UNITED
NATIONS

UNFCCC Framework Convention on Climate Change

Distr.
GENERAL

FCCC/ARR/2008/AUS
21 January 2009

ENGLISH ONLY

Report of the individual review of the greenhouse gas inventory of Australia submitted in 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.

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I. Overview

A. Introduction

1. This report covers the centralized review of the 2008 greenhouse gas (GHG) inventory submission of Australia, coordinated by the UNFCCC secretariat, in accordance with decision 19/CP.8. The review took place from 1 to 6 September 2008 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalist – Ms. Barbara Muik (Austria) and Ms. Kristina Saarinen (Finland); energy – Mr. Christo Christov (Bulgaria) and Ms. Maria Liden (Sweden); industrial processes – Ms. Karin Kindbom (Sweden) and Ms. Sina Wartmann (Germany); agriculture – Ms. Anna Romanovskaya (Russian Federation) and Ms. Fatou Gaye (Gambia); land use, land-use change and forestry (LULUCF) – Mr. Rizaldi Boer (Indonesia) and Mr. Giacomo Grassi (European Community); and waste – Mr. Faouzi Senhaji (Morocco) and Ms. Medea Inashvili (Georgia). Ms. Romanovskaya and Mr. Senhaji were the lead reviewers. The review was coordinated by Mr. Matthew Dudley (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 UNFCCC review guidelines), a draft version of this report was communicated to the Government of Australia, 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. In its 2008 submission, Australia submitted a complete set of common reporting format (CRF) tables for the period 1990–2006 and a national inventory report (NIR) on 13 June 2008 and a revised NIR on 24 June 2008. Where needed the expert review team (ERT) also used the previous years' submission, resubmissions of the 2007 inventory (on 26 May and 21 October 2008) in response to a concurrent expert review process, additional information provided during the review and other information, and the review reports from the expert review of the 2007 submission. 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, the main GHG in Australia was carbon dioxide (CO_2), accounting for 72.8 per cent of total GHG emissions[1] expressed in CO_2 eq, followed by methane (CH_4) (21.7 per cent), and nitrous oxide (N_2O) (4.4 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 1.1 per cent of the overall GHG emissions in the country. The energy sector accounted for 74.8 per cent of the total GHG emissions, followed by agriculture (16.8 per cent), industrial processes (5.3 per cent) and waste (3.1 per cent). Solvent and other product use accounted for 0 per cent of emissions. Total GHG emissions amounted to 536,065.60 Gg CO_2 eq and increased by 28.8 per cent between the base year and 2006. Total national emissions including LULUCF amounted to 549,852.13 Gg CO_2 eq and increased by 6.6 per cent between the base year and 2006.

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

[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, 1990–2006[a]

Greenhouse gas emissions	Gg CO_2 eq								Change base year–2006 (%)
	Base year	1990	1995	2000	2003	2004	2005	2006	
CO_2	277 802.53	277 802.53	304 440.21	350 031.72	373 873.42	379 374.09	385 613.03	390 435.50	40.5
CH_4	114 653.01	114 653.01	114 435.36	116 282.07	114 272.66	114 486.98	113 874.79	116 226.19	1.4
N_2O	18 102.37	18 102.37	20 196.45	24 989.61	24 373.41	24 500.28	23 730.29	23 648.23	30.6
HFCs	1 126.27	1 126.27	1 420.08	2 240.86	3 532.34	3 884.42	4 251.74	4 648.03	312.7
PFCs	3 950.13	3 950.13	1 312.56	1 103.55	1 443.88	1 469.48	1 533.31	586.63	–85.1
SF_6	521.02	521.02	521.02	523.41	521.02	521.02	521.02	521.02	0.0

[a] Data in the above table does not include all of the revisions submitted by the Party in response to the expert review of the 2007 submission that was still in progress at the time this report was published.

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

Sectors	Gg CO_2 eq								Change base year–2006 (%)
	Base year	1990	1995	2000	2003	2004	2005	2006	
Energy	286 420.00	286 420.00	312 730.44	357 044.30	381 116.74	386 659.85	395 118.08	400 931.18	40.0
Industrial processes	24 141.44	24 141.44	24 509.39	26 150.29	28 697.98	29592.02	28 505.09	28 402.81	17.7
Solvent and other product use	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	NA
Agriculture	86 832.12	86 832.12	86 332.68	94 676.97	91 230.08	91 286.62	89 323.89	90 111.69	3.8
LULUCF	99 719.10	99 719.10	29 729.26	29 748.03	10 842.35	15 975.15	25 281.91	13 786.53	–86.2
Waste	18 761.77	18 761.77	18 753.18	17 299.66	16 971.92	16 697.78	16 577.11	16 619.91	–11.4
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	515 874.43	515 874.43	472 054.94	524 919.24	528 859.08	540 211.42	554 806.09	549 852.13	6.6
Total (without LULUCF)	416 155.33	416 155.33	442 325.68	495 171.21	518 016.73	524 236.27	529 524.17	536 065.60	28.8

Abbreviations: IE = included elsewhere, NA = not applicable; NO = not occurring, LULUCF = land use, land-use change and forestry.

[a] Data in the above table does not include all of the revisions submitted by the Party in response to the expert review of the 2007 submission that was still in progress at the time this report was published.

D. Key categories

6. Australia has reported a key category tier 1 analysis, both level and trend assessment, as part of its 2008 submission. The key category analysis performed by the Party and that performed by the secretariat[2] produced similar results. Australia 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 IPCC good practice guidance) and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as IPCC good practice guidance for LULUCF). The ERT concluded that Australia uses the key category analysis as a driving factor for the preparation of its inventory and as a basis to prioritize the development and improvement of its inventory.

E. Main findings

7. The ERT found that the inventory is of high quality and generally prepared 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. More specifically, the ERT found that the Party has submitted an inventory that is generally complete in its coverage of all sectors, most categories and all years of the inventory time series, as well as in its geographic coverage, and that the Party has reported its inventory in accordance with the UNFCCC reporting guidelines. Emissions by sources or removals by sinks that are not reported by the Party are explained in the NIR to be attributed to a lack of either available information or methodology. Australia has used higher tier methods for most key categories, and uses the key category and uncertainty analyses to prioritize the development and improvement of its inventory. The ERT found that improvement of the inventory is also linked to the Party's quality assurance/quality control (QA/QC) plan and its procedures. The ERT concluded that the inventory is in general consistent and comparable with inventories of other Parties, but does contain a number of potential underestimations (see para. 38 below).

8. The ERT found that Australia has improved the transparency of its inventory by including increased information in the NIR on the national carbon accounting system (NCAS) (tier 3 model) that underpins LULUCF estimates. However, the ERT identified that the transparency of the inventory is inhibited by the fact that emissions for numerous categories in the industrial processes and the solvent and other product use sectors are reported as "confidential", and are subsequently clustered under category other (2.G) in Gg CO_2 eq.

F. Cross-cutting issues

1. Completeness

9. The ERT concluded that Australia submitted an inventory that is generally complete in its coverage of all sectors and most categories, and all years of the inventory time series, as well as in its geographic coverage. Emissions by sources or removals by sinks not reported by the Party are explained

[2] The secretariat identified, for each Party, those source categories that are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the Intergovernmental Panel on Climate Change *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Key categories according to the tier 1 trend assessment were also identified for those 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.

in the NIR to be attributed to a lack of either available information or methodology. The ERT recommends that Australia address the issue of completeness in the inventory (e.g. industrial processes), even if emissions for those categories that are currently reported as "not estimated" ("NE") are considered by the Party to be minor, since these activities do occur in the country; Australia is encouraged to explore simple and reasonable approaches, utilizing expert judgement as necessary, in order to estimate emissions from these categories. The ERT noted that a complete LULUCF inventory was resubmitted by the Party on 21 October 2008 in response to the ERT of a concurrent review process of Australia's 2007 inventory submission, and that this resubmission was prepared after the official 2008 inventory submission.

2. Transparency

10. The ERT concluded that Australia's inventory is in general transparent; this is aided to a great extent by the structure of the NIR, which is prepared in accordance with the UNFCCC reporting guidelines, and from further improvement of the documentation in the NIR on the NCAS tier 3 model.

11. The ERT concluded that descriptions of methodologies could be further improved, especially methods that differ from those provided or recommended in the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. The ERT found that reporting emissions data from numerous categories as an aggregate CO_2 eq in order to manage confidential (commercial-in-confidence) data inhibits the transparency of the inventory. The ERT recommends that Australia explore the ways in which the transparency of this aggregated reporting could be improved for future expert reviews, and recommends that it ensure that future NIRs provide explicit information on any changes to underlying activity data (AD), emission factors (EFs) or methods to estimate emissions from any activities for which reporting is aggregated.

3. Recalculations and time-series consistency

12. The ERT noted that recalculations reported by the Party in its revised 2007 submission[3] have been undertaken for the following reasons: (1) to take into account revisions of data; (2) to respond to recommendations of the 2007 and 2006 expert reviews; and (3) to further improve the inventory. The ERT concluded that these recalculations have been prepared in accordance with the IPCC good practice guidance and that the NIR provides justification for and explanation of these recalculations. The ERT concluded that the 2008 submission was based on the revised 2007 submission, therefore no recalculations were undertaken by the Party between these submissions.

13. The ERT recommends that the additional recalculations made in response to the concurrent 2007 expert review are documented and explained in its next annual inventory submission.

14. The ERT noted that reported recalculations include: revision of the coke CO_2 EF (energy and industrial processes); minor revisions of fuel consumption data (2003 and 2004); inclusion of emissions from surface mining of lignite and sub-bituminous coal; correction to decommissioned mines; revised AD in the agriculture sector (2002–2005); change to crude protein intake for dairy cattle; N_2O emissions from soil disturbance associated with land conversion reallocated from agriculture to the LULUCF sector; revision of AD for prescribed burning; and inclusion of additional activity parameters in the solid waste subsector (textiles, sludge, nappies, and rubber and leather) and emissions from the incineration of

[3] The ERT noted that the concurrent expert review of the 2007 submission commenced in April 2008, which resulted in a submission of revised emission estimates for the 2007 submission on 26 May 2008 with a further resubmission of the LULUCF sector estimates on 21 October 2008; the 2008 CRF submission was received by the secretariat on 13 June 2008 and as such does not include the changes made in the 21 October 2008 resubmission of the 2007 inventory.

municipal solid waste. The rationale for these recalculations is provided in the NIR. Recalculations have resulted in an increase of emissions in the 2005 inventory of 0.04 per cent.

4. Uncertainties

15. The ERT found that Australia has prepared an IPCC tier 1 quantitative estimate of uncertainty and reported this in the format of table 6.1 as prescribed in the IPCC good practice guidance and in accordance with the UNFCCC reporting guidelines. The ERT noted that Australia will broaden the implementation of an IPCC tier 2 estimate of uncertainty in future submissions, and encourages the Party to report developments thereof in its next annual submission. The ERT concludes that Australia uses the results of the uncertainty analysis, in conjunction with its key category analysis, to prioritize improvements to its inventory.

16. The ERT found that the overall uncertainty of the inventory has not changed since the previous submission and is estimated at ± 4 per cent, whereas the trend uncertainty has decreased from ± 2.6 per cent to ± 2.0 per cent. The ERT also found that estimates of uncertainty for some categories are reported as 0 per cent. During the review, the Party clarified that the 0 per cent is inserted for AD and EFs when only the total uncertainty is known. The ERT recommends that Australia provide this explanation in its next inventory submission. The ERT concludes that the reported uncertainty ranges are largely consistent with the typical uncertainty ranges expected for each sector.

5. Verification and quality assurance/quality control approaches

17. The ERT concluded that Australia has elaborated and implemented a QA/QC plan in accordance with the IPCC good practice guidance. This plan includes general tier 1 QC procedures as well as source/sink category-specific tier 2 procedures. The NIR provides sufficient information on its implementation and on the role of the Australian Greenhouse Emissions Information System (AGEIS), the National Greenhouse Gas Inventory Committee and experts (including those involved in the review of sector methodologies and the NCAS). However, the ERT recommends that Australia include in its next annual inventory submission additional information on the verification of the estimates made using the highly sophisticated NCAS model that are used to report emissions and removals from LULUCF.

6. Follow-up to previous reviews

18. Australia has implemented improvements to its inventory including: IPCC tier 3 model for heavy vehicles; improved method for halocarbons to incorporate country-specific data on stationary air conditioners; reporting of CO_2 emissions from the application of agricultural lime; revision of AD and EFs; and the inclusion of external territories in the national inventory.

19. The ERT noted that in response to the concurrent expert review of the 2007 submission, Australia submitted revised LULUCF estimates that include other native forests (forest land remaining forest land), grassland remaining grassland based on a tier 2/3 model construct, and cropland remaining cropland based on full tier 3 methods. The 2008 submission did not include these improvements, as they were submitted by the Party on 21 October 2008 (i.e. after the 2008 inventory had been submitted).

G. Areas for further improvement

1. Identified by the Party

20. The 2008 NIR identified several areas for improvement. Australia indicated that it is working to improve:

(a) Estimates of non-CO_2 emissions from road transportation (second National In-Service Emission Study);

(b) Methods to estimate emissions from mining activities;

(c) Completeness of the industrial processes inventory by exploring new data sources;

(d) EFs (cattle), fire dynamics and fuel loads (burning of savannas) and methodology (fertilizer application) by using field research;

(e) Methods to estimate emissions from LULUCF to incorporate the IPCC good practice guidance for LULUCF approach 3 (tier 3 process-based modelling) and the forest soil carbon model within the NCAS soil carbon pools;

(f) Capabilities for comprehensive reporting of all forms of emissions for all activities on the land from which they occur (e.g. XL remaining XL categories);

(g) Underlying assumptions used in municipal wastewater treatment methodology.

21. The ERT noted that the NIR provides information on the new data collection system (National Greenhouse and Energy Reporting Act) that will provide a basis for generating high quality data on activity, EFs and emissions.

2. Identified by the expert review team

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

(a) The exploration of data sources to improve the completeness of the inventory;

(b) The further improvement of the transparency of the inventory, particularly descriptions of methodologies that differ from those provided or recommended in the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and/or the IPCC good practice guidance for LULUCF;

(c) Preparation of a tier 2 uncertainty analysis for all sectors of the inventory.

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

II. Energy

A. Sector overview

24. In 2006, the energy sector accounted for 74.8 per cent (400,931.18 Gg CO_2 eq) of total GHG emissions. Emissions from this sector increased by 1.5 per cent between 2005 and 2006, and by 40.0 per cent in the period 1990–2006. Key drivers for the trend between 1990 and 2006 are the 53.4 per cent increase in emissions from energy industries, and the 27.4 per cent increase from transport. Energy industry was the main category in 2006, contributing 54.7 per cent to total sectoral emissions, while transport, manufacturing industries and construction, solid fuels (fugitives), other sectors, and oil and natural gas (fugitives) contributed 19.7, 11.8, 6.0, 4.8 and 2.7 per cent, respectively. CO_2 is the dominant GHG, contributing 91.7 per cent to total sectoral emissions, while CH_4 and N_2O contributed 7.6 and 0.7 per cent, respectively.

25. The ERT concluded that the energy sector is generally complete in terms of categories, years and geographical coverage, and that emission estimates have been prepared and reported in accordance with the IPCC good practice guidance; these estimates are generally time-series consistent and the descriptions and methods used are sufficiently documented in the NIR. Higher tier methods and country-

specific EFs have been used to estimate emissions from key categories, and key category analysis and uncertainty analysis are used to drive improvements in the energy sector inventory.

26. The ERT recommends that the transparency of the reporting of AD for stationary combustion be improved in the NIR, with a specific focus on reporting such information at the category level. Currently the NIR includes one page of aggregated AD and an appendix (3.A) that does not provide category-level AD for stationary combustion.

27. The ERT found that recalculations have been undertaken in response to recommendations made by the previous expert review regarding the coke CO_2 EF, revision of fuel consumption data, emissions from surface mining, and a correction to decommissioned mines. The ERT concludes that these recalculations have been performed in line with the IPCC good practice guidance and have resulted in time-series consistent emissions estimates.

28. The ERT noted that Australia hopes to initiate new research to improve country-specific EFs for non-CO_2 emissions from road transportation, and to refine the method for estimating fugitive emissions from coal mines. The ERT recommends that Australia report on the developments of this new research in its next annual inventory submission.

B. Reference and sectoral approaches

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

29. In 2006, Australia reported a difference of 9.2 per cent in CO_2 emissions estimated by the reference and the sectoral approaches. The ERT noted that across the inventory time-series the difference in the total CO_2 value is lower than 2 per cent and therefore does not require an explanation. However, the ERT encourages Australia to consider providing explanations for differences greater than 2 per cent for individual fuels.

30. The ERT noted differences between CRF data and corresponding data from the International Energy Agency (e.g. liquid fuels). The ERT encourages Australia to assess and explain these differences in the NIR.

2. International bunker fuels

31. The ERT concludes that Australia has prepared and reported emissions from international bunker fuels in accordance with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. A taxation levy provides a basis for Australia to differentiate domestic and international fuel consumption, and therefore exclude international bunker fuels from national totals. In response to a question raised by the ERT during the review week, Australia confirmed an error in the reference approach regarding gas/diesel oil for the period 1990–1998. The ERT recommends that Australia rectify this error in its next annual inventory submission.

3. Feedstocks and non-energy use of fuels

32. The ERT found that natural gas and coke are reported in the CRF as non-energy use in the iron and steel category, and emissions from these quantities of these fuels are reported in the industrial processes sector. This change was undertaken by the Party in response to the concurrent expert review of the 2007 submission, and has been undertaken in line with the Revised 1996 IPCC Guidelines.

C. Key categories

Stationary combustion: solid fuel – CO_2

33. In response to a recommendation made during the previous expert review, the coke CO_2 EF in the iron and steel subsector was revised based on the carbon balance of iron production. The reported EF in the NIR is 107.0 Gg/PJ (gross calorific value (GCV)), which incorporates emissions from the combustion of blast furnace gas. The ERT concluded that there is no information in the NIR or the CRF on how the carbon balance was established, and therefore the EF cannot be confirmed. In the Australian methodology for the estimation of GHG emissions and sinks, the carbon EF for coke is reported to be 119.5 Gg/PJ (GCV). The ERT recommends that Australia improve transparency with regard to the EF used and to update documentation in both the NIR and the Australian methodology for the estimation of GHG emissions and sinks, where appropriate. In addition, the ERT recommends that Australia review the coke EF annually to reflect the share of solid fuels used each year.

D. Non-key categories

1. Stationary combustion: liquid fuel – CH_4, N_2O

34. The ERT found emissions from off-road vehicles used in industries and construction are calculated in the same manner as stationary energy categories within the same industry sector. Considering that non-CO_2 emissions are very different for mobile equipment, the ERT recommends that Australia explore the possibility of obtaining AD on the amount of mobile equipment used in industries in order to derive the share of fuel used for mobile equipment, and that the Party then apply mobile non-CO_2 EFs to estimate emissions from the use of this mobile equipment.

2. Railways: liquid fuel – CO_2, CH_4, N_2O

35. In response to a question raised by the ERT during the course of the review, Australia confirmed an error in the reporting of AD in 1997 and 1998. Australia indicated that this error will be rectified in its next annual inventory submission.

III. Industrial processes and solvent and other product use

A. Sector overview

36. In 2006, the industrial processes sector accounted for 5.3 per cent (28,402.81 Gg CO_2 eq) of total GHG emissions. Emissions from this sector decreased by 0.4 per cent between 2005 and 2006, and increased by 17.7 per cent in the period 1990–2006. Key drivers for the trend between 1990 and 2006 are the 892.1 per cent increase in emissions from consumption of halocarbons and SF_6; the 215.7 per cent increase in emissions from chemical industry; a 178.6 per cent increase from other that includes confidential emissions aggregated as CO_2 eq; and the 14.2 per cent increase in emissions from mineral products. A notable trend is the 28.2 per cent decrease in emissions from metal production over the same period. Metal production was the main category in 2006, contributing 38.1 per cent to total sectoral emissions, while mineral products, other, consumption of halocarbons and SF_6, and chemical industry contributed 20.6, 18.5, 18.2 and 4.6 per cent, respectively. CO_2 is the dominant GHG, contributing 79.4 per cent to total sectoral emissions, while HFCs accounted for 16.4 per cent, PFCs for 2.1 per cent and SF_6 for 1.8 per cent. CH_4 and N_2O contributed 0.3 and 0.1 per cent, respectively. N_2O emissions from solvent and other product use are reported under other in the industrial processes sector.

37. The ERT concluded that the industrial processes sector is in general complete in terms of categories, years and geographical coverage, and that emission estimates have been prepared and reported in accordance with the IPCC good practice guidance in that they are time-series consistent and

the descriptions and methods used are sufficiently documented in the NIR. Higher tier methods and country-specific EFs have been used to estimate emissions from key categories. However, the ERT identified that issues regarding completeness and transparency inhibit the quality of the inventory.

38. Minor completeness issues regarding the industrial processes inventory, as noted in the NIR, include: CO_2 emissions arising from the calcination of carbonate during the processing of metallic ores (category other under metal production); CO_2 from food and drink production; emissions from sport shoes, tyres and tennis balls under miscellaneous SF_6 uses; and PFC consumption in refrigeration and fire extinguishers. The CRF states that emissions from the production of dichloroethylene, methanol and metered dose inhalers are reported as "NE" due to a lack of AD; however, the NIR does not refer to this fact. The ERT recommends that Australia improve the completeness of the industrial processes inventory since, even if emissions for those categories currently reported as "NE" are considered by the Party to be minor, these activities do occur in the country; Australia is encouraged to explore simple and reasonable approaches, utilizing expert judgement as necessary, in order to estimate emissions from these categories. In addition, the ERT recommends that Australia ensure that information on completeness is consistent between the NIR and the CRF.

39. The ERT found that the reporting of confidential data for various activities, which are not comparable, under the category other restricts the transparency of the inventory and the capacity to subject category-level data to expert review. The ERT concludes that this aggregation leads to the category other becoming a key category, thus introducing a bias into the key category assessment. A high level of aggregation is encountered in consumption of halocarbons and SF_6, where emissions are reported in an aggregated form as CO_2 eq due to reasons of confidentiality. In both instances, the ERT strongly recommends that Australia develop and implement an approach for reporting emissions data in a transparent manner that supports the expert review.

40. The ERT noted from the NIR that the new data collection system in Australia (National Greenhouse and Energy Reporting Scheme) may provide improved data for estimating emissions from numerous categories in this sector that are currently reported as either "NE", "confidential", and with the use of constant parameters (e.g. electrical equipment).

41. The ERT found that Australia reviews data obtained from companies by comparing the data against known published sources. In addition, for example for carbonates in cement production, AD are reconciled according to data on supply and use.

B. Key categories

Iron and steel – CO_2

42. Australia has used an IPCC tier 1b method to estimate CO_2 emissions. Emissions from in-house lime production as well as lime use are accounted for under the category limestone and dolomite use; emissions are accounted for under energy industries when coal is used as a reducing agent. Natural gas was used as a reducing agent in Australia in the period 2000–2005. Emissions from coke use are determined through a mass balance, using plant-specific AD, IPCC default factors and a country-specific carbon content of the steel produced (0.2 per cent).

C. Non-key categories

Other (chemical industry) – CO_2

43. The NIR describes two means of producing titanium dioxide (TiO_2), namely from naturally occurring rutile ore or from the production of synthetic rutile. Emissions from these activities are presented in both the NIR and the CRF. The NIR states that emissions from TiO_2 production are

confidential and are subsequently aggregated with other confidential emissions in other (chemical industry) for reporting purposes. The ERT recommends that Australia improve transparency in the NIR regarding the explanation of the issue of the allocation of confidential and non-confidential emissions from TiO_2 production.

IV. Agriculture

A. Sector overview

44. In 2006, the agriculture sector accounted for 16.8 per cent (90,111.69 Gg CO_2 eq) of total GHG emissions. Emissions from this sector increased by 0.9 per cent between 2005 and 2006, and by 3.8 per cent in the period 1990–2006. Key drivers for the trend between 1990 and 2006 are the 73.7 per cent increase in emissions from prescribed burning of savannas, and the 12.7 per cent increase in emissions from agricultural soils. Emissions from enteric fermentation decreased by 7.2 per cent over the same period. Enteric fermentation was the main category in 2006, contributing 65.8 per cent to total sectoral emissions, while agricultural soils, prescribed burning of savannas, and manure management contributed 16.9, 12.7 and 4 per cent, respectively. CH_4 is the dominant GHG, accounting for 77.4 per cent of total sectoral emissions, with N_2O accounting for the remainder.

45. The ERT concluded that the agriculture sector is generally complete in terms of categories, years and geographical coverage, and that emission estimates and recalculations have been prepared and reported in accordance with the IPCC good practice guidance in that they are time-series consistent and the descriptions and methods used are sufficiently documented in the NIR. Higher tier methods and country-specific EFs have been used to estimate emissions from key categories.

B. Key categories

1. Enteric fermentation – CH_4

46. The ERT found that Australia has used both country-specific and IPCC default methodologies to estimate emissions from this category, using tier 2 methods for the major livestock types (e.g. cattle). The dominant livestock types within this category are cattle and sheep, with cattle predominantly active in pasture, range and paddock areas.

2. Manure management – N_2O

47. The ERT noted that the estimation of nitrogen excretion is based on equations from the Standing Committee on Agriculture (1990) and Freer et al. (1997), developed in Australia. This method uses a mass balance approach. Australia calculated N_2O emissions from dairy cattle, with protein intake from dairy calves not included due to the early removal of calves from the herd. In response to a question raised by the ERT during the course of the review, Australia indicated that it intends to review the age at which calves are removed from the herd for its next annual inventory submission.

3. Prescribed burning of savannas – CH_4, N_2O

48. The ERT recommends that Australia further improve documentation on the burning efficiencies reported in NIR table 6.30 with respect to whether they are based on actual measurements and whether they are averages. The ERT considers savannas to be very fast to burn and a 1.0 burning efficiency would therefore be more appropriate.

49. The pyrolysis efficiency and the fraction of the fire scar area that is burnt were developed from Australian measurement data. The ERT considers the pyrolysis efficiency for fine fuel to be as high as 1; the efficiency is much lower for woody fuels that are coarse and heavy. However, the ERT found that

the reported values were reviewed by experts in 2004 and were consistent with values reported in other countries.

V. Land use, land-use change and forestry

A. Sector overview

50. In 2006[4], the LULUCF sector in Australia was a net source of 13,786.53 Gg CO_2 eq. Emissions from this sector decreased by 86.2 per cent between 1990 and 2006, and its contribution to total GHG emissions in 2006 was 2.5 per cent. The contribution of non-CO_2 emissions to the total sectoral emissions increased from 7.3 per cent in 1990 to 41.1 per cent in 2006. The key driver for the decrease in emissions is the significant decrease in the area of forest land converted annually to other land uses (deforestation). According to the NIR, the area deforested annually decreased from 562 kha in 1990 to 334 kha in 2005, and the corresponding emissions decreased from 136,492.36 Gg CO_2 eq in 1990 to 74,103.07 Gg CO_2 eq in 2005. The second driver for the decrease in total emissions from this sector was the increase in removals in land converted to forest land, from –2,045.58 Gg CO_2 eq to –22,792.53 Gg CO_2 eq between 1990 and 2006.

51. The ERT identified several issues in relation to the representation of land areas:

(a) The representation of land areas in the 2008 submission includes a balancing term (non-anthropogenic forest – grassland transition), which results in an inconsistency in total land areas over time reported in the CRF tables. The ERT noted that a revised land area representation was submitted by Australia in response to questions raised by the ERT of a concurrent expert review process (of Australia's 2007 submission and that the balancing term had been removed. The ERT recommends that Australia improve the transparency of the inventory by providing annual land-use change matrices in its next annual inventory submission;

(b) For 2006, data on total forest extent was not yet available at time of compiling emission estimates for this land use, areas for some subcategories are reported as "NE", although the corresponding emissions were reported as the average of 2003–2005 data. The ERT recommends that, in the absence of updated data, Australia explore the possibility of extrapolating the previous years' data or that it use consistently the same value as the latest available year for both AD and emissions;

(c) In the NIR it is stated that "Australia has not, so far, selected a period of time after which reporting land is moved from a land use conversion subcategory to a land use remaining subcategory" in order to avoid the reporting of unintended artefacts in its tier 3 inventory, and that "in future submissions Australia plans to institute the method proposed in the 2006 IPCC Guidelines which is to subdivide the land remaining category to provide a strata of land remaining that is for lands that are in later stages of transition following land-use change". The ERT concluded that this issue is important in the context of the transparency and comparability of the LULUCF inventory.

52. The Australian LULUCF methodology contains predominantly country-specific methodology and tier 3 models. The emission and removal estimates are largely derived from the FullCAM model developed under the NCAS, which integrates field measurements, modelling and remote sensing with the aim of providing full coverage of Australia's land territory and capability for spatial and temporal

[4] As submitted by Australia in its official 2008 submission to the UNFCCC secretariat. Revised emission estimates for the 2007 submission were submitted to the ERT of a concurrent expert review process that was still in progress at the time this report was published.

tracking of land-use activities and the associated emissions and removals of GHGs. For the 2008 submission, full NCAS capabilities (fully spatially explicit process-based ecosystems modelling) have only been completed for the conversion of forest land to other land uses. However, the ERT noted in the resubmission of the 2007 submission (on 21 October 2008) that full NCAS capabilities were used to estimate emissions also for cropland remaining cropland and NCAS capabilities were partially used for grassland remaining grassland.

53. Australia's efforts in the development, implementation and documentation (including technical reports, public release of the tools used for inventory compilation and publications in peer-reviewed literature) of its highly sophisticated and advanced accounting system are impressive and were commended by the ERT. However, given the difficulty of reviewing a complex model such as FullCAM, the ERT recommends that Australia improve the transparency of such models, including verification efforts, in its next annual inventory submission. The provision of such information would be extremely useful in supporting the evaluation of the tier 3 model results and, ultimately, in increasing confidence in the inventory data. More specifically, the ERT recommends that Australia include the following in the NIR:

(a) A comparison of the tier 3 modelled LULUCF inventory with results from another tier methodology (IPCC good practice guidance for LULUCF, p. 5.70), possibly tier 2, together with adequate explanations of the differences with the tier 3 model results;

(b) A sensitivity analysis for all of the most important parameters used in the model, together with a detailed justification of the values selected for those that are most relevant (e.g. the age of the maximum current aboveground biomass increment (CAI) used for forest growth and the age at which mature biomass is reached);

(c) More data related to the verification of the model results;

(d) A detailed description and justification of unusual patterns emerging from the tier 3 model that are reported in the inventory (e.g. the relevant soil carbon sink in forest land converted to cropland category).

54. The ERT reiterates the recommendation of previous expert review regarding the importance to implement the appropriate changes in the software model to provide flexibility in responding to data requests from a future ERT.

55. For forest lands converted to cropland and grassland, the age of maximum CAI is set at 10 years for all species and growth conditions, based on data such as those reported by West and Mattay (1993) on six Eucalyptus species. As a consequence, the age at which 'mature biomass' is reached seems to be close to 20 years. During the review, the Party clarified that at around 20 years the modelled biomass should have entered the range of values used to calibrate the assumed initial biomass, and it may not necessarily have reached 'mature biomass'. In any case, given that these values appear very different when compared with literature from other countries, and given the importance of these parameters for modelling forest growth, the ERT recommends that Australia:

(a) Further improve the documentation and justification on the selection of the CAI in the NIR;

(b) Include in the NIR the consequences of using different CAI values for the model results (i.e. sensitivity analysis);

(c) Further clarify the concept of 'mature biomass' in the context of the model used.

56. The ERT noted that the CH_4 EF for biomass burning reported by Australia in the NIR is below the range of EFs recommended by the IPCC good practice guidance for LULUCF (0.009–0.015 Gg elements in species/Gg element in burnt fuel). The ERT noted that during the 2006 expert review Australia indicated that a review of its methodologies for this source was planned as part of the NCAS development plan. However, the same EF is reported in the 2008 NIR and no plan to review this value was mentioned. Given the importance of this EF for total emissions from the LULUCF sector in Australia, the ERT recommends that Australia review this EF or, alternatively, explain in the NIR the possible reasons for the difference between this value and those set out in the IPCC good practice guidance for LULUCF.

57. For the cropland remaining cropland and grassland remaining grassland, Australia in its official 2008 submission reported no carbon stock changes in either the biomass or dead organic matter pools (following the IPCC tier 1 method), or in the soil pool, as it is assumed that the soil carbon stocks have reached equilibrium. The ERT noted that emission estimates for cropland remaining cropland and grassland remaining grassland were submitted by Australia in response to questions raised by the ERT of a concurrent expert review process of the 2007 inventory submission. In addition, the ERT noted that the abovementioned emission estimates were submitted for the period 1990–2005 and were based on a combination of tier 2 and tier 3 methods for the categories cropland remaining cropland, grassland remaining grassland and the subdivision other native forest. The ERT recommends that Australia incorporate this improvement into its next annual inventory submission.

B. Key categories

1. Forest land remaining forest land – CO_2

58. The ERT noted that Australia is not yet in a position to identify managed and unmanaged forest land. The ERT reiterated the recommendation from the 2006 expert review regarding the distinction between managed and unmanaged forest land and requests Australia to resolve this problem and to report thereon in its next annual inventory submission.

2. Land converted to forest land – CO_2

59. The ERT noted that this category only includes post-1990 plantations, while under the Convention all lands converted to forest in the last 20 years (or another specified transition period) should be reported. For comparability purposes, the ERT encourages Australia to follow the Convention reporting criteria in its next annual inventory submission.

60. The ERT noted that no changes in soil carbon stock are reported for this category. Given that the Party reports a change in the carbon stock for forest land converted to cropland and forest land converted to grassland, the ERT recommends that Australia estimate and report changes in soil carbon stock for land converted to forest land.

3. Land converted to cropland – CO_2

61. When forest land is converted to cropland, the Party generally reports a significant increase in carbon stock in the soil pool (with large variations from year to year) and, in some cases, these increases almost compensate for the loss of carbon in aboveground biomass. The ERT recommends that Australia further improve the documentation of and justification for this very unusual pattern.

4. Land converted to grassland – CO_2

62. In the NIR, the Party states that “cyclic forest regrowth and reclearing of woody regrowth in grassland is continuously reported under forest land converted to grassland”. The ERT recommends that Australia provide in the NIR an explanation on the rationale for this choice.

VI. Waste

A. Sector overview

63. In 2006, the waste sector accounted for 3.1 per cent (16,619.91 Gg CO_2 eq) of total GHG emissions. Emissions from this sector increased by 0.3 per cent between 2005 and 2006, and decreased by 11.4 per cent in the period 1990–2006. Key drivers for the fall in emissions between 1990 and 2006 are the 11.4 per cent decrease in emissions from solid waste disposal on land and the 10.4 per cent decrease in emissions from wastewater handling. Solid waste disposal on land was the main category in 2006, accounting for 79.2 per cent of total sectoral emissions, while wastewater handling accounted for 20.6 per cent and waste incineration for 0.2 per cent. CH_4 is the dominant GHG, contributing 96.3 per cent to total sectoral emissions, while N_2O and CO_2 contributed 3.5 and 0.2 per cent, respectively.

64. The ERT concluded that the waste sector is generally complete in terms of categories, years and geographical coverage. Emission estimates have been prepared and reported in accordance with the IPCC good practice guidance in that these estimates are generally time-series consistent and the descriptions and methods used are sufficiently documented in the NIR. Higher tier methods and country-specific EFs have been used to estimate emissions from solid waste disposal on land, while an IPCC default method has been used for the other key category (wastewater handling). Australia has reported N_2O emissions from solid waste disposal on land, wastewater handling and waste incineration as "NE". In response to a recommendation from the previous expert review, Australia has commenced reporting N_2O emissions from human sewage.

B. Key categories

1. Solid waste disposal on land – CH_4

65. The ERT found that the driving influence for the decrease in emissions from this category is an increased recovery of CH_4, comprising 4.6 Gg CO_2 eq in 2006. The ERT noted that Australia states that all solid waste disposals on land are managed. The methodology used is consistent with the IPCC tier 2 first order decay method and methods included in the recognized international scientific literature, and high level disaggregation is considered according to data composition and climatic conditions. AD have been collected using a model driven by landfill data provided by state/territory government agencies responsible for waste management. The ERT noted that unavailable AD from 1940 to 1990 have been estimated in order to provide a time series for that period. The methodology and data are well-referenced and reported in the NIR.

66. The ERT reiterates the recommendation from the previous expert review regarding the error in CRF table 6.A and the additional information table concerning the degradable organic carbon value and requests Australia to resolve and report on this problem in its next annual inventory submission.

67. Australia has reported in the NIR that one source of municipal solid waste is sludge from wastewater handling. The ERT found that the CH_4 emissions from sludge are reported in CRF table 6.B for both industrial wastewater and domestic and commercial wastewater. Australia is encouraged to further improve documentation on this issue in the NIR in order to clarify that double-counting is avoided.

2. Wastewater handling – CH_4

68. The ERT concluded that Australia still uses an IPCC default method for this key category. The methodologies used and the underlying data are well described and referenced in the NIR. The ERT encourages Australia to provide more information on sludge from wastewater handling in order to clarify the abovementioned issue on its treatment in solid waste disposal sites.

69. The ERT found that the CH_4 EF is derived from the country-specific ratio of chemical oxygen demand to biochemical oxygen demand, regardless of the removed amount of degradable matter on-site at industrial wastewater facilities. The ERT encourages Australia to provide improved documentation and explanation of this EF in its next annual inventory submission.

VII. Conclusions and recommendations

70. The ERT concluded that Australia has prepared its inventory generally in line with the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF, and has reported the inventory in accordance with the UNFCCC reporting guidelines. The inventory is in general complete in terms of its coverage of all sectors and most categories, and all years, gases and territories. The ERT found that the completeness of the inventory could be improved; however the ERT noted that the Party submitted complete LULUCF estimates on 21 October 2008 in response to an ERT of a concurrent expert review of the 2007 inventory submission.

71. The ERT concluded that the inventory is in general consistent and generally comparable with inventories of other Parties, but it does contain potential underestimations (see para. 38 above).

72. The ERT concluded that Australia has used higher tier methods for most key categories, and uses the key category and the uncertainty analyses to prioritize the development and improvement of its inventory. The ERT found that improvement of the inventory is linked to the Party's QA/QC plan and its procedures.

73. The key recommendations are that Australia:

(a) Further improve the completeness of the inventory by reporting emissions by sources and removals by sinks for activities that do occur in the Party;

(b) Further improve the transparency of the inventory by providing detailed information in the NIR on methods and data, particularly for those methods that differ from those provided or recommended in the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and/or the IPCC good practice guidance for LULUCF, or higher tier methods (e.g. NCAS and FullCAM models);

(c) Rectify identified errors in, and/or inconsistencies between, the NIR and the CRF;

(d) Address transparency issues regarding the reporting of aggregated emissions data in the industrial processes sector;

(e) Address issues regarding the representation of land areas in the LULUCF sector;

(f) Improve reporting in the chapter in the NIR on LULUCF by providing results of verification efforts, sensitivity analyses for the most important parameters and improved documentation on the selection of parameters (e.g. CAI).

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>.

Status report for Australia 2008. Available at <http://unfccc.int/resource/docs/2008/asr/aus.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/2007/AUS. Report of the individual review of the greenhouse gas inventory of Australia submitted in 2007. Available at <http://unfccc.int/resource/docs/2007/arr/aus.pdf>.

B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Robert Sturgiss and Ms. Penny Reyenga (Department of Climate Change), including additional material on the methodology and assumptions used.

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