario. *In*: JD Shorthouse and KD Floote (eds.). *Athropods of Canadian Grasslands (Volume 1): Ecology and Interactions in Grassland Habitats*. Biological Survey of Canada. pp.83–103.

and the NIR on all recalculations in accordance with the IPCC good practice guidance in future submissions to increase transparency and enable reviews.

68. Following the recommendations of the previous review report, Canada extended part 2 of the NIR regarding the methodology for waste incineration. The composition of incinerated municipal solid waste (MSW) is now better described. The ERT commends Canada for this improvement of the transparency of the category waste incineration.

2. Key categories

Solid waste disposal on land – CH_4

69. Canada has reported in the NIR (p. 201) that for four regions the amount of landfilled waste for 1991–2011 is estimated by trending historical landfill data with provincial populations for 1991–2011. The ERT noted that the source of the historical data was not transparently available in the NIR. In response to questions raised by the ERT during the review, Canada provided the source of the data (Levelton, 1991) and expressed the intention to include it in the next inventory submission. The ERT recommends that Canada include this information in the NIR to improve transparency.

70. Canada described an equation on the linear relation between the methane generation rate constant (k) and precipitation in part 2 of its NIR (pp. 154–156). This results in a different k value per province, shown in table 8–2 of the NIR. It is not clear how this relation was achieved. The NIR makes reference to a study from the Research Triangle Institute. Canada provided the study to the ERT during the review. However, even with the content of this study, it is not clear to the ERT how the equation on page 154 of part 2 of the NIR was derived. The ERT recommends that Canada explain in a more transparent manner how the equation is derived in the NIR.

71. In its NIR (p. 202 and annex 3, p. 151), Canada described the parameter methane generation potential (L_0). However, the ERT noted that it was not clear from the description whether the parameter L_0 was determined for all MSW categories (i.e. municipal; institutional-commercial and industrial; construction and demolition (C&D)) separately or together. Furthermore, the calculation process of L_0 in the model used for the estimation was not clear. In response to a question raised by the ERT during the review on the exact relation between the L_0 value and the degradable organic carbon (DOC) value, Canada confirmed that the DOC value[7] from the combination of residential, institutional-commercial, industrial and C&D wastes (together) is calculated as one value (using equation 5.4 of the IPCC good practice guidance) and this is done separately for the three time periods defined (1941–1975; 1976–1989; 1990–2011) and separately for each province. From those DOC values, the value for L_0 was derived. Canada expressed the intention to report in a more transparent way in the next submission. The ERT recommends that Canada improve transparency on this issue.

72. The ERT noted that Canada uses a constant waste composition for each province in the period 1990–2009. Following the recommendations made in the previous review report, Canada mentioned in its NIR that it is considering a study to provide a review of MSW composition values for all provinces and territories for urban and rural areas. In response to the question raised by the ERT during the review on the time schedule and content of the planned improvements, Canada provided information on the time schedule and the expected results from the study in development. New values for DOC will be estimated on the provincial and territorial levels for the four main waste sources (residential, institutional-commercial and industrial, construction and C&D waste and sludge). Canada

[7] Equation 5.1 in the IPCC good practice guidance: $L_0 = MCF.DOC(x).DOC_F.F.16/12$.

expects the results of the study to provide new DOC values for the period 2003–2014, which will be available in late 2014 and can be introduced in the Party's submission of 2016. Canada expressed the intention to include the information regarding the new study in the NIR of its next inventory submission. The ERT recommends that Canada include the results from the study as soon as possible. In the meantime, the ERT encourages Canada to include the information on the content of the study, the expected improvements in the inventory and the expected time schedule in the NIR.

73. In its NIR, Canada described the equations used for estimating CH_4 emissions for waste disposal sites as equations 8-1 and 8-2 (NIR, part 2, p. 159). Comparing the Canadian equations in the NIR with formulas of the first-order decay model described in the IPCC good practice guidance, the ERT concluded that Canada does not include the component "A"[8] in the equation 8-1. "A" is a normalization factor which corrects the summation. In response to a question raised by the ERT during the review, Canada explained that it is following the methodology provided in the Revised 1996 IPCC Guidelines, which does not include the normalization component. Canada plans to implement the methods incorporated in the 2006 IPCC Guidelines for the 2015 inventory submission. The Party indicated that the current estimation is conservative and the use of normalization factor would reduce the emissions by 0.01 to 3.8 per cent. According to the definition of accuracy in the UNFCCC reporting guidelines, reported estimate should be neither over nor under true emissions or removals. Then, the ERT recommends that Canada provide accurate estimation by including the normalization component.

74. Canada has used an oxidation factor (OX) of zero, but has not provided the information for this assumption in the NIR. In response to a question raised by the ERT during the review on the reasons for not using the OX of 0.1 for well-managed solid waste disposal sites in industrialized countries found in the IPCC good practice guidance, Canada explained that it accounts for active, closed and abandoned landfills from 1941 to the present. Since it concerns thousands of landfills and the managing level and final covering of all landfills are not exactly known, Canada has made the conservative estimation by assuming OX as zero. The ERT considers that describing the underlying reasons in the NIR would improve the transparency of the submission. Therefore the ERT recommends that Canada include this information in the NIR.

75. The amounts of C&D waste are included (for the last 15 years) in the total quantities of MSW. However, it is not transparently reported whether the percentage of MSW that is paper/textiles, the percentage of MSW that is garden/park wastes, the percentage of MSW that is food waste and the percentage of MSW that is wood/straw for each region are adjusted for the fraction of C&D waste that is included. The information in the NIR (part 2) suggests that the percentages have been adjusted. In response to a question raised by the ERT during the review, Canada provided the confirmation on the adjusted shares, due to the inclusion of the fraction of C&D wastes. The ERT recommends that Canada include this information in a transparent way in the NIR.

76. The ERT noted that data on the amounts of exported waste are not given in the NIR; nevertheless, recalculations of these quantities are mentioned in the NIR and influence the time series of disposed waste and emissions. In response to a question raised by the ERT during the review, Canada expressed the intention to provide data of the amounts of exported waste in the next inventory submission. The ERT welcomes this improvement and recommends that Canada further improve the transparency of the sector by including a summary of the amounts of waste generated, exported, landfilled, incinerated, composted, etc., in the NIR.

[8] $(A=(1-e^{-k})/k)$ equation 5.1 in the IPCC good practice guidance.

3. Non-key categories

Wastewater handling – CH_4

77. In spite of the recommendation made in the previous review report to provide a further description of its country-specific method and explain how the method is in line with the Revised 1996 IPCC Guidelines, the information in the Canadian 2013 NIR was not revised on this issue. The ERT reiterates the recommendation made in the previous review report that Canada improve transparency on the methods used in the category wastewater handling by providing more information on the wastewater treatment systems, for example, the number of facilities, and the techniques and parameters used (e.g. MCF of 0.3 for all domestic systems). As an example, in response to questions raised by the ERT during the review, Canada provided the ERT with an extract of the report which provides the basis of the MCF factor. The ERT recommends that Canada include this extract and other relevant information on the assumptions for the used parameters in the NIR.

78. In Canada, CH_4 emissions from industrial wastewater handling from the 19 identified facilities were estimated for the period 1990–2009 (and 2010 and 2011 were assumed to be the same as 2009). The ERT noted that in the NIR the description of the AD is not very clear. In response to a question raised by the ERT during the review, Canada indicated that a complete time series of emission data is available for the period 1990–2011 as a result of biannual surveys. Thus, Canada does not need to use extrapolation techniques to provide the complete time series. The ERT recommends that Canada provide transparent information on the AD used, including the source of the data, in the NIR and use actual data as opposed to extrapolation for all years of the time series.

79. Canada reported CH_4 emissions from sludge of industrial wastewater and of commercial and domestic wastewater as "NE" in the CRF tables. Further, Canada reported CH_4 recovery of these categories as "NE". Canada also provided comments in the CRF tables on the notation keys used. In the NIR, information on the emissions from sludge from wastewater handling is available in part 2 of the NIR, in annex 5 (A.5.6.3 and A.5.6.4), but not in part 1 of the NIR and not in annex 3, pages 161–164. The ERT noticed that the use of notation keys in the CRF tables on wastewater handling for sludge is not consistent with the information in the NIR. In response to questions raised by the ERT during the review, Canada provided more information on the treatment of sewage sludge. The ERT recommends that Canada report in a consistent manner on the treatment of sewage sludge in the NIR and in the CRF tables.

Waste incineration – CO_2, CH_4, N_2O

80. In the NIR, Canada described the method for estimating CO_2 emissions from waste incineration using default carbon content and fossil fraction data. Canada indicates that no country-specific carbon content is available. However, the ERT noted that in part 1 of the NIR, Canada has referred to a publication by Tchobanoglous et al. (1993)[9] and part 2 of the NIR refers to a study performed by the hazardous waste branch of Environment Canada (Environment Canada, 1996)[10] to determine CO_2 EFs for MSW. In response to questions raised by the ERT during the review, Canada provided more information on the estimation of the carbon content and EFs. The ERT recommends that Canada correct the information

[9] Tchobanoglous G, Theisen H, Vigil S. 1993. *Integrated Solid Waste Management, Engineering Principles and Management Issues.* New York: McGraw Hill.

[10] Environment Canada. 1996. *Perspectives on Solid Waste Management in Canada: An Assessment of the Physical, Economic and Energy Dimensions of Solid Waste Management in Canada. Vol. I.* Ottawa: Environment Canada, Hazardous Waste Branch.

in the NIR to clarify the use of country-specific factors.. The ERT also recommends that Canada report transparently the sources used for estimating AD and EFs.

81. The ERT noted that Canada has not used the same source for the composition of MSW for landfills as for incineration. The ERT recommends that Canada, in the NIR, provide the reasons for not using the same source for the composition of MSW that is landfilled as for the composition of MSW that is incinerated.

82. In response to a question raised by the ERT during the review, Canada provided information on planned measurements in one hazardous waste incinerator and its intention to derive a country-specific EF based on these measurements. The ERT commends Canada for its efforts to derive a country-specific EF but recommends that the Party ensure that the EF from the incinerator is representative for the other facilities, before using it as a country-specific EF. If the plant-specific derived EF could not be used as a country-specific EF, the ERT encourages Canada to make additional efforts to also gather direct measurements for the three other hazardous waste incinerators.

83. Canada stated in the NIR that it accounts for all emissions from waste incineration under the waste sector. In response to questions raised by the ERT during the review, Canada informed the ERT that it plans the reallocation of emissions from waste incineration with energy recovery to the energy sector as from the 2015 inventory submission. The ERT commends Canada for its efforts to improve the comparability of the inventory and consistency with the IPCC good practice guidance and recommends that the Party include the improvements in the 2015 inventory submission.

84. During the review, the ERT asked Canada to verify whether all incinerated waste is included in the GHG emission estimates. In response to the questions raised by the ERT during the review, Canada provided information that the missing waste types for calculating CO_2, CH_4 and N_2O emissions are planned to be incorporated in the 2015 inventory submission, based on the incineration surveys. The ERT commends the Party for its efforts to improve the completeness of the inventory and recommends that Canada estimate emissions from, and include information on, the missing types of waste incinerated in its next inventory submission.

85. The Canadian NIR does not indicate whether emissions from flaring of waste gases from industrial processes occur. In response to a question raised by the ERT during the review, Canada provided information that emissions from flaring that are related to carbon coming from feedstocks are included in the industrial processes sector. The ERT recommends that Canada include this information on the estimation and allocation of emissions from flaring in the next inventory submission.

III. Conclusions and recommendations

A. Conclusions

86. Table 6 summarizes the ERT's conclusions on the 2013 inventory submission of Canada, in accordance with the UNFCCC review guidelines.

Table 6
Expert review team's conclusions on the 2013 inventory submission of Canada

	Cross-references, if applicable
The ERT concludes that the inventory submission of Canada is complete (categories, gases, years and geographical boundaries and	

		Cross-references, if applicable
contains both an NIR and CRF tables for 1990–2011)		
Non-land use, land-use change and forestry[a]	Complete	
Land use, land-use change and forestry[a]	Not complete	Table 3
The ERT concludes that the inventory submission of Canada has been prepared and reported in accordance with the UNFCCC reporting guidelines	Yes	
The Party's inventory is in accordance with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*	No	9, 24, 29, 83
The institutional arrangements continue to perform their required functions	Yes	

Abbreviations: CRF = common reporting format, ERT = expert review team, IPCC = Intergovernmental Panel on Climate Change, NIR = national inventory report, UNFCCC reporting guidelines = "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories".

[a] The assessment of completeness by the ERT considers only the completeness of reporting of mandatory categories (i.e. categories for which methods and default emission factors are provided in the IPCC *Revised 1996 Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, or the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*).

B. Recommendations

87. The ERT identified the issues for improvement listed in table 7. All recommendations are for the next inventory submission, unless otherwise specified.

Table 7
Recommendations identified by the expert review team

Sector	*Category*	*Recommendation*	*Paragraph reference*
Cross-cutting	Completeness	Improve the completeness of reporting on mandatory categories for the LULUCF and waste sectors	9
	QC	Strengthen QC procedures at the final stage of the inventory preparation to avoid inconsistencies between the CRF tables and the NIR	10
	Uncertainty	Report the results of the trend uncertainty analysis including LULUCF	17
Energy	Sector overview	Improve the transparency of the NIR by providing better documentation on any recalculation or reallocation of emissions	22
		Categorize all fuels in accordance with the Revised 1996 IPCC Guidelines	23

		Document the QA/QC procedures and improve the transparency of the NIR	24
	International bunker fuels	Clarify differences in jet kerosene use for civil aviation and for aviation bunkers	27
		Make further efforts to allocate fuel to domestic and international navigation separately	28
	Feedstocks and non-energy use of fuels	Provide an explanation for the differences between the values in CRF table 1.A(d) and table 2(I).A-G in the NIR	29
		Report coke separately from coal oils and tar	30
	Stationary combustion: liquid, gaseous and solid fuels – CO_2, CH_4 and N_2O	Provide information on the progress of the future improvements in public electricity and heat production that are being investigated with the eventual goal of developing a bottom-up inventory	31
	Road transportation: liquid fuels and biomass – CO_2, CH_4	Provide information on the data sources used and an analysis of the reasons for the differences between the data in the CRF tables and the statistics on fuel sold	32
	Fugitive emissions from solid fuels – CH_4	Include the information on the situation of coal in Canada	33
	Fugitive emissions from oil and natural gas – CO_2, CH_4	Correct the error in the CRF tables and include information on the sources of flared gases	34
Industrial processes and solvent and other product use	Cement production – CO_2	Pursue developing a country-specific EF based on the calcium oxide content in clinker	38
	Aluminium production –PFCs and CH_4	Change the description of the method applied from an IPCC default method to a country-specific method	39
		Improve the transparency of the NIR by including more information on the plant-specific AD and EFs	39
	Consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6	Report the detailed emissions from manufacturing, from stocks and from disposal in the CRF tables for all F-gases to improve transparency and comparability	41
		Collect disaggregated data and report them under semiconductor manufacture to improve transparency and comparability	42
		Report the results of a study undertaken to determine country-specific HFC EFs and any recalculations of the study in a transparent way in line with the IPCC good practice guidance	43
		Investigate whether SF_6 emissions from other (under consumption of halocarbons and SF_6) and if so, estimate	44

		and report them in its inventory submission to avoid a potential underestimation of emissions.	
	Other (industrial processes) – CO_2	Improve the transparency by including a short overview of methods and calculations of all categories included in other (industrial processes)	46
	Lime production – CO_2	Report any recalculations in the CRF tables and in the NIR	47
		Provide the information on the large decline in the share of dolomitic lime during the periods 1999–2000 and 2008–2009	48
	Other (chemical industry: carbon black production) – CH_4	Include an explanation of why the country-specific EF is significantly lower than the default EF in the NIR	49
Agriculture	Sector overview	Provide further documentation that mules and asses are not occurring, and if they are occurring use default methods to estimate emissions, or report "NE".	52
	Manure management – CH_4 and N_2O	Correct the errors on total nitrogen excretion for sheep, goats, horses and poultry	56
	Agriculture soils – N_2O	Include the combined uncertainties for total direct and indirect emissions in a future inventory submission	58
LULUCF	Sector overview	Include information in the NIR on Canada's choice not to report the reversion of managed grassland to unmanaged land and why the Party is also considering this approach in all categories	60
		Provide evidence that the estimation method used for the LULUCF category land converted to wetlands provides unbiased estimates regarding the decay of submerged biomass, or to revert to a tier 1 approach for the category land converted to wetlands, or to use a longer conversion period than 10 years.	60
	Land converted to cropland – CO_2	Include an assessment of biomass carbon stock changes associated with grassland conversion to cropland using default biomass values, or provide some data supporting the assumption that these stock changes are negligible	61
		Provide information on the carbon stock changes in "Boreal Cordillera" under forest land converted to cropland and grassland converted to cropland	62
Waste	Sector overview	Report consistent information in the CRF tables and the NIR on all recalculations	64
	Solid waste disposal on land – CH_4	Include information on the amount of landfilled waste for four regions for 1991–2011 estimated by trending historical landfill data with provincial populations for 1991–2011	66
		Explain in a more transparent manner how the equation on the linear relation between the methane generation rate	67

	constant and precipitation is derived	
	Improve transparency on the relation between the L_0 value and the DOC value	68
	Include the results from the study to provide a review of MSW composition values for all provinces and territories for urban and rural areas	69
	Provide accurate estimation by including the normalization component.	70
	Include the information on the assumption of the oxidation factor	71
	Include the information on the adjusted shares of each type of MSW in a transparent way in the NIR	72
	Improve the transparency of the sector by including a summary of the amounts of waste generated, exported, landfilled, incinerated, composted, etc., in the NIR	73
Wastewater handling	Improve transparency on the methods used in the category wastewater handling by providing more information on the wastewater treatment systems, e.g. the number of facilities, the techniques and parameters used (e.g. MCF of 0.3 for all domestic systems)	74
	Include the extract of the report which provides the basis of the MCF factor and other relevant information on the assumptions for the used parameters in the NIR	74
	Provide transparent information on the AD used, including the source of the data, in the NIR and use actual data as opposed to extrapolation for all years of the time series.	75
	Report in a consistent manner on the treatment of sewage sludge in the NIR	76
Waste incineration	Correct the information in the NIR on how to determine CO_2 EFs for MSW	77
	Describe in the NIR the reasons for not using the same source for the composition of MSW that is landfilled as for the composition of MSW that is incinerated	78
	Ensure that the EF from the one incinerator measured is representative for the other facilities, before using it as country-specific EF	79
	Include the reallocation of emissions from waste incineration with energy recovery to the energy sector in the 2015 inventory submission	80
	Estimate the missing emissions and include information on the missing waste incineration categories	81
	Include the information on the estimation and allocation of emissions from flaring	82

Abbreviations: AD = activity data, CRF = common reporting format, DOC = degradable organic carbon, EF = emission factor, F-gases = fluorinated gases, IPCC = Intergovernmental Panel on Climate Change, IPCC good practice guidance = IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, LULUCF = land use, land-use change and forestry, MCF = methane conversion factor, MSW = municipal solid waste, NIR = national inventory report, QA/QC = quality assurance/quality control, Revised 1996 IPCC Guidelines = *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*.

Annex I

Background data on recalculations in the 2013 inventory submission

Table 8
Recalculations in the 2013 inventory submission for the base year and the most recent year

	1990	*2010*	*1990*	*2010*	
Greenhouse gas source and sink categories	*Value of recalculation (Gg CO_2 eq)*		*Per cent change*		*Reason for the recalculation*
1. Energy	1 952.79	8 477.03	0.4	1.5	EF, AD, methodological change:
A. Fuel combustion (sectoral approach)	1 949.46	8 538.39	0.5	1.7	
1. Energy industries	2 294.14	11 447.22	1.6	7.4	
2. Manufacturing industries and construction	–341.88	–3 353.19	–0.5	–4.1	
3. Transport	0.00	874.90	0.0	0.4	
4. Other sectors	–2.80	–443.19	0.0	–0.6	
5. Other	0.00	2.65	0.0	3.5	
B. Fugitive emissions from fuels	3.33	–51.35	0.0	–0.1	
1. Solid fuels					
2. Oil and natural gas	3.33	–51.35	0.0	–0.1	
2. Industrial processes		1 454.96		2.8	AD updated
A. Mineral products		–359.64		–4.5	
B. Chemical industry		18.58		0.3	
C. Metal production		367.73		2.4	
D. Other production					
E. Production of halocarbons and SF_6					
F. Consumption of halocarbons and SF_6		–3.85		–0.1	
G. Other	NA	1 432.13		9.8	
3. Solvent and other product use	NA	NA	NA	NA	
4. Agriculture	29.77	79.47	0.1	0.1	AD updated
A. Enteric fermentation		–79.87		–0.4	
B. Manure management	38.21	38.47	0.7	0.6	
C. Rice cultivation					
D. Agricultural soils	–8.19	121.03	0.0	0.4	
E. Prescribed burning of savannas	NA	NA	NA	NA	
F. Field burning of agricultural residues	–0.25	–0.15	–0.1	–0.5	AD updated
G. Other	NA	NA	NA	NA	
5. Land use, land-use change and forestry	5 857.50	31 231.16	–8.7	43.4	AD updated
A. Forest land	5 485.65	30 452.88	–5.9	44.7	

Greenhouse gas source and sink categories	*1990*	*2010*	*1990*	*2010*	*Reason for the recalculation*
	Value of recalculation (Gg CO_2 eq)		*Per cent change*		
B. Cropland	495.85	–183.60	4.4	2.5	
C. Grassland	NA	NA	NA	NA	
D. Wetlands	160.89	308.62	3.1	12.9	
E. Settlements	–284.88	653.26	–3.1	7.4	
F. Other land	NA	NA	NA	NA	
G. Other	NA	NA	NA	NA	
6. Waste	–196.94	–880.39	–1.0	–3.9	AD and EF updated
A. Solid waste disposal on land	0.18	–530.23	0.0	–2.6	
B. Wastewater handling	–197.12	–349.86	–19.2	–26.1	
C. Waste incineration	NA	–0.30	NA	0.0	
D. Other	NA	NA	NA	NA	
7. Other	NA	NA	NA	NA	
Total CO_2 equivalent without LULUCF	**1 785.61**	**9 131.07**	**0.3**	**1.3**	
Total CO_2 equivalent with LULUCF	**7 643.12**	**40 362.24**	**1.5**	**5.3**	

Abbreviations: AD = activity data, EF = emission factor, LULUCF = land use, land-use change and forestry, NA = not applicable.

Annex II

Documents and information used during the review

A. Reference documents

Intergovernmental Panel on Climate Change. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>.

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>.

Status report for Canada 2013. Available at <http://unfccc.int/resource/docs/2013/asr/can.pdf>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2013. Available at <http://unfccc.int/resource/webdocs/sai/2013.pdf>.

FCCC/ARR/2012/CAN. Report of the individual review of the greenhouse gas inventory of Canada submitted in 2012. Available at <http://unfccc.int/resource/docs/2013/arr/can.pdf>.

B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Lindsay Pratt (Environment Canada), including additional material on the methodology and assumptions used. The following documents[1] were also provided by Canada:

[1] Reproduced as received from the Party.

Cheminfo Services Inc. 2010. *Study of Potential Additions and Updates to the Industrial Process Sources of GHGs in the Canadian GHG Inventory, and Development of Canadian-Specific Methodologies and Emission Estimates for such Sources* Unpublished report prepared for Environment Canada by Cheminfo Services Inc..

Levelton BH. 1991. *Inventory of Methane Emissions from Landfills in Canada.* Unpublished report prepared for Environment Canada by B.H. Levelton & Associates.

Annex III

Acronyms and abbreviations

AD	activity data
ARR	annual review report
AWMS	animal waste management system
C&D	construction and demolition
CH_4	methane
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CRF	common reporting format
DOC	degradable organic carbon
EF	emission factor
ERT	expert review team
F-gas	fluorinated gas
FAO	Food and Agriculture Organization of the United Nations
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 without GHG emissions and removals from LULUCF
HFCs	hydrofluorocarbons
IE	included elsewhere
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram (1 kg = 1,000 grams)
LULUCF	land use, land-use change and forestry
MCF	methane conversion factor
MSW	municipal solid waste
Mt	million tonnes
N	nitrogen
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
Nex	nitrogen excretion rates
NIR	national inventory report
NO	not occurring
OX	oxidation factor
PFCs	perfluorocarbons
PJ	petajoule (1 PJ = 10^{15} joule)
QA/QC	quality assurance/quality control
SF_6	sulphur hexafluoride
UNFCCC	United Nations Framework Convention on Climate Change