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Report of the individual review of the greenhouse gas inventory of Australia submitted in 2006*

* In the symbol for this document, 2006 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 2006 greenhouse gas (GHG) inventory submission of Australia, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8. The review took place from 15 to 19 January 2006 in Bonn, Germany, and was conducted by the following team of nominated experts from the roster of experts: generalist – Mr. Paul Filliger (Switzerland) and Ms. Inga Konstantinaviciute (Lithuania); energy – Mr. Christo Christov (Bulgaria), Mr. Javier Gonzalez (Spain) and Mr. Francis Yamba (Zambia); industrial processes – Mr. Menouer Boughedaoui (Algeria) and Mr. Hongwei Yang (China); agriculture – Mr. Paul Duffy (Ireland) and Mr. Mahmoud Medany (Egypt); land use, land-use change and forestry (LULUCF) – Mr. Leandro Buendia (Philippines) and Mr. Sandro Federici (Italy); waste – Ms. Tatiana Tugui (Moldova) and Mr. Hiroyuki Ueda (Japan). Ms. Tatiana Tugui and Mr. Paul Duffy were the lead reviewers. The review was coordinated by Mr. Javier Hanna (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", a draft version of this report was communicated to the Government of Australia, which provided comments that were considered and incorporated, as appropriate, in this final version of the report.

B. Inventory submission and other sources of information

3. In its 2006 submission, Australia has submitted a complete set of common reporting format (CRF) tables for the years 1990–2004 and a national inventory report (NIR). Where needed the expert review team (ERT) also used the previous year's submission, additional information provided during the review and other information. The full list of materials used during the review is provided in the annex to this report.

C. Emission profiles and trends

4. In 2004, the most important GHG in Australia was carbon dioxide (CO_2), contributing 73.0 per cent of total[1] national GHG emissions expressed in CO_2 equivalent (71.7 per cent of total national GHG emissions including LULUCF), followed by methane (CH_4), 21.2 per cent (22.2 per cent of total national GHG emissions including LULUCF) and nitrous oxide (N_2O), 4.7 per cent (4.9 per cent of total national GHG emissions including LULUCF). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) taken together contributed 1.1 per cent of overall GHG emissions in the country both including and excluding LULUCF. The energy sector accounted for 73.9 per cent of total GHG emissions, followed by agriculture (17.1 per cent), industrial processes (5.8 per cent) and waste (3.3 per cent). The LULUCF sector was a net sink in 2004 of 6,993.49 Gg of CO_2. Total GHG emissions amounted to 525,914.4 Gg CO_2 equivalent excluding LULUCF and 525,674.61 Gg CO_2 equivalent including LULUCF. Total national GHG emissions increased by 25.7 per cent between 1990 and 2004 (by 5.2 per cent if the LULUCF sector is included).

D. Key categories

5. Australia has reported a key category tier 1 analysis, both level and trend assessment, including and excluding LULUCF, as part of its 2006 submission. The key category analyses performed by

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

Australia and the secretariat[2] produced similar results. The small differences between these two analyses arise because Australia is using a more detailed category structure. Australia has identified more than 50 key categories based on both level and trend assessment. The results of the key category analysis are used to prioritize the development of the inventory. The ERT encourages Australia to incorporate the tier 2 approach in identifying key categories in its future inventories.

E. Main findings

6. The quality of Australia's inventory submission is high. The structure of the NIR in general is consistent with the structure outlined in 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). The NIR includes information on key categories, and gives very comprehensive and transparent descriptions of methodologies used, activity data (AD), emission factors (EFs), uncertainty estimates, quality assurance/quality control (QA/QC) procedures and the overall structure of the national inventory system. The data provided in the CRF are largely consistent with the information provided in the NIR. Australia uses a combination of country-specific and the Intergovernmental Panel on Climate Change (IPCC) methodologies (predominantly tier 2) and EFs.

F. Cross-cutting topics

1. Completeness

7. The overall completeness of the inventory in terms of years and geographic coverage is good. Almost all sources and sinks are covered, as are the relevant GHGs (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) and the indirect GHGs nitrogen oxides (NO_X), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs), as well as sulphur dioxide (SO_2). The 2006 submission complements the previous submission with estimates of N_2O emissions from soil disturbance taking into account the recommendations of the previous ERT. The summary of categories not included is provided in CRF table 9 and in annex 5 to the NIR. Categories that are not estimated are assumed to be of only minor importance and to make no significant contribution to total national emissions.

2. Transparency

8. The information provided in the NIR is generally transparent and allows for assessment of the underlying assumptions and the rationale for choices of methods, EFs and other inventory parameters. The NIR is better documented than previous submissions and the use of the notation keys in the CRF tables has been revised and improved compared with the previous submission.

3. Recalculations and time-series consistency

9. The ERT noted that recalculations of the time series 1990–2003 reported by Australia have been undertaken in all sectors. CRF tables 8(a) were used for checking the recalculations of emissions since Australia's May 2006 submission.

10. The reasons for the recalculations are described in chapter 10 of the NIR and in the sectoral chapters, as well as in CRF table 8(b), and are adequately justified. The most important changes for 1990 are the recalculations of N_2O emissions in the energy sector and of CO_2 and CH_4 emissions in the

[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 IPCC good practice guidance for LULUCF. 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 year 1990. 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.

waste sector due to the revision of methodologies and AD. The resulting changes in the estimates of total CO_2 equivalent emissions are 0.1 per cent for 1990 and 0.2 per cent for 2003 (excluding LULUCF). For the year 1990 the sectoral differences between the 2005 and 2006 submissions are: (i) CO_2 emissions: energy 0.6 per cent; industrial processes –12.3 per cent; waste 83.6 per cent; (ii) CH_4 emissions: energy 1.1 per cent; industrial processes –0.7 per cent; agriculture –6.1 per cent; waste 82.8 per cent; and (iii) N_2O emissions: energy –42 per cent; industrial processes –19.6 per cent; agriculture –6.9 per cent. The ERT recommends Australia to include more detailed information on the reasons for these recalculations in its next NIR to improve transparency.

4. Uncertainties

11. Australia has provided quantitative uncertainty estimates for the level (2004) and the trend using the tier 1 method. The estimates are prepared using expert judgement. The total inventory uncertainty of 4 per cent reported is quite low and has been reduced since the Party's previous submission. Taking into account the recommendations of the previous ERT, Australia reported separate uncertainty estimates for AD and EFs using table 6.1 of the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance). Only the overall uncertainty is reported for enteric fermentation, manure management, agricultural soils, forest land, cropland, solid waste disposal on land, waste-water handling and waste incineration (NIR table A.7). The ERT encourages Australia to investigate the possibility of providing more information on these uncertainties for future submissions and to footnote the use of zero in columns E and F of table A.7 of the NIR.

12. Table 10.4 in the NIR shows the clear link between the inventory improvement plan and the uncertainty estimates. Australia has already conducted uncertainty estimates for the industrial processes sector and some agriculture categories using the Latin Hypercube approach. The ERT welcomes Australia's plan to undertake more extensive tier 2 analysis (using the Monte Carlo method) in the future.

5. Verification and quality assurance/quality control approaches

13. A QA/QC plan and a description of QA/QC activities are included in the NIR. In 2005 Australia introduced the Australian Greenhouse Emissions Information System into the inventory production process. Tier 1 QA/QC procedures for inventory compilation have been systematically built in to this system. The NIR states that Australia integrates QC procedures fully into the compilation process, as well as centralizing the estimation of emissions, inventory compilation, reporting and data storage activities. Tier 2 QC checks on domestic waste-water emissions are reported. The NIR states that QA activities are generally undertaken by external experts. The ERT encourages Australia to continue the introduction of source category-specific QC procedures (tier 2).

6. Follow-up to previous reviews

14. Australia has implemented many of the recommendations from previous reviews: the transparency of the NIR has been improved by including the respective sectoral chapters according to the UNFCCC reporting guidelines; a number of source/sink categories that were previously not estimated have been included in the 2006 inventory submission; and separate uncertainty estimates for AD and EFs using table 6.1 of the IPCC good practice guidance have been reported.

G. Areas for further improvement

1. Identified by the Party

15. The NIR identifies several areas for improvement, including sectoral methodologies and data sources. Prioritization of improvements is done taking into account the results of the key category and uncertainty analyses as well as comments received from previous reviews. Planned improvements are summarized in table 10.4 of the NIR.

2. Identified by the ERT

16. The ERT recognized that the Australian inventory is sufficiently complete and the NIR provides very comprehensive and transparent descriptions of the methodologies, AD and EFs used. The ERT identifies the following cross-cutting issues for improvement. Australia should:

(a) Incorporate the tier 2 approach to identify key categories in its future inventories;

(b) Provide more details in the NIR on the impact of the recalculations, to increase transparency;

(c) Continue developing its uncertainty estimates using the tier 2 method.

17. The estimation of emissions/removals in the LULUCF sector should be further improved, as set out in section V below. Other improvements relating to specific source/sink categories are presented in the relevant sector sections of this report.

II. Energy

A. Sector overview

18. In 2004, the energy sector contributed 73.9 per cent of total national GHG emissions, and CO_2 emissions from the sector contributed 93.6 per cent of the total CO_2 emissions of Australia. The energy industries category contributed 40.8 per cent and transport 15.1 per cent of total national GHG emissions. Emissions from fuel combustion increased by 38.8 per cent between 1990 and 2004, mainly due to increasing emissions in energy industries, other sectors and transport.

19. The reporting of the energy sector is transparent. The calculation methodologies are summarized and extensively documented in the NIR, and detailed descriptions can be found in the methodology workbooks which are part of the Australian submission.

20. Recalculations for the period 1990–2003 have been performed in the energy sector. The recalculations are due to the release of updated national statistics of the Australian Bureau of Agricultural and Resource Economics (ABARE) for energy industries (public electricity), manufacturing industries and construction, and transport categories; emissions from non-energy use for industrial processes (ammonia production) being separated out from the energy sector (manufacturing industries and construction); and the adoption of a refined methodology for estimating non-CO_2 emissions for passenger gasoline cars and civil aviation. Similar recalculations have been performed for coal mining and handling due to the inclusion of emissions from decommissioned mines and fugitive emissions from oil and gas following updating of the statistical data for natural gas.

21. Australia reports that it uses tier 1 methods for some non-CO_2 key categories (e.g. navigation, railways). The ERT encourages Australia to review its classifications and to extend its tier 2 methods to all non-CO_2 categories in transport, especially for N_2O, as recommended in the IPCC good practice guidance (page 2.51).

B. Reference and sectoral approaches

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

22. CO_2 emissions from fuel combustion have been calculated using the reference approach and the sectoral approach. For the year 2004, there is a difference of –0.56 per cent in the CO_2 emission estimates between the reference approach and the sectoral approach, which is explained in the documentation box to CRF table 1.A(c).

23. The primary and secondary fuel quantities used for calculating apparent consumption are reported in energy units (PJ), while the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines) recommend the use of natural units (tons and m^3). The oxidation factors used for some liquid and solid fuels and natural gas (0.99 and 0.995) in the reference approach are high. The ERT recommends that Australia report the natural units and revise the oxidation factors for the reference and sectoral approaches.

24. Apparent consumption in the reference approach corresponds to the International Energy Agency (IEA) data, within about 5 per cent for all years. For 2004, the apparent consumption in the reference approach is 4.2 per cent higher than the IEA data, mainly due to a large quantity of stock changes for crude oil that is reported in the CRF. The growth rate over the period 1990–2004 for total apparent consumption is 39 per cent according to the CRF but 32 per cent according to the IEA. Both the CRF and the information sent to the IEA rely on data published by ABARE; however, differences may arise due to revisions to the ABARE data. Australia is encouraged to reconcile the data provided to international organizations following the revision of the ABARE data set.

2. International bunker fuels

25. The data for international aviation and international marine bunkers, as reported in CRF table 1.C, are generally comparable with those reported to the IEA. For 2003 and 2004 the figures for the consumption of jet kerosene are 20 per cent lower in the CRF tables than the IEA data, while the figures for consumption of residual fuel oil for marine bunkers are 20 per cent higher in the IEA data than in the CRF tables for the two years 1993–1994 (for 2002–2003 an opposite discrepancy is observed). In the CRF, discrepancies are observed between table 1.C and table 1.A(b) for jet kerosene (international aviation) and residual fuel oil (international marine bunkers) for the two years 2000–2001, and for gas/diesel oil (international marine bunkers) for the period 1990–1998. The ERT recommends Australia to provide explanations for the differences and correct the discrepancies in its next submission.

3. Feedstocks and non-energy use of fuels

26. The NIR states that in the category chemicals a separate supply of ethane is widely used as feedstock. It is not clear from the NIR or the CRF tables whether this ethane is properly accounted as fuel and feedstock. The ERT recommends Australia to explain this in its next inventory submission.

C. Key categories

1. Public electricity and heat production: gas – CO_2

27. The 2004 value of the CO_2 implied emission factor (IEF) for public electricity and heat production (60.51 t/TJ) is the highest of all reporting Parties (the range is 54.07–60.51 t/TJ), and for the period 1998–2003 the CO_2 IEFs are among the highest of reporting Parties. Australia explained in its comments made in response to the previous review stages that one portion of the energy usage was not reported in the CRF tables (coal-seam gas), although the emissions were reported. This resulted in an overestimation of the IEFs which will be rectified in subsequent submissions. The ERT noted that the coal-seam gas EF is not reported in the NIR either. The ERT encourages Australia to report these missing data in its next submission and to provide the necessary information in the NIR.

2. Public electricity and heat production: solid – CO_2

28. The tier 2 approach is used for this category, where the emissions are calculated plant by plant based on plant-specific EFs. The oxidation factors (from 0.98 to 1.00) that are reported in the NIR for the specific power plants are generally higher than the IPCC-recommended oxidation factor (0.98). The methodology that is applied for measuring and calculating the oxidation factors at the power plants should be checked and documented in Australia's next submission.

3. Manufacture of solid fuels and other energy industries: solid – CO_2

29. The solid fuels CO_2 IEF in 2004 (85.15 t/TJ) is at the lower end of the range of reporting Parties (the range is 44.21–199.01 t/TJ). The reasons, as reported in the NIR, originate in the combustion of gaseous coal by-products in this category. The EF reported for these by-products is 40.7 t/TJ and is 14 per cent lower than the IPCC default value. The ERT recommends Australia to provide more explanation of this in its next submission.

4. Manufacturing industries and construction: gas – CO_2

30. The CO_2 IEFs for the category chemicals for the period 1990–2001 and for 2003 (ranging from 56.83 t/TJ to 59.05 t/TJ) are the highest or at the high end of the range of reporting Parties and are higher than the IPCC default value (56.1 t/TJ). The trend is unstable and fluctuates. Australia explains that the variations are a result of the varying contribution of town gas to energy usage in this category. Higher proportions of town gas result in the higher IEFs. The NIR reports that town gas is produced from liquefied petroleum gas (LPG) and natural gas, assuming that all LPG is converted to town gas, and none is combusted in the conversion process. The ERT encourages Australia to provide further information on the ratio of natural gas to LPG in the town gas and, if LPG has the larger share, consider town gas within liquid fuels; otherwise Australia may allocate emissions between liquid and gaseous fuels in the correct proportion.

5. Manufacturing industries and construction: solid – CO_2

31. The solid fuels CO_2 IEF (56.40 t/TJ) in 2004 for the category iron and steel is among the lowest of reporting Parties (the range is 4.62–200.57 t/TJ). The reasons for the unusually low IEF originate in the combustion of gaseous coal by-products in the subsector. Australia's NIR discusses the EFs for these products under the categories manufacture of solid fuels and other energy industries. The ERT recommends Australia to provide more information on this in its next submission.

6. Civil aviation: liquid – CO_2

32. Over the period 1990–2004, CO_2 emissions increased by 65.3 per cent (from 2,893.91 Gg to 4,783.55 Gg). The trend fluctuates, particularly between 1990 and 1991, between 1994 and 1995, and between 2001 and 2002. The increase of CO_2 emissions in the early 1990s is justified in the NIR but the large decline between 2001 and 2002 is not explained. The ERT recommends that the fluctuations in the trend be better documented in Australia's next submission.

7. Road transportation: gas, liquid – CO_2

33. The CO_2 emissions trend fluctuates, particularly between 1990 and 1991, between 2000 and 2001 and between 2002 and 2003. A decrease in emissions between 1990 and 1991 is explained by the influence of an economic recession. The decrease between 2002 and 2003 has been checked and adjusted to 0.95 per cent as observed in recalculations provided by the Party; however, the unusual decrease of emissions between 2000 and 2001 is not explained in the NIR. The ERT recommends Australia to review the data as the natural gas consumption data in the past three years seem too low to be reasonable, and to provide better documentation on the trends in this category in its next submission.

8. Road transportation: gas, liquid – N_2O

34. A new methodology and a new set of AD led to recalculation of the estimates for N_2O emissions in the 2006 submission. The recalculated estimates are significantly lower than those estimated using the previous methodology. This decrease is consistent for the whole time series: it ranges from 63.6 per cent to 75.5 per cent, and has an impact in the whole energy sector. The ERT noted that the revised IEFs for this sector are consistent with those of other Parties. The ERT also noted that the reason for revising this methodology is explained in Australia's May 2006 submission.

9. Navigation: gas, liquid, solid – CO_2

35. As mentioned in previous review stages, the trend of CO_2 emissions fluctuates considerably between 1994 and 1999. Australia addressed this issue in its response to previous review stages and the emissions time series have been recalculated. The fluctuations are lower but still very significant between 1994 and 1995, between 1997 and 1998, and between 1998 and 1999 (19.8 per cent, –12.6 per cent and –11.6 per cent, respectively). No explanations of these fluctuations are provided in the NIR. The ERT recommends that Australia document the reasons for the fluctuations in the trend of CO_2 emissions for this category in its next submission.

36. As mentioned in previous review stages, over the period 1990–1998 the CO_2 IEFs of gas/diesel oil decreased significantly (from 126.58 t/TJ to 72.84 t/TJ), and in the periods 1990–1994 and 1997–1998 they are the highest of the reporting Parties. Australia has explained that the problem arose from a reporting error and that the IEFs reported are not correct; however, the CO_2 emissions are reported correctly. The ERT recommends Australia to correct the IEFs reported for this category in its next submission.

10. Oil and natural gas – CO_2 and CH_4

37. Under oil – exploration, the notation key "not applicable" ("NA") is reported for AD, but CO_2, CH_4 and N_2O emissions are reported. At the same time, AD and emissions for natural gas – exploration are reported as included elsewhere ("IE"), indicating that data for this category are included under oil – exploration. The ERT recommends that Australia improve the consistency and transparency of its reporting of AD and its use of the notation keys in its next submission.

11. Coal mining and handling – CH_4

38. CH_4 emissions from decommissioned mines have been estimated using a tier 2/tier 3 method which models the decline of emissions following mine closure using emission decay curves (EDCs) for dry gassy and non-gassy mines. In addition, the EDCs are adjusted on a mine-by-mine basis according to the flooding characteristics of each mine. Australia is commended for using a higher-tier method based on the recently reviewed international scientific literature for estimating emissions from decommissioned mines.

D. Non-key categories

Other sectors: biomass – CO_2 and CH_4

39. For the residential category, the value of the CO_2 IEF (81.58 t/TJ) in 2004 is among the lowest of reporting Parties (the range is 0.007–110.00 t/TJ). The values of the CH_4 IEF – of 751.78 kg/TJ in 2004, and 1,158 kg/TJ in 1990 – are much higher than the default value in the Revised 1996 IPCC Guidelines (300 kg/TJ), although the 2004 value is consistent with the recently published recognized international literature. References to national publications are given in the NIR, but more information is needed to facilitate the ERT's assessment of the accuracy of the EFs. The ERT recommends Australia to provide more background information to justify the choice of the EFs for biomass in its next submission.

III. Industrial processes and solvent and other product use

A. Sector overview

40. In 2004, emissions from the industrial processes sector accounted for 5.8 per cent of total national GHG emissions. Within the sectoral total, in 2004 CO_2 accounted for 80.4 per cent, CH_4 for 0.2 per cent, N_2O for 0.1 per cent and fluorinated gases for 19.3 per cent. It should be noted that data on emissions from the following categories are confidential: soda ash production and use (CO_2), magnesia production (CO_2), nitric acid production (N_2O), ammonia production (CO_2), acetylene use (CO_2) and the

use of N_2O in aerosols and anaesthesia (N_2O). Together these accounted for 16.6 per cent of the total emissions from the sector in 2004. Emissions from industrial processes increased by 20.9 per cent from 1990 to 2004 and by 3.2 per cent from 2003 to 2004, mainly due to growth in emissions associated with the consumption of halocarbons and the categories making up confidential emissions reported in terms of CO_2 equivalent.

41. The inventory includes estimates of most sources of emissions from the industrial processes sector, and the relevant methodologies used in calculating these estimates are described in more detail in separate documents which are available from the Australian Greenhouse Gas Office website. On the other hand, as indicated in previous review stages and in the 2005 review report, emissions from road paving with asphalt, dichloroethylene, methanol, and food and drink, and SF_6 emissions from magnesium foundries (2000–2004), are still reported as not estimated ("NE"). The ERT encourages Australia to provide estimates for these categories in order to improve the completeness of its inventory wherever applicable.

42. Because they are aggregated into one category due to data confidentiality, the emissions from the categories mentioned in paragraph 40 are identified as a key category. This may distort the key category analysis, as other presently non-key categories may become key if this "artificial" big category is disaggregated into smaller groups. In response to the ERT's questions during the review, Australia mentioned that it is considering this as a possibility for future improvement. The ERT encourages Australia to consider ways of reporting these categories in a more disaggregated way so as to ensure better results of the key category analysis while maintaining the necessary confidentiality.

B. Key categories

1. Cement production – CO_2

43. The ERT welcomes Australia's improvements to the estimates of this category as compared to previous submissions: emissions resulting from cement kiln dust (CKD) in clinker production are now explicitly identified, as required by the IPCC good practice guidance.

44. Over the period 1990–2004 the CO_2 IEFs decreased by 1.9 per cent (from 0.558 t/t to 0.548 t/t). In its comments in response to previous review stages, Australia explained that this is because the IEFs for total CO_2 will fluctuate according to the quantity of CKD calcined annually.

2. Iron and steel production – CO_2

45. The CO_2 IEFs for pig iron fluctuate considerably: there are increases of 75.2 per cent between 2000 and 2001, and 24.4 per cent between 2001 and 2002. In its response to questions raised by the ERT during the review, Australia explained that the fluctuations are mainly due to variations in the output of iron per unit of natural gas consumed as a reductant at an experimental plant. As Australia reports emissions from this category under both the industrial processes and the energy sectors (emissions from the use of coke as a reductant are reported under industrial processes, while emissions from coke production and coke oven gas combustion are reported under energy), the ERT recommends that Australia enhance the QA/QC procedures to avoid potential misallocation of emissions from this category.

3. Consumption of halocarbons and SF_6 – HFCs and SF_6

46. The ERT noticed that Australia has improved its estimates of HFC emissions thanks to the implementation of its Ozone Protection and Synthetic Greenhouse Gas Management Act, which has made better-quality data available. The ERT encourages Australia to further extend this practice to other fluorinated gases such as PFC emissions from fire extinguishers in order to improve the completeness and accuracy of the inventory.

IV. Agriculture

A. Sector overview

47. In 2004, emissions from the agriculture sector in Australia accounted for 17.1 per cent of total national GHG emissions, or 89,794.10 Gg CO_2 equivalent. In this year, CH_4 emissions from agriculture amounted to 68,394.80 Gg CO_2 equivalent, or 61.3 per cent of total national CH_4 emissions, and N_2O emissions amounted to 21,399.30 Gg CO_2 equivalent, or 87.2 per cent of total national N_2O emissions. Between 1990 and 2004, emissions from the sector increased by 2.4 per cent, the increase being mostly in N_2O emissions as a result of more intensive practices in livestock industries and in particular the use of feedlots. Between 2003 and 2004, estimated emissions from agriculture decreased by 1.2 per cent.

48. The ERT welcomes the improvements in the completeness of the inventory which Australia has made since its last submission. New estimates of emissions have been made for CH_4 from manure management for minor animal categories – buffalo, goats, camels and llamas, horses, mules and asses. Australia has also provided estimates of N_2O indirect emissions from agricultural soils, and CH_4 and N_2O emissions from field burning of pulses. Australia has identified four key categories from agriculture: CH_4 from enteric fermentation, CH_4 from manure management, N_2O from agricultural soils, and CH_4 and N_2O from prescribed burning of savannas. The ERT noted that Australia has revised its estimates of emissions from prescribed burning of savannas for both CH_4 and N_2O and employed a three-year average, as recommended in the 2005 review report.

B. Key categories

1. Enteric fermentation – CH_4

49. Australia uses country-specific and tier 2 methods and country-specific EFs to estimate CH_4 from cattle, sheep and swine. For all other animal categories a tier 1 methodology and IPCC default EFs are used. The high IEF of 113 kg/hd/yr for dairy cattle is much higher than the default value for Oceania (68 kg/hd/yr). Australia maintains that the dairy industry in Australia is closer in type to those of Western Europe or North America than to those found in Oceania, with dairy cattle yielding nearly 5,000 litres of milk per year. The ERT recommends that Australia provide milk yield statistics by region in an appendix to its next NIR.

50. The ERT noted that Australia has not provided any additional information in the NIR as requested by the 2005 review report in relation to the applicability of the methodology used (Howden et al., 1994) for estimating CH_4 emissions from sheep.

2. Manure management – CH_4

51. Australia uses country-specific and tier 2 methods along with mostly country-specific EFs to estimate CH_4 emissions from manure management. The most significant animal category is swine, accounting for 64.3 per cent of CH_4 emissions from this category in 2004. Australia estimates CH_4 emissions for swine using a model called PIGBAL.

52. The ERT found it difficult to assess the volatile solids (VS) daily excretion values documented in CRF table 4.B(a) without a livestock characterization. The ERT encourages Australia to provide in its next NIR a livestock characterization by animal type, territory and climatic region in order to make it possible to compare VS values across Parties and facilitate the work of the ERT in assessing the estimates.

53. The ERT noted that in some instances the percentages of total nitrogen excreted to the different animal waste management systems, as reported in CRF table 4.B(b), add up to over 100 per cent. For example, those for sheep add up to 100.1 per cent and those for other livestock species add up to 100.5 per cent. Australia is encouraged to check these estimates for its next submission.

3. Agricultural soils (direct soil emissions) – N_2O

54. Australia uses a tier 1 method and country-specific EFs to estimate emissions of N_2O from synthetic fertilizer use, as described in section 6.6.2.1 of the NIR. It appeared to the ERT that Australia has not calculated total fertilizer applied to soils after volatilization of ammonia (NH_3) and NO_X (i.e., F_{SN}) before applying country-specific EFs based on different production systems. The ERT encourages Australia to check this for future submissions and to provide additional information that demonstrates consistency with the IPCC good practice guidance (e.g. equations in page 4.56).

55. The ERT recommends that Australia split section 6.6.2.2 of the NIR into separate sections to describe the methodologies used for animal manure applied to soils (4.D.1.2) and pasture, range and paddock (4.D.2). This would improve the transparency of its reporting of each method.

4. Agricultural soils (indirect emissions) – N_2O

56. The ERT noted Australia's efforts to provide emission estimates for atmospheric deposition and nitrogen leaching and run-off from agricultural soils. In section 6.6.2.6, and also in table 6.22 of the NIR, no aggregated value for volatilized animal manures applied to soils or $Frac_{GASM}$ is provided. Australia is encouraged to provide this in its next submission in order to improve comparability of reporting between Parties and facilitate the work of the ERT in assessing the estimates. These fractions should also be reported in CRF table 4.D (the additional information table).

V. Land use, land-use change and forestry

A. Sector overview

57. In 1990, the LULUCF sector in Australia was a net source of CO_2 emissions, of 75,370.87 Gg. In 2004, the LULUCF sector was a net carbon sink of 6,993.49 Gg CO_2. This represents a decline of 56.1 per cent compared with the carbon removals reported for 2003. The CH_4 and N_2O emissions reported for 2004 (5,305.19 and 1,448.5 Gg CO_2 equivalent, respectively) were not greatly changed when compared with the 2003 values.

58. Australia does not provide a consistent representation of all land-use areas, and therefore reports only emissions/removals from the categories forest land, forest land converted to cropland and forest land converted to grassland. The good practice approach for consistent representation of land-use areas, as stated in the *IPCC Good Practice Guidance for Land Use, Land-use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF), is that the whole land area within a country should be included. For 2004, total land area reported is 33.7 Mha, while the total area of Australia is approximately 700 Mha. During the review Australia explained that the National Carbon Accounting System (NCAS) is not yet fully able to produce a report of the areas for each of the six land-use categories defined by the IPCC good practice guidance for LULUCF. Australia also informed the ERT that the categories not reported should not have significant/measurable net emissions. However, the ERT recommends that Australia pursue its inventory development plans and report carbon stock changes and non-CO_2 emissions for all land use and land-use change categories in its future submissions.

59. Australia does not estimate carbon emissions from agricultural lime application, indicating in the NIR that data of sufficient quality are not available for the time series and that the limited data available indicate that this is likely to be only a minor source of emissions. The ERT noted in the report "Australia State of Environment Report 2006" that lime application in cropping systems is a necessary and increasingly routine operation. The ERT recommends that Australia consider providing estimates of emissions from this category in its future submissions.

60. In CRF table Summary 3, Australia has used a letter – "M" – to describe the CO_2 EFs. The ERT suggests that Australia, in its future submissions, use the notation key other ("OTH") and explain what it means in the documentation box.

B. Key categories

Forest land remaining forest land – CO_2

61. In 2004, under the category forest land, an area of 16.78 Mha is reported as managed, which represents only 10 per cent of total forest land area in Australia (164.4 Mha). Moreover, in the NIR (volume 2, part A, page 3) Australia reports 50 Mha of forest land as "available for harvesting" even if "less than 1 per cent are harvested annually". The ERT believes that it may not be good practice to report only the harvested portion of the forest area declared as available for harvesting under the forest land category, since the IPCC good practice guidance for LULUCF defines managed forest as area *subject to periodic or ongoing human interventions*, that is, any forest area where a human activity is carried on, whatever it is (e.g. fire suppression, forest conservation, recreation, harvesting, etc.). The ERT therefore requests the Party to complete its report including carbon stock changes and non-CO_2 emissions occurring in each Australian forest area that is subject to periodic or ongoing human interventions. During the review, Australia noted that it will be reviewing its net emissions estimates from managed forests for its next submission as part of its scheduled stepwise transition from the production of estimates according to the Revised 1996 IPCC Guidelines to estimates prepared according to the 2003 IPCC *Good Practice Guidance for Land Use, Land Use Change and Forestry*. These planned developments have been indicated in the NCAS Development Plan (Australian Greenhouse Gas Office, 2005).

62. Australia informed the ERT that fuelwood is composed of coarse woody debris belonging to the dead organic matter (DOM) pool. The ERT, however, considers that any piece of wood belongs to the living biomass pool before it becomes woody debris stock in the DOM pool. The ERT therefore noted that carbon stock change from living biomass due to woody debris production has not been reported under "decrease" in the CRF tables. Australia noted that the creation of DOM from living biomass is accounted for in its estimates of the net change in living biomass, but it agrees that this has not been explicitly identified in the estimates of the change in carbon stock of living biomass. The ERT recommends Australia to report carbon stock decreases from the living biomass pool (to the DOM pool) due to the production of the coarse woody debris stock.

63. The ERT noted that the methodology explained in the NIR for estimating carbon stock changes in living biomass in managed native forest calculates gains (increment) and losses (harvest), while Australia reports only net gains. The ERT recommends Australia to report both gains and losses in the living biomass in order to improve the consistency and transparency of the inventory.

64. The ERT noted that the hardwood slash ratio applied for estimating carbon stock change in the DOM pool (0.9) is much higher than the default values of the IPCC good practice guidance for LULUCF (0.25–0.15). The ERT suggests that Australia document the reasons for the choice of this value.

C. Non-key categories

1. Land converted to forest land – CO_2

65. This category includes all afforestation/reforestation activities since 1990 as indicated in the documentation box of CRF table 5.A. The reported value for carbon (C) stock change corresponds to a net removal in the reporting year for all the area planted between 1990 and 2004. The areas afforested prior to 1990 are reported under forest land remaining forest land as Australia states that these are currently not separately identifiable from forest land remaining forest land. The ERT recommends that

Australia continue to implement its current inventory development to provide the data for this separation in future inventories.

2. Land converted to cropland and land converted to grasslands – CO_2

66. The total area of forest land converted to cropland and grassland has increased by 46.6 per cent from 1990 to 2004 (from 10,835.88 kha in 1990 to 15,882.38 kha in 2004), while the annual net carbon stock changes have decreased by 59.1 per cent over the same period (from –33,966.07 Gg C to –13,899.63 Gg C).

67. Australia reports in the NIR (volume 2, page 88) that "the 1972 map layer is assumed to represent biomass at maturity. This assumption has been made as no age definition was available for forests in 1972". In practice the forest carbon pools have been set as fully stocked all over Australia's forest land. Then the carbon stocks have been recalculated for any following year taking into account any disturbance and any regrowth that has occurred. In this way any map layer of the following years should show a progressively decreasing average carbon stock per hectare because the stock level was highest at the starting point. During the review, Australia noted that it believes that it has addressed this issue by "running in" the NCAS model over a period of 18 years prior to the first year for which results are reported – that is, the base year (1990).

68. For the period 1972–1988, Australia has used satellite images with a definition[3] (circa 0.5 ha) which is higher than its minimum area (0.2 ha) selected for the forest definition, so that the uncertainty attached to these estimates of the area of forest land use and related land-use changes in that period is higher than it is for the estimates for the period after 1988. Australia's NIR notes that for the period 1972–1988 image data from the United States National Aeronautics and Space Administration (NASA) are re-sampled to a 0.25 ha (50 m x 50 m) pixel (this is done by the NASA agent, the Australian Centre for Remote Environmental Sensing). For years subsequent to 1988, when Australia moved from the 50-m resolution MSS data to the 25 m resolution TM and ETM+, then the "50 m MSS data being resampled to four 25 m pixels… …the greater resolution may not have allocated the same forest/non-forest status for all four pixels as was determined for the average condition within the original 50 m pixel".[4] That is, the estimates of land-use changes for that year have a higher uncertainty because of changes in the technical quality of the data sets.

69. Some lands where forest regrowth is occurring are reported under incorrect subcategories (forest land converted to cropland and forest land converted to grassland), while according to the IPCC good practice guidance for LULUCF forest regrowth should be reported under the relevant land converted to forest land subcategory. During the review, Australia noted that, regardless of which subcategory of land unit is reported, each pixel in the analysis can only be reported under one subcategory, and therefore no double counting can occur. Australia also informed the ERT that its approach tracks in a consistent way the carbon stock status of the units of land resulting from the original land-use conversion and over subsequent land management practices.

70. The ERT believes that the value of carbon stocks in carbon pools in 1972 could be set in a random manner, taking into account for every land portion the additional variable "intactness". This will indicate the probability that the portion of land has been disturbed (e.g. a portion of forest close to a settlement has a high probability of being disturbed). Australia informed the ERT that it would be extremely difficult to identify parameters to produce accurate or unbiased estimates of land-use change using this approach and believes that the "running in" approach described in paragraph 67 is more robust and involves less uncertainty and less potential for bias. The ERT, however, considers that it is not possible to identify forest area consistently in a wall-to-wall map using satellite data with a pixel wider

[3] The spatial resolution of the multispectral scanner (MSS) sensor is ca. 79 m and a nominal picture element (pixel) ground area of 68 x 83 m at the satellite nadir point. See <http://landsat.gsfc.nasa.gov/about/mss.html>.
[4] Page 68 of volume 2 of the NIR.

than 0.5 ha when the minimum forest area has been set at 0.2 ha. The ERT suggests that Australia select a minimum area for forest definition higher than 0.2 ha (e.g. 0.5 ha as the Food and Agriculture Organization of the United Nations definition of forest). During the review, Australia noted that its approach is already designed to ensure that its land-use change estimates are consistent, that is, the approach is "capable of representing management and land use consistently over time, without being unduly affected by artificial discontinuities in time series data" (IPCC good practice guidance for LULUCF, 2003, page 2.5). Australia agrees that the approach cannot deliver perfect results, given the limitations in technology prior to 1988, but believes that its estimates are transparent, consistent, accurate, and comparable with those of other Parties, and that its approach minimizes the uncertainty of the estimates, being based on the best available technologies and data for all periods under review. The ERT recommends Australia to report removals due to forest regrowth either under forest land remaining forest land (if a land-use change has never occurred) or under the relevant land converted to forest land category (if the land use has changed back to forest).

71. The NIR (volume 2, part A, pages 69–70) states that, when a loss of forest is detected, the cause is analysed and, if the loss is not attributed to direct human action, the emissions are neither estimated nor reported. Australia should clarify this point to highlight that this refers to the mechanism of entry of land into the reporting framework, and clarify that all emissions from converted managed lands and unmanaged lands are reported.

72. The ERT noted that the average values of basic wood density reported in the NIR (table 7.C7, volume 2, part A, page 89) for various forest typologies are higher than an average of those reported in the Updated Australian Species Wood Density Database.[5] The ERT recommends that Australia further explain its choice of the average values of basic wood density in its next submission.

3. Biomass burning – CO_2, CH_4 and N_2O

73. Australia estimates CH_4 and N_2O emissions from forest fires taking three-year moving averages of individual annual estimates in order to dampen the effects of climatic variability, which causes major inter-annual variations in biomass burning in Australia. The ERT considers that this method is not in line either with the UNFCCC reporting guidelines, as inventories are to be reported without adjustments relating to climate variations, or with the IPCC good practice guidance for LULUCF. Since in the year 1989 the level of forest fires was relatively low (there were only 33.8 per cent of wildfires and 64.4 per cent of prescribed fires compared to the average for the period 1990–2004), the three-year average method leads to an underestimation of emissions in the year 1990 and affects the trend since then. In response to the ERT's comments, Australia noted that, in moving to a three-year average for its AD, it has implemented the recommendation of the previous review report on its 2005 inventory submission. Australia also notes that its approach provides for comparable treatment for emissions both from forest fires and from savanna fires (reported under agriculture). The ERT recommends Australia to use annual data for forest area burned in its next submission.

74. Australia does not report estimates of CO_2 emissions from forest fires. The ERT noted that the reasons for this are not documented in a transparent manner in the NIR as recommended in the IPCC good practice guidance for LULUCF when the method applied does not capture removals by regrowth after forest fires; the ERT is of the opinion that the Australian gain–loss method for carbon stock changes in living biomass suggests that in fact it does since there is no evidence that Australia is discounting carbon stock increases in burnt areas from total carbon stock changes in forest area. The ERT recommends Australia, in its future submissions, to report emissions resulting from both prescribed fires and wildfires so that carbon losses on managed lands are taken into consideration, following the IPCC good practice guidance for LULUCF. During the review, Australia noted that the IPCC good practice guidance for LULUCF (page 3.50) states that it is not necessary for a Party to report CO_2 emissions from

[5] Available at: <http://www.greenhouse.gov.au/ncas/reports/tr18final.html>.

forest fires if its methodology does not capture removals from the subsequent regrowth. Australia contends that this is the case for its inventory because, in its current methodology, the expansion of biomass for forests is constant each year, regardless of recent fire activity – that is, there is no attempt to model the additional uptake following fires. Nonetheless, as indicated above, Australia acknowledges that its current methodology requires updating, and plans to take the ERT's views into consideration during its review of this sector.

75. Australia has selected a carbon mass fraction of 0.46 for forest vegetation composition in its calculation for forest fires (table 7.7 of the NIR), which is lower than the value selected for the same variable in stock changes reported for harvested and living biomass (0.5). The ERT suggests that Australia revise the carbon mass fraction value and use the same value consistently across all relevant categories.

76. The ERT noted that the CH_4 EF (0.0054) reported by Australia in the NIR (table 7.8) comes from the scientific literature and is below the range of EFs recommended by the IPCC good practice guidance for LULUCF (0.009–0.015). Moreover, the ERT noted that the scientific paper quoted refers to Australian savanna fires while the EF is applied to fires occurring on any type of forest. The ERT noted Australia's planned review of its methodologies for this source as part of the NCAS Development Plan and recommends Australia to review the use of such a low value.

VI. Waste

A. Sector overview

77. In 2004, emissions from the waste sector in Australia accounted for 3.3 per cent of total national GHG emissions. In 1990 the share was 4.4 per cent. Most of these emissions were contributed by the solid waste disposal on land category (86.2 per cent of waste sector emissions in 2004). Waste-water handling contributed 13.7 per cent of sectoral emissions in 2004, and waste incineration 0.2 per cent.

78. Specific methodologies, assumptions, AD and EFs are well documented in the NIR. Australia uses a country-specific methodology which is consistent with the IPCC tier 2 method (first order decay) for estimating CH_4 emissions from solid waste disposal on land and IPCC default methods for estimating CH_4 and N_2O emissions from waste-water handling.

79. CH_4 emissions from managed waste disposal on land were identified as key a category in both the level and the trend analyses. The methodology used includes the assumption that all solid waste disposal sites in Australia are managed. Recalculations for this sector are documented in table 8(a) for the years 1990–2003; they result in an increase of 82.9 per cent in the estimated CH_4 emissions from this category in 2003. This increase is explained by improved data on waste disposed to landfills. For example, according to the country-specific Harvested Wood Products Model, the percentage of paper and textiles in municipal solid waste increased to 30 per cent in 2004, whereas the previous estimate was 12 per cent, and the percentage of paper and textiles in commercial and industrial waste increased to 55 per cent, whereas the previous estimate was 20 per cent.

80. All the CRF tables for the waste sector are provided and include estimates of CH_4, N_2O, CO_2 and NMVOCs.

B. Key categories

1. Solid waste disposal on land – CH_4

81. The trend of CH_4 emissions from solid waste disposal on land is relatively constant over the period 1990–2004, decreasing by 3.1 per cent since 1990. Australia has used a dynamic spatially explicit model driven by landfill data provided by the relevant state/territory government agencies responsible for waste management.

82. Australia has provided detailed information on the estimation of CH_4 emissions from this category, including the approach used, the justification for most parameters and the AD used since 1940. The methodologies are referenced and adequately summarized in the NIR. Australia has followed the recommendations of the 2005 in-country review and provided values for the relevant parameters in the additional information table 6.A. The notation key "NA" has been used correctly for this category. In CRF table 6.A, the value of degradable organic carbon degraded (DOC degraded) has been incorrectly reported. The ERT recommends Australia to report this value as a percentage in its next submission.

83. Estimated CH_4 emissions per capita (35 kg/capita) in 2004 are among the highest of reporting Parties (the range is 2–41 kg/capita). The ERT recommends that Australia document this value in the NIR of its next submission.

84. Australia indicates in chapter 6.B.1 of the NIR that industrial sludge disposed to landfill is accounted for in the solid waste disposal on land category, but details are not provided in chapter 6.A of the NIR. The ERT encourages Australia to include CH_4 emissions from landfilled industrial sludge in its next submission and to explain in what category they are included.

2. Waste-water handling – CH_4

85. CH_4 emissions from waste-water handling are identified as a key category in the trend analysis. Australia has followed the recommendation of the 2005 in-country review and provided the values of the parameters used for these estimations in the CRF tables. The methodology and parameters for CH_4 emissions from industrial waste water have been revised and are well documented in the NIR.

C. Non-key categories

Waste-water handling – N_2O

86. N_2O emissions from industrial waste water are not estimated because no data are available. Australia is encouraged to examine the possibility of providing this information in its next submission.

Annex

Documents and information used during the review

A. Reference documents

IPCC. Good practice guidance and uncertainty management in national greenhouse gas inventories, 2000. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gp/english/>.

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B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Robert Sturgiss (Australian Greenhouse Gas Office) including additional material on the methodology and assumptions used.

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