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Report of the review of the initial report of Australia

According to decision 13/CMP.1, each Annex I Party with a commitment inscribed in Annex B to the Kyoto Protocol shall submit to the secretariat, prior to 1 January 2007 or one year after the entry into force of the Kyoto Protocol for that Party, whichever is later, a report (the 'initial report') to facilitate the calculation of the Party's assigned amount pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol, and to demonstrate its capacity to account for emissions and the assigned amount. This report presents the results of the review of the initial report of Australia conducted by an expert review team in accordance with Article 8 of the Kyoto Protocol.

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I. Introduction and summary

A. Introduction

1. This report covers the in-country review of the initial report of Australia, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat in accordance with the "Guidelines for review under Article 8 of the Kyoto Protocol" (decision 22/CMP.1) (hereinafter referred to as the Article 8 review guidelines). The review took place from 7 to 12 April 2008 in Canberra, Australia, and was conducted by the following team of nominated experts from the roster of experts: generalist – Ms. Anke Herold (European Community); energy – Mr. Tinus Pulles (Netherlands); industrial processes – Mr. Hongwei Yang (China); agriculture – Mr. Sergio Gonzalez Martineaux (Chile); land use, land-use change and forestry (LULUCF) – Mr. Sandro Federici (Italy); waste – Mr. Sabin Guendehou (Benin). Ms. Herold and Mr. Guendehou were the lead reviewers. In addition the expert review team (ERT) reviewed the national system, the national registry, and the calculations of the Party's assigned amount and commitment period reserve (CPR), and took note of the LULUCF parameters and the elected Article 3, paragraph 4, activities. The review was coordinated by Ms. Ruta Bubniene and Mr. Sergey Kononov (UNFCCC secretariat).

2. In accordance with the Article 8 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, in this final version of the report.

B. Summary

1. Timeliness

3. Decision 13/CMP.1 requests Parties to submit the initial report prior to 1 January 2007 or one year after the entry into force of the Kyoto Protocol for that Party, whichever is later. The initial report of Australia was submitted on 11 March 2008, which is in accordance with decision 13/CMP.1 given that Australia ratified the Kyoto Protocol on 12 December 2007 and that it entered into force for Australia on 11 March 2008. In its initial report, Australia refers to a revised 2007 greenhouse gas (GHG) inventory (submitted on 26 February 2008) which replaced its original 2007 GHG inventory submission of 8 May 2007.

4. In response to questions raised by the ERT during the course of the in-country visit Australia submitted revised emission estimates and revised elements of its initial report on 26 May 2008. Based on the responses received, the ERT requested further clarification. In response, Australia provided additional data and relevant information on 23 June, 8 August, 12 September, 15–17 September and 21 October 2008.

2. Completeness

5. Table 1 provides information on the mandatory elements that have been included in the initial report and revised values for the assigned amount and CPR provided by Australia resulting from the review process. These revised values are based on revisions of emissions of carbon dioxide (CO_2) from manufacturing industries and construction – solid fuels (see para. 54); fugitive emissions of methane (CH_4) from coal mining and handling – solid fuels, surface mines and decommissioned mines (see paras. 57 and 58); CO_2 emissions from iron and steel production (see para. 63); nitrous oxide (N_2O) emissions from agricultural soils (see para. 81); N_2O emissions from manure management – dairy cattle (see para. 85); CO_2 emissions from forest land remaining forest land (see para. 99); CO_2 emissions from cropland remaining cropland (see para. 102); CO_2 emissions from grassland remaining grassland (see para. 104); CO_2, CH_4 and N_2O emissions from forest land converted to cropland and CO_2, CH_4 and N_2O emissions from forest land converted to grassland (see para. 113); CH_4 and N_2O emissions from biomass burning (see para. 120); CH_4 emissions from managed waste disposal on land (see para. 127); and CO_2 and N_2O emissions from waste incineration (see para. 130). These revised values resulted in

revisions of the total GHG emissions, including base year emissions, from 553,773,801 t CO_2 eq as reported originally by Australia to 547,699,841 t CO_2 eq (see para. 135).

Table 1. Summary of the reporting on mandatory elements in the initial report

Item	Provided	Value/year/comment
Complete GHG inventory from the base year 1990 to the most recent year available 2005	Yes	1990–2005
Base year for HFCs, PFCs and SF_6	Yes	1990
Agreement under Article 4	No	Not applicable
LULUCF parameters	Yes	Minimum tree crown cover: 20% Minimum land area: 0.2 ha Minimum tree height: 2 m
Election of and accounting period for Article 3, paragraphs 3 and 4, activities	Yes	No activities elected under Article 3, paragraph 4. Australia has chosen annual accounting period for Article 3, paragraph 3, activities
Calculation of the assigned amount in accordance with Article 3, paragraphs 7 and 8	Yes	2,990,378.528 t CO_2 equivalent
Calculation of the assigned amount in accordance with Article 3, paragraphs 7 and 8, revised value		2,957,579,143 t CO_2 equivalent
Calculation of the commitment period reserve	Yes	2,691,340.675 t CO_2 equivalent
Calculation of the commitment period reserve, revised value		2,661,821,229 t CO_2 equivalent
Description of national system in accordance with the guidelines for national systems under Article 5, paragraph 1	Yes	
Description of the national registry in accordance with the requirements contained in the annex to decision 13/CMP.1, the annex to decision 5/CMP.1 and the technical standards for data exchange between registry systems adopted by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol	Yes	Description provided, although national registry was not yet in place during the in-country review visit. In the course of the review, Australia informed the expert review team about its plans to have a fully functional registry by the end of 2008

Abbreviations: GHG = Greenhouse gas; HFCs = hydrofluorocarbons; LULUCF = land use, land-use change and forestry; PFCs = perfluorocarbons; SF_6 = sulphur hexafluoride.

6. The information in the initial report covers all elements as required by decision 13/CMP.1, section I of decision 15/CMP.1, and other relevant decisions of the Conference of the Parties serving as the meeting of the Parties (CMP).

3. Transparency

7. The initial report is generally transparent. During the review process the ERT identified emissions/removals from the LULUCF sector as a key area where transparency needs to be further enhanced.

4. Emission profile in the base year, trends and emission reduction target

8. In the base year (1990 for all gases) the most important GHG in Australia was CO_2, contributing 66.8 per cent to total[1] national GHG emissions expressed in CO_2 eq, followed by CH_4 (27.6 per cent) and N_2O (4.3 per cent) (see figure 1). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) taken together made up 1.3 per cent of the total national GHG emissions in the base year. The energy sector accounted for 68.8 per cent of the total national GHG emissions in the base year, agriculture for 20.9 per cent, industrial processes for 5.8 per cent and waste for 4.5 per cent (see figure 2).

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

According to the revised estimates provided by Australia total GHG emissions (excluding LULUCF) amounted to 416,155.33 Gg CO_2 eq in the base year and increased by 27.2 per cent between the base year and 2005; total GHG emissions including LULUCF amounted to 547,699.841 Gg CO_2 eq in the base year including 131,544.513 Gg CO_2 eq emissions from deforestation.

Figure 1. Shares of greenhouse gases in total greenhouse gas emissions, base year

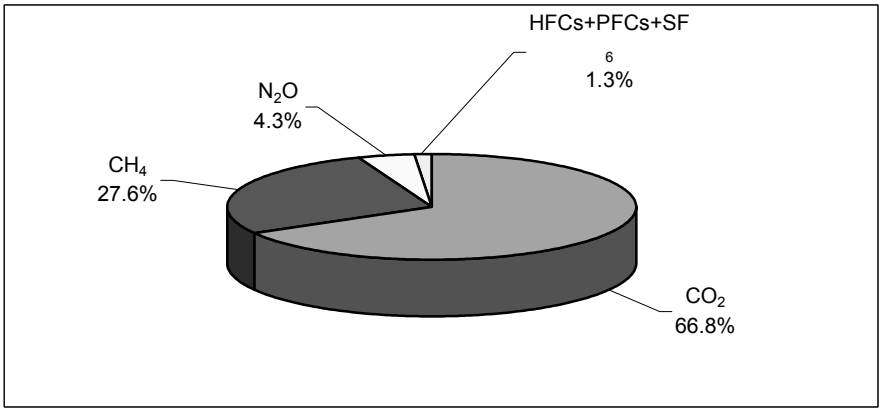
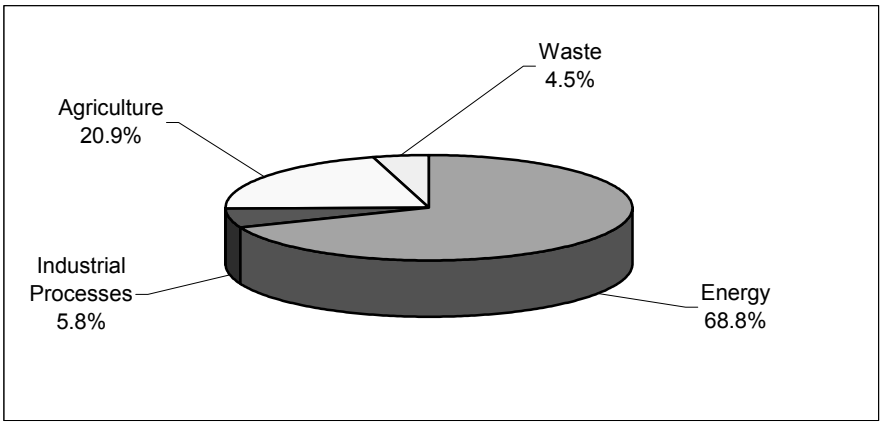


Figure 2. Shares of sectors in total greenhouse gas emissions, base year



9. Tables 2 and 3 show greenhouse gas emissions by gas and by sector, respectively.

10. Australia's quantified emission limitation, as inscribed in Annex B to the Kyoto Protocol, is 108 per cent of its base year emissions.

Table 2. Greenhouse gas emissions by gas, 1990–2005

GHG emissions (without LULUCF)	Gg CO_2 equivalent									Change Base year–2005 (%)
	Base year	1990	1995	2000	2001	2002	2003	2004	2005	
CO_2	277 802.53	277 802.53	304 440.21	350 031.72	356 681.32	361 189.74	373 436.27	379 101.99	385 613.03	38.8
CH_4	114 653.01	114 653.01	114 435.38	116 282.18	119 892.71	117 841.74	114 295.47	114 156.12	113 747.20	–0.8
N_2O	18 102.37	18 102.37	20 196.55	24 990.01	26 365.11	25 804.90	24 343.51	24 393.33	23 648.60	30.6
HFCs	1 126.27	1 126.27	1 420.08	2 240.86	2 659.84	3 083.35	3 532.34	3 884.42	4 251.74	277.5
PFCs	3 950.13	3 950.13	1 312.56	1 103.55	1 544.96	1 481.29	1 443.88	1 469.48	1 533.31	–61.2
SF_6	521.02	521.02	521.02	523.41	521.02	521.02	521.02	521.02	521.02	0.0

Abbreviations: GHG = greenhouse gas; LULUCF = land use, land-use change and forestry.
Note: Australia submitted revised estimates for the time series 1990–2005 in the course of the initial review on 26 May 2008 and 21 October 2008. These estimates differ from Australia's 2007 GHG inventory submission.

Table 3. Greenhouse gas emissions by sector, 1990–2005

Sectors	Gg CO_2 equivalent									Change Base year–2005 (%)
	Base year	1990	1995	2000	2001	2002	2003	2004	2005	
Energy	286 420.00	286 420.00	312 730.44	357 044.30	364 518.96	368 445.21	380 678.01	386 386.77	395 118.02	38.0
Industrial processes	24 141.44	24 141.44	24 509.39	26 150.29	27 278.83	27 863.11	28 697.98	29 592.02	28,505.09	18.1
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	IE,NA,NO	NA
Agriculture	86 832.12	86 832.12	86 332.80	94 677.49	98 311.79	95 864.61	91 224.57	90 849.78	89 114.67	2.6
LULUCF[a]	NA	44 459.94	126 105.86	–82 608.62	–80 540.41	266 489.23	67 335.69	–183 619.47	81 595.09	NA
Waste	18 761.77	18 761.77	18 753.18	17 299.66	17 555.38	17 749.10	16 971.92	16 697.78	16 577.11	–11.6
Total (with LULUCF)	NA	460 615.27	568 431.66	412 563.11	427 124.56	776 411.28	584 908.18	339 906.89	610 909.99	NA
Total (without LULUCF)	416 155.33	416 155.33	442 325.80	495 171.73	507 664.96	509 922.04	517 572.49	523 526.36	529 314.90	27.2

Abbreviations: LULUCF = land use, land-use change and forestry; NA = not applicable; IE = included elsewhere; NO = not occurring.
Note: Australia submitted revised estimates for the time series 1990–2005 in the course of the initial review on 26 May 2008 and 21 October 2008. These estimates differ from Party's original 2007 GHG inventory submission.
[a] The LULUCF sector is a net source for Australia in the base year. In accordance with decision 13/CMP.1, total base year emissions for the purpose of the calculation of the assigned amount under the Kyoto Protocol shall include greenhouse gas emissions from conversion of forests (deforestation). In 1990, emissions from deforestation amounted to 131,544.513 Gg CO_2 eq according to the estimates of Australia. Net emissions from deforestation are neither shown separately nor included as a separate element of the emissions from the LULUCF sector in the rows for total emissions in this table. However, they were added to the total base year emissions for the purpose of the calculation of the assigned amount (see section II.D of this report).

II. Technical assessment of the elements reviewed

A. National system for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks

11. Australia's national system is generally prepared in accordance with the guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (decision 19/CMP.1). All required general and specific functions of a national system are clearly described in the initial report.

12. Table 4 shows which of the specific functions of the national system are included and described in the Party's initial report. Australia also provided revised elements of the initial report which addressed calculation of assigned amount and CPR and the identification of the accounting period for activities under Article 3, paragraph 3.

Table 4. Summary of reporting on the specific functions of the national system

Reporting element	Provided	Comments
Inventory planning		
Designated single national entity*	Yes	See section II.A.1
Defined/allocated specific responsibilities for inventory development process*	Yes	See section II.A.1
Established process for approving the inventory*	Yes	See section II.A.1
Quality assurance/quality control plan*	Yes	See section II.A.2
Ways to improve inventory quality	Yes	See section II.B.3
Inventory preparation		
Key category analysis*	Yes	See section II.B.1
Estimates prepared in line with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* and the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories**	Yes	See section II.B.2
Sufficient activity data and emission factor collected to support methodology*	Yes	See section II.B
Quantitative uncertainty analysis*	Yes	See section II.B.2
Recalculations*	Yes	See section II.B.2
General QC (tier 1) procedures implemented*	Yes	See section II.A.2
Source/sink category-specific QC (tier 2) procedures implemented	Yes	See section II.A.2
Basic review by experts not involved in inventory	Yes	See section II.A.2
Extensive review for key categories	Yes	See section II.A.2
Periodic internal review of inventory preparation	Yes	See section II.A.2
Inventory management		
Archive inventory information*	Yes	See section II.A.3
Archive at single location	Yes	See section II.A.3
Provide ERT with access to archived information*	Yes	See section II.A.3
Respond to requests for clarifying inventory information during review process*	Yes	See section II.A.1

Abbreviations: ERT = expert review team; IPCC = Intergovernmental Panel on Climate Change; QC = quality control
* Mandatory elements of the national system

1. Institutional, legal and procedural arrangements

13. During the in-country visit, Australia explained the institutional arrangements, as part of the national system, for preparation of the inventory. The Department of Climate Change (DCC) is the designated single national entity. Australia's National Carbon Accounting System (NCAS) has been specifically designed for the estimation of emissions and removals from LULUCF and is managed by a separate team of experts.

14. The DCC uses activity data (AD) published by Australia's main statistics agencies, the Australian Bureau of Agricultural and Resource Economics (ABARE) and the Australian Bureau of Statistics (ABS). The ABARE collects energy consumption data, whereas the ABS collects agriculture data and some energy related data. The ABS is the national statistical agency, with the legally established mandate for data collection. The ABARE collects and publishes results of surveys on energy use and reports to the International Energy Agency (IEA). The DCC employs consultants to collect data on industrial processes direct from industrial companies. Contributors of data for LULUCF, engaged in the inventory process, include the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Co-operative Research Centre for Spatial Information, universities, State government research organizations and the private sector. The collection of solid waste data is encouraged by an exchange of data requests between agencies of the State and Territory governments – data providers – and the federal government.

15. The National Greenhouse and Energy Reporting Act 2007 (the NGER Act) established the legislative framework for a national greenhouse and energy reporting system. The act is designed to develop the GHG emissions reporting framework for the Australian emissions trading system (ETS) and a system for the international reporting. The first reporting period under this act will be in 2008–2009, but reporting is mandatory only for those companies whose energy production, energy use or GHG emissions exceed certain defined thresholds. This information will replace the existing data submitted on a voluntary basis by the companies by the DCC and will also be used for the ABARE internal purposes. The ERT noted that to ensure completeness of the information, it is important that Australia continues to estimate emissions from all sources and that it combines data reported under the NGER Act with data collected from facilities whose energy production or use, or emissions, are below the defined thresholds. The ERT encourages Australia to transparently describe, in its future inventory submissions, how completeness of the AD reported will be maintained and how data are collected from the emission sources that are below the thresholds.

16. The GHG emissions are estimated using the Australian Greenhouse Emissions Information System (AGEIS) database. The database receives activity data and other inputs and calculates the emission estimates using programmed algorithms. The AGEIS includes automatic quality control (QC) and quality assurance (QA) checks and generates graphs that can be used for QA/QC purposes. The AGEIS ensures well-organized and transparent storage of all data and calculations performed. The ERT noted that a systematic description of necessary steps to transform/convert AD or other parameters into the AGEIS input data – an essential part of the QC procedures – is under development. The AGEIS emission data are publicly accessible through an interactive web interface, available at <www.climatechange.gov.au/inventory>. The ERT commends Australia for the established AGEIS and encourages it to continue the development and the application of the system.

17. The ERT noted that the NCAS applied by Australia to estimate GHG emissions and removals from the LULUCF sector is an element of the national system for the LULUCF sector. The ERT also noted that Australia has been developing this tool for 10 years and has involved relevant national institutions (government agencies, universities, research organizations) in its development. However, neither the national inventory report (NIR) nor the initial report provides a clear description of the institutional arrangements and the specific responsibilities of the institutions involved in the NCAS. The ERT encourages Australia to provide a more detailed description of the institutional arrangements of the NCAS in its next inventory submission.

18. At the time of the in-country visit, the NCAS provided complete estimates only for the forest conversions to other land uses, but not for the emissions and removals from cropland remaining cropland and grassland remaining grassland that are reported as "NA"; emissions and removals from wetland remaining wetland and settlement remaining settlement, subject to voluntary reporting, are reported as "NE". The ERT noted that emissions/removals from other native forest and forest balancing term are reported as "NA". During the review, Australia provided to the ERT estimates from cropland remaining cropland and grassland remaining grassland, revised emissions/removals from other native forest and eliminated reporting of the forest balancing term. The ERT encourages Australia to continuously develop

the NCAS by including the GHG estimates from the missing categories and parameters in its next annual submission.

19. Five persons manage the GHG inventory system at the DCC, supported by a pool of 16 consultants. The ERT noted that the stability of the team of experts responsible for the inventory compilation contributed to the quality of the inventory. The ERT further noted that a separate team of experts is managing the NCAS and that Australia has allocated adequate resources (AUD 4 million per year) for its development.

20. Australia has established the necessary formal procedures for the functioning of the national inventory system. The ERT noted that the established procedures are working effectively and regularly. The response to requests to clarify inventory information during review process was received according to the timeframe set by decision 22/CMP.1. Due to the complexity of the issues covered in the first response to the ERT request for clarification, there was a need for additional and more complete information and requests for data.

21. In Australia there is an established process for the official consideration and approval of the inventory, including recalculations, prior to its submission, and for responding to any issues raised by the inventory review. Since the early 1990s the National Greenhouse Gas Inventory Committee, which comprises representatives of the Federal, State and Territory governments, has been the responsible organization. Release of the GHG inventory and its submission to the UNFCCC secretariat is also approved by the Australian Minister for Climate Change and Water.

2. Quality assurance/quality control

22. Australia has elaborated and implemented a QA/QC plan in accordance with the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance). This includes general QC procedures (tier 1) as well as source/sink-category-specific procedures (tier 2). The AGEIS has been developed in such a way that it is able to strongly assist QC checks using automated and systematized QC processes. Data handling and data approval roles are separated within the DCC. Reconciliation checks are performed by aggregating emission data to the States' and Territories' emissions and to different economic sectors. The available QC tools in the AGEIS could be used to a greater extent in the inventory compilation, for example to check time series fluctuations in energy and industrial processes. The ERT encourages Australia to elaborate on the trends generated by the QA/QC tools in its next inventory submission.

23. QA activities include comparison of the data with data of the other countries and specific reviews of sectoral methodologies by consultants who are not part of the inventory team. The ERT noted that in 2007, the methodologies of industrial processes (iron and steel production, petroleum refining) and waste (solid waste disposal on land, industrial wastewater treatment and waste incineration) were reviewed by independent experts. Australia applies separate QA processes for the NCAS. The key NCAS research results are published in international peer-reviewed journals. The ERT noted that an inventory improvement plan and NCAS improvement plan are elaborated. The ERT encourages Australia to establish additional QA checks in some areas, such as carbon balance checks for iron and steel production.

3. Inventory management

24. Australia has a centralized archiving system, which includes the archiving of disaggregated emission factors (EFs), AD, and documentation on how these factors and data have been generated and aggregated for the preparation of the inventory. The archived information also includes internal documentation on QA/QC procedures, external and internal reviews, documentation on annual key categories and key category identification, and planned inventory improvements. The AGEIS includes documentation of all sources used and allows the estimation to be tracked back to the original data

sources. In addition to the AGEIS, publications with the input data are archived in paper copies. Australia was able to provide requested additional archived information during the review.

25. The ERT noted that the record-keeping and archiving system may get more complex in Australia in the future due to a larger amount of confidential commercial data being provided by industrial companies under the NGER Act. The ERT noted that the confidential data were provided to the ERT upon request. The ERT encourages Australia to continue its efforts to keep a transparent archiving system.

B. Greenhouse gas inventory

26. In conjunction with its initial report, Australia has submitted a complete set of common reporting format (CRF) tables for the years 1990–2005 and an NIR which was used as the basis for the review by the ERT. Australia officially resubmitted its CRF tables for the years 1990–2005 on 21 October 2008 in response to questions raised by the ERT during the course of the review. Where needed, the ERT also used previous years' submissions. During the review Australia provided the ERT with additional information, which further clarified the information submitted in the initial report. The full list of materials used during the review is provided in annex I to this report.

1. Key categories

27. Australia has reported a key category tier 1 analysis, both level and trend assessment, as part of its initial report submission. Australia has included the LULUCF sector in its key category analysis and has undertaken a separate analysis excluding the LULUCF sector. The key category analysis performed by the Party and the secretariat[2] produced similar results. Key categories are prioritized in the QC/QC plan and with regard to the planned improvements. The detailed information on key categories provided in the annex to the NIR does not clearly explain to which year(s) the information refers. The ERT encourages Australia to add such clarification in its next inventory submission.

2. Cross-cutting topics

28. The inventory is generally in line with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), IPCC good practice guidance and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF). The inventory is compiled broadly in accordance with Article 7, paragraph 1, and decision 15/CMP.1.

Completeness

29. The Australian inventory is generally complete, with gaps in the LULUCF sector and few minor gaps in some other sectors. In industrial processes, CH_4 emissions from dichloroethylene and methanol, PFC emissions from fire extinguishers and HFC emissions from aerosols and metered dose inhalers are reported as "NE". Contributions to the total national GHG emissions from the sources reported as "NE" under energy and industrial processes are considered negligible or small. During the review, data on emissions from open pit coal mines in Victoria, Western Australia and South Australia were provided. During the review Australia provided estimates for emissions/removals and parameters for missing categories (e.g. cropland remaining cropland, grassland remaining grassland) in the LULUCF sector, thus increasing the completeness of reporting.

[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 Land Use, Land–use Change and Forestry* for the base year or base year period and for the latest inventory year. Key categories according to the tier 1 trend assessment were also identified. Where Australia performed a key category analysis, the key categories presented in this report follow Australia's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

30. The ERT noted that, in Australia's original 2007 submission, there was a number of gaps in reporting of emissions/removals from LULUCF. Australia assured the ERT that the NCAS will be further developed to estimate categories currently not yet estimated (such as forest soil carbon). During the review, Australia provided emissions and removals for cropland remaining cropland and grassland remaining grassland categories as well as for "other native forests" in the forest land remaining forest land category. The tier 1 and 2 methods used for "forest land remaining forest land" do not estimate emissions or removals from carbon stock changes in mineral soils (e.g. for harvested native forests or plantations). The ERT recommends that Australia further enhance the completeness of the reporting of emissions and removals from carbon stock changes in forest soils in the LULUCF sector, in particular for the plantation areas where such changes are reported by other Annex I Parties.

Transparency

31. Australia has put in place a transparent approach to documenting methods and data used in the inventory since the early 1990s and later adapted its national approach to the UNFCCC requirements related to the national inventory report. Methodologies and data sources are well explained in the NIR and the ERT was able to assess the data used and the methodologies applied. Most categories are reported with the detail required by the CRF, with a few exceptions where emissions from specific source categories have been reported as confidential (in the industrial processes sector). Australia provided the ERT with access to confidential data during the in-country review. A considerable amount of information beyond the scope of the NIR is made publicly available. This includes a large number of NCAS reports that are published on the NCAS website. AGEIS ensures a transparent approach to implementing the estimation methodology because large amounts of data are accessible to the public on a continuous basis and because all parts of the estimation had to be made sufficiently transparent to integrate them into the AGEIS.

32. The ERT noted that in some sectors additional information should be provided in the NIR to ensure transparency, for example, information on the emission allocations between the energy and the industrial processes sectors, on the trends in emissions of subcategories, on the sudden decreases or increases in implied emission factors (IEFs), on the rationale of country-specific EFs for livestock and synthetic fertilizers, and on the inclusion of sewage sludge under animal waste applied to soils and on estimation methods of emissions/removals in LULUCF.

Consistency

33. The inventory is generally consistent, as defined 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" (thereinafter referred to as the UNFCCC reporting guidelines) with the exception of the allocation of fuel consumption to different industries within manufacturing industries and construction (see para. 48).

Comparability

34. The inventory is generally comparable with inventories of other Parties, and agreed reporting formats are used. During the review the ERT recommended some reallocations in the sectoral sections, such as the reallocation of N_2O emissions from soil disturbance reported under agricultural soils to the LULUCF sector. Notation keys are mostly reported correctly; some exceptions in agriculture and industrial processes are indicated in the sectoral sections of this report.

Accuracy

35. Australia's inventory is considered to be generally accurate, as defined in the UNFCCC reporting guidelines. Some errors were detected and corrected during the course of the review and are reported in the sectoral sections. The ERT investigated a number of issues relating to accuracy in the modelling approach in the LULUCF sector; these are documented in the sectoral section.

Recalculations

36. Australia's national system can ensure that recalculations of previously submitted estimates of GHG emissions by sources and removals by sinks are prepared in accordance with the IPCC good practice guidance. Within the national inventory system, annual inventory improvement plans have been prepared. When the improvements led to changes in the emission estimates, the historical time series were recalculated to achieve consistent time series.

37. The ERT noted that recalculations reported by Australia from the base year to 2005 took into account end-of-series averaging effects (for the agriculture sector), revisions of data, inclusion of additional data sources, refining of the estimation methodology and the inclusion of external territories. The recalculations also reflect a number of methodological improvements, for example, the use of tier 3 methods for heavy vehicles; refined methodology for HFCs and PFCs (halocarbons) which incorporates country-specific data on the capital stock of stationary air conditioners; the inclusion of CO_2 emissions from agricultural lime application; and a number of revisions of AD and EFs. The largest changes are due to the revision of the models used and the AD in the LULUCF sector, and due to revision of oxidation factors and degradable organic carbon (DOC) values for wood and garden waste for the emissions from solid waste disposal on land. The rationale for the important recalculations are provided in the NIR. In general the recalculations performed reflect improvements of data and methodologies. Based on the revised 2007 inventory submission and the latest 2006 inventory submission, the ERT noted that the recalculations decreased total national GHG emissions by 1.6 per cent in 1990 and by 1.1 per cent in 2004.

Uncertainties

38. Australia has provided an uncertainty analysis for each source category and for the inventory in total, following the IPCC good practice guidance. The tier 1 approach was used for all source categories, and tier 2 methodology (Monte Carlo and Latin Hypercube approaches) has been used in some sectors. The uncertainty estimates were reviewed in 2005 by independent experts under protocols developed by the Atmospheric Research Division of CSIRO, which confirmed the uncertainty estimates used with few exceptions. The ERT encourages Australia to provide some more information on the updating of uncertainty estimates.

3. Areas for further improvement identified by the Party

39. The NIR identifies several areas for improvement, which include:

(a) The use of new data collection processes and company reporting of fuel consumption under the NGER Act;

(b) The increased use of country-specific EFs in the agriculture sector;

(c) The incorporation of land use parameters and emissions/removals from plantations into the NCAS.

40. In its response to the issues raised during the in-country visit, Australia indicated that it is working to include decommissioned mines into the AGEIS; to fully implement carbon balance tracking within the AGEIS for fugitive emissions from oil and gas and from stationary fuel combustion; to develop updated country-specific EFs for light vehicles; to improve models for HFC estimation; to improve QC processes in the AGEIS for the industrial processes sector; and to improve quality of data for solid waste composition and characteristics and for wastewater treatment processes.

4. Areas for further improvement identified by the ERT

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

(a) Provide a more complete estimation and transparent reporting of emission sources and sinks in the LULUCF sector;

(b) Improve the use of the QA/QC features of the AGEIS system;

(c) Implement tier 2 uncertainty analysis for all sectors;

(d) Review the disaggregation level used for the key category analysis;

(e) Provide a transparent description of how data collected under the NGER Act are included in the GHG inventory and how time-series consistency is ensured.

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

5. Energy

Sector overview

43. In 1990, emissions from energy accounted for 68.8 per cent of total national GHG emissions. CO_2 made up 90.5 per cent, CH_4 9.0 per cent and N_2O 0.5 per cent of this sector's emissions. Between the base year and 2005 GHG emissions from the energy sector increased by 38.8 per cent. The increase was driven by increased emissions from energy industries (50.0 per cent), transport (30.1 per cent), manufacturing industries and construction (27.3 per cent) and fugitive emissions from fuels (11.4 per cent).

44. 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 workbooks of the methodologies, which are included in the inventory submission. The AD are directly derived from energy statistics data published by the ABARE.

45. The reporting of the energy sector is complete. During the in-country visit two missing sources in coal mining and handling (1.B.1.a) and some minor double counting due to data overlap with the industrial processes sector were identified. In the course of the review, Australia provided detailed explanations of these corrections and revised estimates.

46. The AD in the energy sector and the information sent to the IEA both rely on the data published by ABARE. Nevertheless, there area differences between these data sets. Some specific differences between the CRF data and the IEA data are that liquid fuels are 14 per cent higher, natural gas is 8 per cent higher and solid fuels are 7 per cent lower in the CRF than in the IEA data; that data for stock changes of solid fuels disagree, with a very large discrepancy being observed for bituminous coal in 2000; and that data on coal mines are comparable within 10 per cent. The ERT noted that differences may arise due to revisions of the ABARE data and recommends that Australia reconcile the data provided to the IEA.

47. Recalculations for the period 1990–2004 have been performed in the energy sector. The recalculations are due to the release of updated national statistics by ABARE for energy industries (public electricity), manufacturing industries and construction, as well as for transport. Recalculations have been performed for coal mining and handling as a result of an improved coverage of mine-specific data, the reallocation of some mines from the non-gassy to the gassy category, the revision of flaring data, and the inclusion of CH_4 emissions from some missing open-cut mines, which were not estimated before.

48. The ERT noted that the interpretation of the energy statistics for liquid fuels could be improved. The ABARE data show unexplained shifts in the fuel use attributed to different industries. For example, there are apparent inconsistencies between the data for 2000–2001 and for 1999–2000 in the use of liquefied petroleum gas (LPG) and between the data for 2004–2005 and for 2003–2004 in the use of diesel oil, attributed to the food and beverages industry, as well as between the data for 2004–2005 and for 2003–2004 in the use of LPG in petroleum refining. This leads to apparent time-series inconsistencies in IEFs for source categories that include these industries. The total energy use data, however, do not demonstrate these fluctuations, indicating that this is an allocation problem only. The ERT recommends that Australia explore this issue with the ABARE , as part of its QA/QC procedures, and improve time-series consistency in all source categories within manufacturing industries and construction in its next inventory submission.

Reference and sectoral approaches

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

49. CO_2 emissions from fuel combustion have been calculated using the reference approach and the sectoral approach. For the base year, the difference in the CO_2 emissions estimated by these two approaches is 0.15 per cent, which is within the acceptable range for this comparison.

50. Australia is reconciling the energy use data with the energy supply balance, so ideally, no differences between the reference approach and the sectoral approach should occur. Australia explained that the differences occur because, among other reasons, of deficiencies in the design of CRF tables 1.A(b) and 1.A(d). In the sectoral approach, the calculation of emission estimates is based on the fuel burned, which is obtained by subtracting the carbon sequestered in products from the fuel supplied. The ERT noted that any carbon sequestered in the ashes, slags or similar products should be reflected in the EFs and/or the oxidation factor and should not lead to differences between the approaches. The ERT recommends that Australia reanalyse the differences between sectorial and reference approaches and provide an explanation in its next inventory submission.

International bunker fuels

51. The fuel consumption for, and emissions from, international aviation and marine bunker fuels are reported separately as required by the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. Fuel consumption for domestic aviation and for international aviation is also reported separately and information on this distinction is provided.

Feedstocks and non-energy use of fuels

52. Due to an underestimation of the carbon used as a reducing agent in the production of synthetic rutile and of the carbon used as anodes in aluminium production, the quantity of coal, petroleum, coke and coal tars burned for energy use is overestimated. The ERT noted the double counting between the energy and the industrial processes sectors. In response to the ERT request during the review, Australia provided revised estimates for the entire time series; these are discussed in paragraph 54.

Key categories

Manufacturing industries and construction: solid fuels – CO_2

53. The EF applied for coke (119.5 Gg CO_2/PJ) is above the upper limit of the uncertainty range as derived from recognized international scientific literature. The carbon balance, calculated by Australia during the review, for the major use of coke in iron and steel production suggested that this EF should be 105.9 Gg CO_2/PJ. This revision decreases the CO_2 emissions in this category to 82.3 Gg in the base year and 100.7 Gg in 2005. The ERT agrees with this revision.

54. As noted paragraph 52, Australia provided, in response to the ERT's request, revised estimates for CO_2 emissions from production of synthetic rutile and from anodes in aluminium production. The revised estimates decreased CO_2 emissions by 35.2 Gg CO_2 (rutile) and 295.7 Gg CO_2 (anodes) in the base year and by 273.1 Gg CO_2 (rutile) and 445.6 Gg CO_2 (anodes) in 2005.

55. Revision of EFs for coke and revisions of carbon used as reductant in the production of synthetic rutile and as anodes in aluminium production, taken together, resulted in the revision of CO_2 emissions from solid fuels used in manufacturing industries and construction from 11,508.65 to 11,099.64 Gg CO_2 (by 3.6 per cent) in the base year and from 13,711.18 to 12,898.05 Gg CO_2 (by 5.9 per cent) in 2005 compared to the inventory originally submitted by Australia. The ERT agrees with these revisions and recommends that Australia apply these inventory improvements in its next inventory submission.

Non-key categories

Coal mining and handling: solid fuels – CH_4

56. For a small number of coal mines where emission measurements are not available, Australia used the results of two regression analyses to estimate emissions: a two-parameter linear regression (Williams et al., 1992) and a single-parameter linear regression (Williams et al., 1996), performed for two different years. The reported emissions for these mines are calculated as the average of these two regressions for the entire time series. The ERT suggests that, given the scatter in the regression plots in Williams at al (1992), Australia should assess whether the two regressions are significantly different; if not, it should use the data from both studies together to generate a single-parameter regression line, and apply it directly for all years in its next annual submission. During the review, Australia noted that the estimates of emissions from coal mining will be updated in light of data to be reported under the newly implemented NGERs.

57. In its estimate of CH_4 emissions from coal mining and handling in surface mines (1.B.1.a.ii.) Australia has not included the emissions from open-pit coal mines in Victoria (surface mining of brown coal), Western Australia (surface mining of sub-bituminous coal) and South Australia (surface mining of low rank sub-bituminous coal). During the in-country review, Australia provided an estimate of the emissions from these mines, which improved the completeness of the inventory for the entire time series. The revised values of CH_4 emissions from surface mines (3,385.22 Gg CO_2 eq in 1990 and 1,708.57 Gg CO_2 eq in 2005) resulted in an increase of Australia's emissions from this subcategory by 105.09 Gg CO_2 eq (3.2 per cent) in 1990 and by 156.3 Gg CO_2 eq (2.0 per cent) in 2005. The ERT agrees with these revisions and encourages Australia to continue to report the complete emissions from coal mining and handling in its future inventory submissions.

58. In the course of the review Australia provided revised estimates of CH_4 emissions from decommissioned mines. The revision is based on the correction of an error in the formula for conversion from run-of-mine coal tonnage data into mine volume void data. The correction of the formula resulted in a decrease of CH_4 emissions from decommissioned mines under other (1.B.1.c.) from 425.11 to 355.14 Gg CO_2 eq (by 16.5 per cent) in 1990 and from 1,850.79 to 1,708.57 Gg CO_2 eq (by 7.7 per cent) in 2005. The ERT agrees with these revisions.

6. Industrial processes and solvent and other product use

Sector overview

59. In 1990, GHG emissions from the industrial processes sector accounted for 5.8 per cent of the total national GHG emissions. CO_2 emissions accounted for 76.4 per cent, HFC, PFC and SF_6 emissions for 23.2 per cent, CH_4 emissions for 0.3 per cent and N_2O emissions for 0.1 per cent. In this sector, CO_2 emissions mainly come from iron and steel, aluminium and cement production; all the PFC (CF_4 and C_2F_6) emissions come from aluminium production; HFC emissions mainly come from refrigeration and air-conditioning equipment; and all the SF_6 emissions come from electrical equipment.

60. Total GHG emissions from industrial processes increased by 18.1 per cent between the base year and 2005, mainly because of the increase of emissions from aluminium production and from confidential emissions reported as CO_2 eq (other). Sectoral total emissions show an increasing trend between 1990 and 2004 but between 2004 and 2005 emissions decreased by 3.7 per cent.

61. The ERT welcomes Australia's efforts to improve QA/QC through a carbon balance check for cross-cutting categories (iron and steel, aluminium and rutile production) between the industrial processes and the energy sectors, which was completed during the in-country review visit following the ERT's recommendation. The ERT recommends that Australia further strengthen communications between its national inventory team and the external experts contributing to the preparation of the inventory for industrial processes, in order to improve the understanding of the rationale behind the figures provided by these experts and to increase the ability to detect outliers/potential problems. The ERT also recommends that Australia provide further explanations on emission allocations between the energy and the industrial processes sectors of its next inventory submission to increase transparency of the reporting.

62. There is no IPCC default methodology for CO_2 emissions from road paving with asphalt and from food and drink, and the ERT noted that CO_2 from road paving with asphalt and from food and drink, CH_4 from dichloroethylene and methanol, PFCs from fire extinguishers and HFCs from aerosols and metered dose inhalers are reported as "NE". The ERT encourages Australia to make efforts to provide emissions estimates for those categories to improve completeness of the inventory in its next inventory submission.

Key categories

Iron and steel production – CO_2

63. Australia accounted for the net CO_2 emissions from coke use for iron and steel production and carbon stored in steel under the industrial processes sector. As discussed in paragraph 53, the ERT noted that the EF for coke, 119.5 Gg CO_2/PJ (based on gross calorific value), is above the upper limit of the uncertainty range derived from recognized international scientific literature. Following a request from the ERT during the in-country review visit, Australia conducted a carbon balance check and corrected the EF of coke to 105.9 Gg CO_2/PJ. During the review Australia provided revised CO_2 estimates for the whole time series using the corrected coke EF. These revisions resulted in a decrease of CO_2 emissions from iron and steel production from 10,174.16 to 9,018.39 Gg (by 11.4 per cent) in 1990 and from 8,074.65 to 7,180.99 Gg (by 11.1 per cent) in 2005. The ERT agrees with the revised estimates.

64. The ERT noted that the IEF for CO_2 for iron and steel production decreased by 16.9 per cent in 1990–2005 but that the NIR does not provide an explanation for this decrease. During the in-country review visit the ERT identified that a decrease in the IEF in 2005 was due to a increased amount of pulverized coal (emissions reported in energy sector) used in the furnace to replace a part of the coke used as a reducing agent. The ERT recommends that Australia include the explanation of this trend in its next inventory submission.

Aluminium production – CO_2, CF_4 and C_2F_6

65. As indicated in paragraph 52, the ERT noted the double counting of CO_2 emissions between the energy and the industrial processes sectors due to an underestimation of the carbon used in rutile production and as anodes in aluminium production, and hence overestimation of the quantity of coal, petroleum, coke and coal tars burned for energy. During the review Australia provided revised estimates for anodes used in aluminium production for the entire time series, with which the ERT agrees. The ERT recommends that Australia revise these emissions accordingly and apply a carbon balance check as a regular QA/QC procedure for this category.

66. The ERT noted that IEFs for CF_4 and C_2F_6 both decreased by 53.3 per cent between 1993 and 1995, but that the NIR does not provide an explanation for this decrease. During the in-country review visit, Australia provided general information on its aluminium production but no specific explanation for

the fluctuations. The ERT recommends that Australia explore the specific reason for the fluctuations in the IEFs and provide explanations in its next inventory submission. The ERT also recommends that Australia, as a part of its QA/QC procedures, using the AGEIS system, systematically analyse fluctuations in IEFs and provide explanations for significant inter-annual changes in its future inventory submissions.

Cement production – CO_2

67. Australia uses plant-specific data to estimate CO_2 from cement production, in accordance with the IPCC good practice guidance. The IEFs decreased by 1.9 per cent between 1990 and 2005. Since 1997 the trend shows a sharper decrease, which is, as explained by Australia, due to the inclusion of the impact of cement kiln dust in the emission estimates (whereas less cement kiln dust was produced at the end of the time series).

Production and consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6

68. For the period 1990–1994 some AD for consumption of HFCs, PFCs and SF_6 are reported as "NO" and respective emissions are reported as "IE". During the in-country review visit, Australia explained that there had not been consumption of halocarbons in refrigeration and air-conditioning during that period, as indicated in the report of the Australian Greenhouse Office (2002). The ERT recommends that Australia correct the notation keys and include necessary explanations in its next inventory submission.

Other – CO_2 and N_2O

69. Australia reports GHG emissions from ammonia, nitric acid and magnesia production, from soda ash production and use, and from acetylene and nitrous oxide use (under 2.G. Other) as aggregated emissions in CO_2 eq. The ERT noted that the reporting is unnecessarily over-aggregated. For example, CO_2 emissions from ammonia production by four companies may be reported separately without disclosing confidential information. The ERT recommends that Australia report the confidential emissions at a more disaggregated level (as required by the IPCC good practice guidance) once the mandatory reporting under NGER Act comes into force, and correct the key category analysis accordingly.

Non-key categories

Other: synthetic rutile production – CO_2

70. As indicated in paragraph 54, due to an underestimate of the quantity of coal used as a reducing agent in the production of synthetic rutile (2.B.5), the quantity of coal burned for energy is overestimated. The ERT noted the double counting between the energy and the industrial processes sectors. During the review Australia provided revised estimates for the entire time series. The ERT agrees with the revised estimates and recommends that Australia apply a carbon balance check as a regular QA/QC procedure for this category.

7. Agriculture

Sector overview

71. In 1990, GHG emissions from the agriculture sector accounted for 20.9 per cent of total national GHG emissions (86,832.1 Gg CO_2 eq). Agriculture accounted for 61.7 per cent of total CH_4 emissions and 88.9 per cent of total N_2O emissions. Total GHG emissions from agriculture increased by 2.6 per cent between the base year and 2005, showing an increasing trend until 2001 but a decreasing trend from 2002 to 2005.

72. In general, the NIR provides sufficient information on methodological issues, including background information. The ERT noted that more detailed information is required to fully understand

the rationale of country-specific EFs for livestock and synthetic fertilizers. The ERT recommends that Australia, in its next inventory submission, clarify the inclusion of sewage sludge under animal waste applied to soils and whether the different categories use a three-year average of AD or emission estimates.

73. The sectoral inventory submission is complete, in terms of territories, gases and categories covered, and is consistent with the IPCC good practice guidance. Notation keys are reported accurately throughout the tables with exception of reporting "NA" instead of "NO" in some cases. The ERT recommends that Australia report "NO" instead of "NA" when a notation key relates to the AD.

Key categories

Enteric fermentation – CH_4

74. The ERT noted some differences in animal populations between the NIR and the statistical databases of the Food and Agriculture Organization of the United Nations (FAOSTAT). Differences are lower for major animal species such as cattle (5.6 per cent), sheep (1.1 per cent), swine (0.4 per cent) and poultry (6.8 per cent), and higher for minor animal species such as goats (15.7 per cent) and horses (13.1 per cent). During the in-country review visit, Australia explained that the differences are due to the fact that correction factors are taken into account for reporting of emissions in the inventory. The correction factors were used to avoid time-series inconsistency due to the changes in the estimated threshold value of agricultural operation introduced by ABS during the inventory preparation. The ERT recommends that Australia include this explanation in its next inventory submission.

75. For sheep and swine, Australia reports IEFs that are lower than the IPCC defaults. During the in-country review visit, Australia explained that its values are based on industry's research and expert judgement, and that variation along the time series reflect changes in the composition of the sheep and swine population and in feeding characteristics. The ERT recommends that Australia include this explanation in its next inventory submission.

Manure management – CH_4

76. In CRF table 4.B(a)s1, CH_4 emissions from management of manure from sheep and swine populations are not correctly split between temperate and warm regions. The ERT encourages Australia to report correct shares of these animal populations for different climate regions in its next inventory submission.

77. The IEFs for all the animal species except swine and dairy cattle are much lower than the IPCC default EFs. In the NIR and during the in-country review visit, Australia explained that it uses country-specific EFs for pasture-kept animals, based on values for EFs published in peer reviewed publications. These country-specific EFs reflect the prevalence of aerobic decomposition of animal excreta in a dominantly dry and sunny territory.

78. The IEFs for CH_4 from management of manure from dairy cattle (ranging from 0.002 to 7.9 g CH_4/head/year) range from one third to one quarter of the IPCC default EFs for Oceania (31–33 kg/head/year). During the in-country review visit Australia provided additional information to justify these differences, including information on the allocation of animals to different animal waste management systems (AWMS), the use of a lower CH_4 conversion rate for temperate regions, and the use of lower values for volatile solids. The ERT recommends that Australia include this explanation in its next inventory submission.

79. The IEFs for poultry (0.027–0.0249 kg CH_4/head/year) are lower than the IPCC defaults for developed countries (0.117–0.157 kg CH_4/head/year). During the in-country visit Australia explained that the difference is due to an average daily volatile solids (VS) value (0.0202 kg dry matter per day) which is one fifth of the IPCC default (0.1 kg dry matter per day). The ERT recommends that Australia explain the difference in its next inventory submission.

Agricultural soils – N_2O

80. Australia reported FracBURN, FracFUEL, FracGRAZ, FracNCRBF, FracNCRO and FracR as "NA", as it has applied different values for different cropping systems and regions. The ERT recommends that Australia explain the reasons for reporting "NA" in the documentation box of CRF table 4.Ds2 and in its next inventory submission.

81. Australia allocated N_2O emissions from soil disturbance under category other, soil disturbance. As these emissions arise from the conversion of forest land to cropland, they should, according to the IPCC good practice guidance, be reported under the LULUCF sector. During the in-country review visit the ERT recommended that Australia reallocate these emissions to the LULUCF sector (under category N_2O emissions from disturbance associated with conversion of cropland) and remove the related emissions from the assigned amount. In the course of the review, Australia corrected this misallocation. The reallocation resulted in a reduction of GHG emissions from other by 606.3 Gg CO_2 eq in 1990 and by 410.0 Gg CO_2 eq in 2005. The ERT agrees with the revised estimates and recommends that Australia continue reporting N_2O emissions from soil disturbance under the LULUCF sector.

82. The NIR does not clearly specify whether sewage sludge is included in the total animal waste applied to soils. During the in-country review visit, Australia explained that application of sewage sludge to soils is not permitted in Australia because of sanitary restrictions. The ERT recommends that Australia clarify this issue in its next inventory submission.

83. The NIR identifies that direct N_2O emissions from agricultural soils and N_2O emissions from pasture-kept animals were estimated following a tier 1 method and applying country-specific EFs. The ERT notes that the methodological approach applied corresponds to a tier 2 approach and recommends that Australia correct this reference in its next inventory submission.

84. The IEF of N_2O emissions from synthetic fertilizers applied to soils (0.01 kg N_2O–N/kg N) is much larger than the IPCC default EF (0.0064–0.0075 kg N_2O–N/kg N). The ERT noted that in CRF reports incorrect IEF of N_2O for 2002. Australia provided a general explanation in the NIR, and elaborated during the in-country review visit, that the IEF is lower due to application of country-specific EFs for different crop–soil systems based on national research published in peer reviewed publications. The ERT recommends that Australia correct the IEF of N_2O for 2002 and explain the application of the country-specific EFs in its next inventory submission.

Non-key categories

Manure management – N_2O

85. The ERT noted that in 1990 the N-excretion rates for dairy cattle (130.1 kg N/head/year) are the highest among the reporting Parties and higher than the IPCC default for Oceania (80 kg N/head/year). During the in-country visit, Australia explained that expert judgement was used to define the rate. The ERT recommended that Australia review the assumptions used in the determination of N-excretion rates, in particular the crude protein content, and recalculate the N_2O emissions estimates from management of manure from dairy cattle. In the course of the review, Australia revised the value for crude protein content used in the model to derive dairy cattle N-excretion rates of 112.45 kg N/head/year in 1990 and 120.33 kg N/head/year in 2005. This revision resulted in a decreased of N_2O emissions from manure management from 525.0 to 524.14 Gg CO_2 eq (by 0.2 per cent) in 1990 and from 1,545.7 to 1,544.5 Gg CO_2 eq (by 0.1 per cent) in 2005. In addition, these revisions resulted in a decrease of N_2O emissions from agriculture soils (animal manure applied to soils, pasture, range and paddock manure; atmospheric deposition, nitrogen leaching and run-off) from 13,705.1 to 13,496.2 Gg CO_2 eq (by 1.5 per cent) in 1990 and from 16,244.6 to 15,971 Gg CO_2 eq (by 1.7 per cent) in 2005. The ERT agrees with the revised estimates.

86. The N-excretion rates applied by Australia for horses (39.5 kg N/head/year) and mules/asses (13.2 kg N/head/year) differ substantially from each other and from the IPCC default EF

(25 kg N/head/year) for the both categories. The application of such a different N-excretion rates for rather similar animals was not explained in the NIR. The ERT recommends that Australia review the N-excretion rates and apply them consistently in its next inventory submission.

87. The IEFs of N_2O for other animal waste management system for 1990–2005 (0.017–0.018 kg N_2O–N/kg N) are among the highest for the reporting Parties and are higher than the IPCC default (0.005 kg N_2O–N/kg N). Australia explained that IEFs differ because Australia applied the AWMS differently from those considered by the IPCC. The ERT recommends that Australia explain this issue in its next inventory submission.

Field burning of crop residues – CH_4 and N_2O

88. The ERT noted that CH_4 and N_2O emissions from this category fluctuate at different rates over the time series. During the in-country review visit Australia explained that the reason for the different rates is the different annual mix of crop residues used, where each mix has a different N/C ratio. The ERT recommends that Australia include this explanation in its next inventory submission.

8. Land use, land-use change and forestry

Sector overview

89. In 1990, the LULUCF sector in Australia was a net source of GHG emissions (44,459.94 Gg CO_2 eq.) and accounted for 9.7 per cent of total national GHG emissions including LULUCF. The sector continued to be a net source until 2005 when net GHG emissions were equal to 81,595.09 Gg CO_2 eq. and accounted for 13.4 per cent of total national GHG emissions including LULUCF. From 1990 to 2005, net GHG emissions from the LULUCF sector increased by 83.5 per cent. As the LULUCF sector is a net source for Australia in the base year, total base year emissions for the purpose of the calculation of the assigned amount under the Kyoto Protocol shall, in accordance with decision 13/CMP.1, include GHG emissions from conversion of forests (deforestation).

90. Australia used a process-based model called FullCAM to estimate carbon stock changes in forest land converted to cropland and in forest land converted to grassland. The model covers the full change sequence of each pixel of the Australian forest estate and establishes whether a clearing or regrowth event has occurred between each image sequence for that pixel. Then it allocates to the event a date randomly generated within the time period determined by the two images. Carbon stocks are reconstructed following the disturbance history (including clearing) starting from 1972 and assuming an initial condition referred to as the maximum potential biomass.[3] The maximum potential biomass is then estimated by means of a regression with a long-term productivity index. The regrowth following the disturbance is calculated as the derivative of the biomass sigmoidal function, adjusted for climatic and ecological conditions by applying a productivity index. The sigmoidal function has its upper limit as the maximum potential above-ground biomass – calculated pixel by pixel – and its inflection point at 10 years for each species and forest typology. The dynamic of other carbon pools is based on inputs coming from the estimated changes of the above-ground carbon pool.

91. The FullCAM model is also used to estimate carbon stock changes in plantations under forest land and in land converted to forest land. For these categories the FullCAM model uses the data on growth increments from yield tables and wood flow estimates which are based on plantation types and management regimes. For these categories the ERT noted that the model does not calculate carbon stock changes in soil organic matter. Thus, the ERT recommends that Australia, following its inventory development plan, include soil organic matter changes in its next submission. Carbon stock changes in

[3] As stated in technical paper 4 "the maximum potential biomass predicted by the model is the highest biomass value that the model will assign to any forest area and is the average of the range of measured biomasses (field) for a range of forest disturbances. It reflects the ongoing, low-level disturbance patterns (e.g. grazing and low intensity fire) that dominate Australian woodlands and represents a maximum biomass that is slightly less than the theoretical maximum".

living biomass (LB), dead organic matter (DOM) and soil organic matter (SOM) of crops and pastures are calculated by a subset of the FullCAM model, the CAMAg (Carbon Accounting Model for Agriculture) model. The CAMAg model integrates the Roth C model for the estimation of carbon stock changes in the soil organic matter pool.

92. The ERT noted two areas of apparent inconsistency in the analysis of remote sensing data in the FullCAM model used for forest land area identification. The first is the methodology applied for detection of forest areas. During the review, the ERT noted that according to the implemented methodology, a pixel (covering 0.0625 ha) with at least 20 per cent tree cover is classified as a forest only if it directly connects with at least two other pixels where forest tree cover exceeds the 20 per cent tree coverage threshold. Then the aggregated area of three pixels (0.1875 ha) is classified as forest. According to the Australian forest definition,[4] a fully covered pixel surrounded by two pixels containing a tree-cover less than 20 per cent should also be considered as a forest because the aggregated area of three pixels shows a tree cover higher than 20 per cent, but it would not be identified as forest applying the FullCAM methodology. This apparent inconsistency may cause an underestimation of forest areas. The ERT recommends that Australia check the impact of this apparent inconsistency on a subset of remote sensing data by validating this approach with field data from areas that are close to the 20 per cent canopy coverage and report the result in the next inventory submission.

93. The second area of apparent inconsistency is the resolution of satellite images used. In the period 1973–1988 activity data were estimated using satellite images acquired by MSS sensor with a resolution of about 0.5 ha, which is higher than the minimum area of forest land according to the Australian forest definition (0.2 ha). The ERT noted that such an inconsistency between the resolution of the satellite images and the minimum unit of forest area could result in either overestimation or underestimation of net emissions. Based on the data available, the ERT could not judge whether one of these situations occurred. The ERT recommends that Australia check the impact of the application of the selected resolution on the net emissions estimates and, if the impact is relevant, revise estimates in its next inventory submissions.

94. During the in-country review the ERT noted that Australia estimated lagged net emissions from areas deforested before 1990 where soil carbon stocks did not reach a new equilibrium as defined by the IPCC good practice guidance for LULUCF. In response to a request by the ERT, Australia clarified that lagged net emissions generated from areas deforested since 1973 have been reported as part of the emission estimates even if the areas were not reported. The ERT further noted that according to the IPCC good practice guidance for LULUCF the default period to account for the lagged emissions is 20 years and that Australia has not reported lagged net emissions for two years (1971 and 1972) as part of the 1990 estimates. Nevertheless, taking into account that this will only cause an insignificant methodological deviation from the IPCC good practice guidance for LULUCF, the ERT considered the approach applied by Australia as acceptable.

95. Australia explained that the FullCAM model reaches a "steady state" – where output data are independent from starting conditions – after a certain number of calculation cycles, and that such a "steady state" should have been reached by 1988. The ERT noted that estimates of carbon stocks calculated before the model reaches the steady state could be affected by the assumed starting conditions. Consequently, the ERT concludes that lagged net emission estimates from areas deforested before the "steady state" is reached could have also been affected by the assumed starting conditions. The ERT recommends that Australia make further efforts to explore the effects of model starting assumptions before the "steady state" is reached on the estimation of lagged emissions, and present the results of the analysis in its next inventory submission to enhance the transparency of the reporting.

96. During the review the ERT was informed that, unlike in other countries, the national forest inventory is not one of the key data sources for forest area and biomass in Australia because different

[4] According to the Australian definition, forest is an area of at least 0.2 ha where forest trees with a potential height of 2 m or more cover at least 20 per cent of the area.

definitions are used for the national inventory and for the GHG inventory. Therefore, the area estimation in Australia fully relies on the assessment of satellite data. Because of the lack of comparison with forest inventory data in Australia, the ERT strongly recommends the Australia perform additional studies to use additional field data to validate the model results for both forest areas as well as biomass changes. Such an additional validation test with field data will be essential for the reporting under the Kyoto Protocol. Moreover, Australia was not able to respond to some of the data requests of the ERT. This was mainly due to the software structure of the FullCAM model that allows Australia only to report data for the CRF tables or at pixel level, but not to address other levels of disaggregation. The ERT believes that additional transparency with regard to the disaggregation of data is necessary for the reporting in the commitment period report of Article 3, paragraph 3, activities under the Kyoto Protocol, and requests Australia to implement the appropriate changes in the software model to allow Australia to respond in a more flexible way to data requests from the ERT, but also for verification and QA/QC purposes.

Key categories

Forest land remaining forest land – CO_2

97. During the in-country review visit, the ERT identified an inconsistency in reporting the land area, in particular land area for the forest land subcategory forest balancing term. In the revised CRF tables (submitted 5 June 2008) Australia included forest balancing term under the other native forests (as requested by the ERT during the review) without including corresponding removals of an equivalent area under the category grassland remaining grassland. Thus the issue of inconsistent reporting of activity data was not resolved. The ERT recommends that Australia report consistent activity data and include annual land use and land-use change matrix tables in its next annual submission.

98. In this category Australia has neither estimated nor reported carbon stock changes of woody biomass that occurred in other native forests subcategory and for the forest balancing term. The ERT noted that the forest thickening process is only partly captured by methodologies that estimate carbon stock changes due to changes in forest cover. The ERT also noted that some information sources indicate large net removals in forest areas included in this subcategory. This includes areas such as managed native forests no longer available for harvest (Resource Assessment Commission, 1992a), conservation reserves previously disturbed (Resource Assessment Commission, 1992b), and wooded land where grazing and fire regimes have been modified (see NCAS Technical Papers 4 and 13). In the course of the in-country review visit, the ERT requested Australia to provide quantified estimates for carbon stock changes in living biomass occurring in the other native forests subcategory including the forest balancing term.

99. In response to a request by the ERT, Australia provided estimates (16,100.00 Gg CO_2 eq removals) for other native forests (including the forest balancing term), in particular estimates of woody biomass changes due to forest expansion, forest thickening and forest degradation, estimates of leaf biomass changes, and estimates of changes in debris due to forest fires for the time series. The revision resulted in an increase of removals from forest land from 33,130.32 to 44,445.18 Gg CO_2 eq (by 34.2 per cent). The ERT agreed that the new estimates provided by Australia complete the estimates in the forest land remaining forest land category and acknowledges the planned efforts of Australia to further improve the estimates for biomass changes on the areas classified as “other native forests”.

100. The ERT noted that Australia applies the FullCAM model for calculating net changes in carbon pools in the plantations subcategory and in the land converted to forest land category, under some specific conditions which are not described clearly in the NIR. According the UNFCCC reporting guidelines, the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. Therefore, the ERT recommends that Australia improve the description of the model reported in the NIR and complement it with data on validation of model estimates based on independently collected data, such as the harvested wood products statistics, in its next submission.

Cropland remaining cropland – CO_2

101. The ERT noted that Australia did not estimate changes in soil carbon for this category. During the review, the ERT identified, based on the information provided by Australia, that management changes occured that are likely to change carbon stocks. For example, Technical Paper 7 (page 14), presents trends in carbon stock changes of Australian cropland that indicate a net increase in carbon stocks over time due to human activities (management practice) and, as in any other biological carbon pools, due to climate variability.

102. The ERT further noted that apparent changes in management practices have occurred. According to national carbon accounting system, Technical Paper 13 (Australian Greenhouse Office, 2002a) the management of cropland changed with regard to trash burned or unburned, stubble grazed, baled, mulched or retained, changes in tillage intensities, changes in shares of crops with different amounts of residues, and shifts from complete cropland systems to cropland/pasture systems. The increase in productivity as shown in figure No. 6 of Technical Paper 7 is also an indication that changes in management practices have occurred. These management changes will affect stocks in carbon pools over time. In response to a request by the ERT, Australia reported estimates for LB, DOM and SOM pools for entire time series. The revised estimates decreased emissions from the cropland in 1990 from 25,101.41 to –9,595.88 Gg CO_2 eq (by 138.2 per cent). The ERT agreed that the new estimates provided by Australia completed the estimation and acknowledges the planned efforts of Australia for further improvements of the estimates of changes in soil carbon on croplands.

Grassland remaining grassland – CO_2

103. The ERT noted that with a total area of 448 320.93 kha, the grassland area in Australia in 1990 was very large and that emissions or removals from grassland remaining grassland were reported as 'NA'. The national carbon accounting system, Technical Paper 13 (Australian Greenhouse Office, 2002a) indicates that 'savannah thickening' or woody biomass encroachment occurred in the early 1990s. The ERT noted that in some areas an increase in the woody biomass density in grassland ecosystems over time occurred due to changes in fire and/or grazing regimes and due to climate changes. Such savannah thickening would result in a net carbon stock increase reported under the grassland remaining grassland category. The ERT noted that as the total area reported under this category is large, the occurrence of 'savannah thickening' on a relatively small share of this area (for example, 10 per cent) may result in rather large net removals. Therefore, during the review the ERT requested Australia to provide quantified estimates for carbon stock changes in living biomass for the area reported under grassland remaining grassland for the years 1990–2005. Australia clarified that the lands where 'savannah thickening' or woody biomass encroachment occurs are reported under the "other native forest" subcategory of the forest land remaining forest land category.

104. Australia did not report stock changes in soil carbon for the grassland remaining grassland category. During the review the ERT noted that there is evidence of management changes that are likely to change soil carbon stocks on these areas. According to national carbon accounting system, Technical Paper 13 (Australian Greenhouse Office, 2002a), changes in beef prices changed management intensity of pasture strongly over time between minimally managed pastures and intensively managed pastures with considerable inputs (e.g. fertilization), grass species used for improved pastures changed over time, the fire regime of pasture changed over time and hay production was present or absent. In response to a request by the ERT, Australia reported estimates for LB, DOM and SOM pools for 1990–2005. The revised estimates decreased emissions from grassland from 111,390.95 to 102,199.22 Gg CO_2 eq (by 8.3 per cent). The ERT acknowledged that the new estimates are complete and encourages Australia to further improve the estimates of changes in soil carbon on grassland.

Forest land converted to cropland and forest land converted to grassland – CO_2, CH_4, N_2O

Assumptions of FullCAM model

105. The ERT noted that the FullCAM model applied by Australia for estimating net CO_2 emissions from forest conversion to other land uses is based on a number of assumptions, three of which the ERT analysed in detail. The first assumption concerns the maximum current annual increment where Australia assumed that all the forest typologies and tree species reach the maximum current annual increment (CAI) at the same age. The second assumption states that the age at which all the forest typologies and tree species reach the maximum above-ground biomass increment (BIa) is 10 years . The third assumption states that the carbon stocks of all the Australian forests were at maximum potential biomass in 1972. Maximum potential biomass is equivalent to the highest biomass value that the model assigns to any forest area and is an average of a range of measured biomass for a range of forest disturbances.

106. Analysing the first and the second assumptions, the ERT noted that the CAI is species-specific and depends on site productivity (for example, environmental conditions). Australia explained that assumptions relating to BIa are expert judgments based on available literature. Australia provided the results of a sensitivity test of the model demonstrating that changes in the BIa had negligible impact on net CO_2 emissions from deforestation (see Technical Paper 4). The ERT agreed with the results of the test performed. The ERT, considering the potential relevance of the BIa value for the reporting under the Kyoto Protocol, recommends that Australia elaborate assumptions for BIa taking into account the wide range of tree species and forest typologies in Australia. The ERT further recommends that Australia quantify the impact of different BIa values (20, 25, 30 years) on net carbon stock changes under both forest land converted to cropland and forest land converted to grassland categories over the entire time series. To demonstrate these improvements, the ERT encourages Australia to provide the data outputs of the model running under different BIa values in its next inventory submission.

107. Analysing the third assumption, the ERT noted that Australia, in response to a request from the ERT, stated that "the forests are fully mature, but in a state of ongoing low level disturbance" (Technical Paper 4). The ERT further noted that the other literature source (Kurz et al, 1998) states that "because of natural and human disturbances, landscapes are rarely at maximum biomass, and the extent to which the average biomass carbon density (t per ha) is below the maximum carrying capacity depends on the disturbance type and frequency in prior years". Therefore, the ERT noted that the assumption that all Australian forests were at maximum potential biomass in 1972 could lead to an overestimation of net CO_2 emissions from deforestation, until the time at which these model starting assumptions are no longer relevant because the FullCAM model has run over a period in which even plots that were young in 1972 would have reached maximum potential biomass or would have been cleared again.

108. Further, in order to substantiate the third assumption and to prove that the FullCAM model achieves equilibrium before 1990, Australia (in Technical Paper 4) explained that the ratio of first time clearing (conversion) to the amount of reclearing (areas already cleared between 1972 and 1990) should stabilize once all areas subject to regrowth and reclearing have been through at least one full cycle. A figure titled "Regrowth clearing as a percentage of total clearing" (Technical Paper 4) shows a continuous increasing share of "Regrowth clearing" from 0 per cent (in 1972) to 10 per cent (in 1980), to 20 per cent (in 1989) and to 30 per cent (in 1998). The ERT noted that the figure identifies an increasing trend in the ratio between "Regrowth clearing" and "Total clearing" until 1998. The increasing share of regrowth clearing means that in each year during the time series, a portion of land accounted as at first time clearing (conversion) had potentially a forest carbon stock level below the maximum potential biomass.

109. In addition, in response to a request by the ERT, Australia provided the time series of 'notional biomass' at maximum potential biomass level (biomass estimates that would have been applied if only the maximum potential biomass values had been used) and of 'average of actual biomass cleared' (biomass outputs of each major forest type for areas cleared in 1990 calculated taking into consideration losses of

carbon stocks due to registered historical disturbances) calculated with different BIa values, namely 10, 15 and 20. The ERT noted that these data show a continuous increasing difference over the time series between 'notional biomass' at maximum potential biomass and 'average of actual biomass cleared'. The difference starts from values close to 0 in 1972 (due to the assumption of forests at maximum potential biomass in 1972), progressively increases, and does not stabilize at a certain value during the time-series. Following Austalia's further clarification, the ERT noted that the achievement of the steady state means that all the areas cleared for the first time, and consequently accounted as undisturbed, were not affected, prior to the conversion, by outstanding disturbances that lowered the carbon stocks below the maximum potential biomass. Before the achievement of the steady state some areas that are accounted as undisturbed have conversely experienced some disturbances that lowered the carbon stocks below the maturity level.

110. During the in-country visit the ERT noted that a study provided by Australia (Brack et al (2006)) presents a validation test of the regression[5] applied by the NCAS model. The validation test shows that above-ground biomass estimates are significantly larger (the probability is higher than 0.05) than the estimates derived from the inventory' for an area of remnant vegetation in Queensland. In response to an ERT request during the review Australia provided assessments by external experts stating that as far as can been judged, the questioned regression should result in neither an underestimation nor an overestimation of FullCAM outputs. Australia also provided a validation test performed using 15 additional data points collected from the literature that have not been used for model calibration and are therefore available for validation. Based on the data provided, the ERT concluded that there is no clear evidence of overestimation of the above-ground biomass estimates. Furthermore, given the relevance of validation for the reporting under the Kyoto Protocol, the ERT recommends that Australia provide additional validation results of the output data of the FullCAM model by comparing it with the field data (not used for model calibration) and present these results in its next inventory submissions.

111. The IPCC good practice guidance for LULUCF provides a value for the average per hectare above-ground biomass in Australian forest (57 t dry matter) derived from the National Forest Inventory report to the Food and Agriculture Organization of the United Nations (FAO). This value expanded to the whole living biomass pool (by factor 1.3) and converted to carbon (by factor 0.5) makes 37.05 t C/ha. Then, taking into account the differences between the forest definition applied by Australia in the NCAS for reporting under the Kyoto Protocol and the forest definition applied by Australia in the Australian National Forest Inventory (NFI) for the Convention, the ERT normalized this value. The main difference between the forest definitions is due to the fact that the minimum area (0.2 ha) selected to report under the Kyoto Protocol determines the exclusion of gaps in the forest cover. In Australian woodlands that have a very sparse cover the exclusion of gaps results in a large reduction of the total forest area[6] although the whole biomass is equally accounted. In practice, for Kyoto Protocol purposes an equivalent amount of biomass is accounted on a smaller area resulting in a higher density of biomass. Then, in order to compare biomass values retreated from different statistical data sources under different forest definitions, the ERT estimated the biomass data per forest area. To do so, the ERT calculated the ratio between the areas reported under the NFI and the NCAS (NFI area / NCAS area = 1.4057). This value was applied to the NFI per ha biomass (37.05 * 1.4057 = 52.08 t C/ha) in order to make it comparable to the NCAS value.

112. In order to make sure that no overestimation of net emissions from deforestation in 1990 occurred, the ERT, following NCAS data provided for 1990 (41.72 t C/ha), compared these data with the calculated data of living biomass of Australian forest derived according to the IPCC good practice guidance for LULUCF (52.08 t C/ha). The ERT concluded that the data provided by Australia is by 19.9 per cent below the value calculated following the IPCC good practice guidance for LULUCF. Such evidence supports the

[5] Regression between long-term productivity index (P) and above-ground biomass (M) (t/ha) at maximum potential biomass. That regression is applied to the FullCAM model in order to estimate carbon stocks in carbon pools in pixels that have been not disturbed before being cleared.

[6] The NCAS estimates 45.4 Mha of forest less than the Australian national forest inventory.

ERT's conclusion that there is no overestimation of Australian net emissions from deforestation in 1990. The calculation of the average per hectare living biomass of Australian forest following the IPCC good practice guidance is elaborated in the following paragraph.

113. In response to the ERT request, due to the absence of a clear evidence that the steady state was achieved before 1990, Australia revised its assumption that carbon stocks of all the Australian forests were at maximum potential biomass in 1972 by applying a discount factor. The revised assumption states that 7.25 per cent of the cleared area in 1990, that has been accounted as previously undisturbed, had some degree of disturbance that lowered the carbon stocks by 50 per cent of the maturity level. Therefore, Australia applied a discount factor of 3.625 per cent to net emissions from deforestation in 1990. The discounting resulted in a decrease of GHG emissions from forest land converted to cropland and forest land converted grassland from 136,492.36 to 131,544.51 Gg CO_2 eq (by 3.6 per cent) (the total difference of 4,947.848 Gg CO_2 eq is calculated from 4,783.311 Gg CO_2, 6.153 Gg CH_4, 0.114 Gg N_2O). The ERT, considering the potential relevance of the starting assumption for the reporting under the Kyoto Protocol, recommends that Australia further investigate the impact of the starting assumption on estimates of carbon stock changes in forest land converted to cropland and forest land converted to grassland.

Time-series variability of carbon stock changes

114. The ERT noted that, under forest land converted to cropland and under forest land converted to grassland in 2003, carbon stock changes in living biomass are three times lower than in 2002, while in dead organic matter (DOM) pools these changes are ten times lower than in 2002. Moreover, the ERT found that FullCAM outputs show high inter-annual variability (greater than 1000 per cent). This high inter-annual variability affects different carbon pools in different ways, and the changes show opposite signs for different pools in the same year. In order to gain a better understanding of the reason for these marked differences between years and pools, the ERT requested Australia to provide the disaggregated data for area converted, net carbon stock changes occurring in living biomass, DOM and SOM pools in areas deforested in the same years and, for each year in the time series 1972–2005, for forest land converted to cropland and forest land converted to grassland. In response to this request, Australia noted that collecting the required components to run the model is technically impossible for the FullCAM model in the version of the software which is current implemented and explained that the inter-annual variability is linked mainly to extremes in weather conditions, such as the El Niño-related drought of 2002–2003. During the review, Australia provided the percentage change in carbon stock by pool which helped understanding of this issue.

115. After checking the estimates for 1990, the ERT concluded that such time-series variability does not affect these estimates. Nevertheless, the ERT requests Australia, for the sake of transparency and comparability, to ensure that the software version of the FullCAM model provides data at an aggregation level suitable for the review (e.g. per forest type, final use and management practice, year of conversion and ecological/administrative region) and to report such disaggregation in the inventory submissions during the commitment period. The ERT recommends that Australia provide clear explanations for carbon stock changes between the reported years for the different pools in its next inventory submission.

Trends in soil carbon stocks

116. The ERT considered the output data generated by the FullCAM model (Roth C sub-model), in particular the consistency of trends in soil carbon stocks under forest land converted to cropland, which shows an unusual increasing trend as a consequence of the removal of trees and the subsequent cultivation of the land. In response to the request of the ERT, Australia provided Technical Paper 2 to explain the unusual trend in carbon stocks in mineral soils in forest land converted to cropland. Australia explained that, in order to ensure that the conversion from forest land to cropland results in an increase in soil carbon stock, 75 per cent of the country's agricultural land is under rotation between crops and pasture. In practice, according to the explanation provided, this rotation system means that forest land is

first converted into cropland (with a loss of soil carbon) and then into pasture (with a gain in soil carbon compared with the carbon stock level of the original forest land.

117. The ERT noted that the trend in soil carbon stocks under forest land converted to cropland (i.e. an increase in soil carbon stocks) differs from the trend in soil carbon stocks under forest land converted to grassland, the latter showing a continuous decrease in soil carbon throughout the conversion period. The increase in soil carbon stocks under forest land converted to cropland was explained by the effects of having crop–pasture rotations. The ERT requested further clarification as to why conversions to grassland do not also lead to increases, but rather decreases, in soil carbon stocks. In response to this request, Australia went on to explain that it is not possible to draw parallels between the pasture phases of crop–pasture rotations and arid grassland systems, as the management practices and the climate under which they occur vary considerably. Native grassland systems are often found in areas that would not support crop production. In addition, Australia provided additional literature that confirmed the carbon stock trends reported for the conversion of forest land to grassland. The ERT recommends that Australia provide, in its next inventory submission, independently collected data on soil carbon stock changes after forest conversion to cropland and grassland, in order to validate the FullCAM output data and trends.

Non-key categories

Biomass burning – CO_2, CH_4 and N_2O

118. Australia estimates 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 with either the UNFCCC reporting guidelines or the IPCC good practice guidance for LULUCF, as inventories are meant to be reported without adjustments relating to climate variations being made. The ERT recommends that Australia use annual data for forest area burned, in its reporting under the Kyoto Protocol.

119. In its response to the draft report, Australia noted that the IPCC good practice guidance for LULUCF, as an elaboration of the Revised 1996 IPCC guidelines, provides guidance on the methods for estimating annual emissions/removals and that it does not indicate that reporting three year averages is no longer good practice. Australia further noted that three year averaging is allowed in the agriculture sector (for savanna burning).

120. In the course of the review, Australia informed the ERT that the New South Wales Government had provided a new consolidated dataset, which improved the accuracy of the data by removing the double counting of area burned. On the basis of this new dataset, Australia has provided revised estimates for CH_4 and N_2O emissions from biomass burning for the entire time series. The revisions resulted in a 0.5 Gg CO_2 eq increase in emissions in 1990 (from 2,117.58 to 2,118.07 Gg CO_2 eq, owing to a 0.1 per cent increase in the area of biomass burned in forest land remaining forest land) and a decrease in emissions in 2005 by 11.9 Gg CO_2 eq (from 1,372.78 to 1,360.85 Gg CO_2 eq, owing to a 1.8 per cent increase in the area of biomass burned in forest land remaining forest land). Over the time series, the changes range from an increase of 173.0 Gg CO_2 eq to a decrease of 68.0 Gg CO_2 eq. The ERT agrees with these revisions.

9. Waste

Sector overview

121. In 1990, GHG emissions from the waste sector accounted for 4.5 per cent of the total national GHG emissions (18,761.77 Gg CO_2 eq). CH_4 emissions accounted for 97.0 per cent of sectoral GHG emissions, N_2O emissions for 2.6 per cent and CO_2 emissions for 0.4 per cent. CH_4 emissions from solid waste disposal on land accounted for 79.2 per cent of emissions from waste.

122. The inventory in the waste sector is, in general, transparent and complete. The ERT appreciates the improvement in transparency and completeness made by Australia during the review, in terms of the estimation of some missing emissions, additional clarification and documentation of the assumptions used for data generation for waste landfilled, and further clarification and documentation of the use of some parameters for the calculation of emissions from different categories.

123. In accordance with the IPCC good practice guidance, Australia reported recalculations owing to changes in methodology and data, and the improvement in completeness (inclusion of external territories). Australia also conducted category-specific QA/QC activities and an uncertainty assessment.

Key categories

Managed waste disposal on land – CH_4

124. The ERT noted an improvement in the methodology used by Australia to estimate CH_4 emissions from managed waste disposal on land. Australia applied the first order decay (FOD) model, which is based on recently published reviewed scientific literature, instead of the country-specific method previously used. The ERT noted that the use of the FOD model for a key category is in line with the IPCC good practice guidance.

125. In order to apply the FOD model, Australia collected and generated historical as well as recent data. The data sources include states' and territories' waste agencies, the harvested wood products (HWP) model, companies (landfill gas and incineration) and existing documents. The assumptions used to fill the gap in the country's knowledge about the amount and composition of waste landfilled since 1940 were provided during the in-country review. The ERT encourages Australia to investigate the possibility of using appropriate drivers (e.g. population, management practices) in order to extrapolate data on waste landfilled since back in 1940 for its next inventory submission.

126. The ERT recommends that Australia validate the HWP model used to estimate the amount of wood and paper sent to landfill by collecting and comparing ground-based data on the amount, composition and characteristics of waste from landfill sites in states and territories with the results of the HWP model, because the outputs of the HWP model would be different from data on Australia published in a recognized international scientific literature. The ERT recommends that Australia use data from landfill sites when available, as this will lead to more accurate emission estimates than those currently given.

127. The default data on degradable organic carbon used for textiles and the decay rate constant for some climate zones in Australia are not in line with the IPCC good practice guidance. Also, it is not clear whether Australia has included sewage sludge in its estimates. During the in-country review, Australia, following the recommendations of the ERT, provided revised estimates for CH_4 emissions from solid waste disposal on land, and the data spreadsheets used, and explained the assumptions applied. The revised estimates took into account the different waste components at a more disaggregated level (distinguishing, for example, textiles and sewage sludge) and applied appropriate IPCC default parameters. The revised estimates resulted in an increase in CH_4 emissions from managed waste disposal on land by 8.5 per cent in 1990 (from 13,696.9 to 14,857.97 Gg CO_2 eq) and by 10.5 per cent in 2005 (from 11,927.0 to 13,184.83 Gg CO_2 eq). The ERT agrees with the revisions and recommends that Australia include the revised estimates in its next inventory submission.

Non-key categories

Wastewater handling – CH_4

128. Australia used the IPCC default methodology and country-specific data on biochemical oxygen demand, chemical oxygen demand and methane correction factor (MCF) to estimate CH_4 emissions from both industrial wastewater and domestic and commercial wastewater. The references on some parameters were provided during the in-country review and the derivation of the weighted MCF for different sludge

treatment systems was also explained. The ERT recommends that Australia include, in its next inventory submission, detailed information on the country-specific data used.

Wastewater handling – N_2O

129. Australia used the IPCC default methodology from the Revised 1996 IPCC Guidelines with a constant value on protein consumption for 1990–2005. The ERT recommends that Australia investigate whether this value has changed during the time series and report revised values of protein consumption in its next inventory submission.

Waste incineration – CO_2, N_2O

130. Australia used a method which is in line with the IPCC good practice guidance to estimate emissions of CO_2 from clinical waste and solvents. Although incineration of municipal solid waste was not reported in the inventory, during the in-country review the ERT identified, in documentation provided by Australia, that municipal solid waste incineration did in fact occur in Australia during the period 1990–1996. Australia confirmed this and provided the missing estimates for CO_2 and N_2O emissions from municipal waste incineration in order to improve the completeness of the inventory. The estimates provided are 51.9 Gg of CO_2 and 11.8 Gg CO_2 eq of N_2O in 1990. The inclusion of these estimates in the inventory resulted in an increase of the GHG emissions from waste incineration by 299.1 per cent (from 21.3 to 85.0 Gg CO_2 eq). The ERT agrees with the revision and recommends that Australia include the revised estimates in its next inventory submission.

C. Calculation of the assigned amount

131. The assigned amount pursuant to Article 3, paragraphs 7 and 8, is calculated in accordance with the annex to decision 13/CMP.1.

132. Australia's base year is 1990 and it has chosen 1990 as the base year for HFCs, PFCs and SF_6. Australia's quantified emission limitation, inscribed in Annex B to the Kyoto Protocol, is 108 per cent.

133. Land-use change and forestry constituted a net source of GHG emissions in 1990 and Australia's aggregate anthropogenic CO_2 eq emissions by sources minus removals by sinks from land-use change (deforestation) in 1990 are included in the 1990 emissions base year for the purpose of the calculation of the assigned amount.

134. Based on Australia's base year emissions including emissions from deforestation (553,773.80 Gg CO_2 eq) and its Kyoto Protocol target (108 per cent), the Party calculates its assigned amount to be 2,990,378,528 tonnes CO_2 eq.

135. In response to issues identified during the review, Australia submitted a revised estimate of its base year emissions (547,699,841 t CO_2 eq), which resulted in a recalculation of the assigned amount to 2,957,579,143 t CO_2 eq. The ERT agrees with this figure.

D. Calculation of the commitment period reserve

136. The calculation of the required level of the commitment period reserve is in accordance with paragraph 6 of the annex to decision 11/CMP.1.

137. Based on its calculated assigned amount of 2,990,378,528 tonnes CO_2 eq, Australia calculates its commitment period reserve to be 2,691,340,675 tonnes CO_2 eq.

138. In response to issues identified during the review, the Party submitted revised estimates of its base year inventory, which resulted in a recalculation of the commitment period reserve to 2,661,821,229 t CO_2 eq. The ERT agrees with this figure.

E. National registry

139. Australia has provided some of the information on the national registry system as required by the reporting guidelines under Article 7, paragraphs 1 and 2, of the Kyoto Protocol (decision 15/CMP.1). During the in-country review, Australia provided further information on the national registry which only partially follows the requirements of these reporting guidelines.

140. During the in-country review, Australia informed the ERT that the registry would be procured in August 2008 and is planned to be fully operational by the end of 2008. The ERT is satisfied with these deadlines and that Australia follows these.

141. Table 5 summarizes information on the mandatory reporting elements of the national registry system, as stipulated by decision 15/CMP.1, which describes how the national system performs the functions defined in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1.

Table 5. Summary of information on the national registry system

Reporting element	Provided in the initial report	Comments
Registry administrator		
Name and contact information	Yes	
Cooperation with other Parties in a consolidated system		
Names of other Parties with which Australia cooperates, or clarification that no such cooperation exists.	Yes	No cooperation in a consolidated system
Database structure and capacity of the national registry		
Description of the database structure	No	Provided during review
Description of the capacity of the national registry	No	Provided during review
Conformity with data exchange standards (DES)		
Description of how the national registry conforms with the technical DES between registry systems	No	Provided during review
Procedures for minimizing and handling discrepancies		
Description of the procedures employed in the national registry to minimize discrepancies in the transaction of Kyoto Protocol units	No	Provided during review
Description of the steps taken to terminate transactions where a discrepancy is notified, and to correct problems in the event of a failure to terminate the transaction	No	Provided during review
Prevention of unauthorized manipulations and operator error		
An overview of security measures employed in the national registry to prevent unauthorized manipulations and operator error	No	Provided during review
An overview of how these measures are kept up to date	No	Provided during review
User interface of the national registry		
A list of the information accessible to the public by means of the user interface to the national registry	No	Provided during review
The internet address of the interface to Australia's national registry	Yes	
Integrity of data storage and recovery		
A description of measures taken to safeguard, maintain and recover data in order to ensure the integrity of data storage and the recovery of registry services in the event of a disaster	No	Provided during review
Test results		
The results of any test procedures that might be available or developed with the aim of testing the performance, procedures and security measures of the national registry undertaken pursuant to the provisions of decision 19/CP.7 relating to the technical standards for data exchange between registry systems.	No	Provided during review

142. Australia also informed the ERT that the function of the national registry with regard to domestic emissions trading will evolve once a registry provider has been selected. Information on the current development of the registry is available at <http://www.climatechange.gov.au/emissionstrading>.

143. In the course of the review, the ERT was informed about the procedures and security measures employed to minimize discrepancies, terminate transactions and correct problems, and minimize operator error. The ERT acknowledged the effort made to put these adequate procedures and security measures in place. The ERT gained the overall impression that Australia attached adequate importance and allocated adequate resources, including human resources, to the development, operation and maintenance of the registry.

144. The ERT took note of the results of the technical assessment of the national registry, including the results of the standardized testing, as reported in the independent assessment report that was forwarded to the ERT by the administrator of the international transaction log, pursuant to decision 16/CP.10, on 19 December, 2008.

145. The ERT reiterated the main findings of this report, including that the registry has fulfilled sufficient obligations regarding conformity with the data exchange standards. These obligations include having adequate transaction procedures, adequate security measures to prevent and resolve unauthorized manipulations, and adequate measures for data storage and registry recovery.

146. On the basis of the results of the technical assessment, as reported in the independent assessment report, the ERT concluded that Australia's national registry is sufficiently compliant with the registry requirements defined in decisions 13/CMP.1 and 5/CMP.1, noting that registries do not have obligations regarding operational performance or public availability of information prior to the operational phase.

F. Land use, land-use change and forestry parameters and election of activities

147. Table 6 shows Australia's choice of parameters for forest definition, as well as elections for Article 3, paragraphs 3 and 4, activities in accordance with decision 16/CMP.1.

Table 6. Selection of LULUCF parameters

Parameters for forest definition		
Minimum tree cover	20 per cent	
Minimum land area	0.2 hectares	
Minimum tree height	2 metres	
Elections for Article 3, paragraphs 3 and 4, activities		
Article 3, paragraph 3, activities	**Election**	**Accounting period**
Afforestation and reforestation	Mandatory	Annual
Deforestation	Mandatory	Annual
Article 3, paragraph 4, activities		
Forest land management	Not elected	Not applicable
Cropland management	Not elected	Not applicable
Grazing land management	Not elected	Not applicable
Revegetation	Not elected	Not applicable

148. During the in-country review, the ERT identified differences between forest area reported under the UNFCCC and forest area reported to the Food and Agriculture Organization of the United Nations, and sought clarification on this matter. Australia explained that the reason for the discrepancy in forest area is the application of difference thresholds for the minimum forest area. In addition, Australia

explained that forest conservation areas, and the relative carbon stock changes, are included in the estimates under the harvested native forests subcategory (Technical Paper 6, page 1). Considering that Australia reported a constant area for the whole time series under the harvested native forests subcategory, and that forest conservation areas have increased during the period 1990–2005, the ERT recommends that Australia describe in more detail how the area of harvested native forests has been estimated and provide more information on the background data (and related references) used to make these estimates in its next submission. Moreover, the ERT encourages Australia to reconcile the data on forest land provided to the UNFCCC with the data provided to other international organizations.

III. Conclusions and recommendations

A. Conclusions

149. The ERT concluded that the information provided by Australia in its initial report generally covers the elements required by paragraphs 5, 6, 7 and 8 of the annex to decision 13/CMP.1, section I of the annex to decision 15/CMP.1, and other relevant decisions of the CMP. Additional information on all elements was provided to the ERT during the in-country review.

150. Australia's national system is prepared in accordance with the guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (decision 19/CMP.1) and can perform the general and specific functions required by these guidelines. In its initial report, Australia submitted a complete set of CRF tables for the years 1990–2005 and a comprehensive NIR. The inventory is complete in terms of geographical coverage and covers almost all categories for the whole period 1990–2005, with the exception of several categories in the energy, industrial processes and LULUCF sectors.

151. Australia responded in good time to the potential problems identified by the ERT during the review, by providing additional information and submitting revised estimates. The ERT noted that, in the course of the review, Australia provided responses to the two sets of requests for clarification in the energy and industrial processes sectors, and provided some additional information required in the LULUCF sector. The ERT concluded that the national system is generally in line with the guidelines for national systems.

152. The assigned amount pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol is calculated in accordance with the annex to decision 13/CMP.1 and is consistent with the Party's reviewed and submitted revised inventory estimates. The calculation of the required level of the commitment period reserve is in accordance with paragraph 6 of the annex to decision 11/CMP.1. The ERT confirms that Australia's assigned amount is 2,957,579,143 t CO_2 eq, based on its base year emissions of 547,699.841 Gg CO_2 eq (including the revised estimates provided) and its Kyoto Protocol target of 108 per cent, and that Australia's commitment period reserve is 2,661,821,229 t CO_2 eq (based on the revised estimates provided). The ERT agrees with the approaches used for the revision of the emissions and removals estimates.

153. Australia's choice of parameters for forest definition is in accordance with decision 16/CMP. This includes minimum tree crown cover of 20 per cent, minimum land area of 0.2 ha and minimum tree height of 2 m. Australia has chosen to account for Article 3, paragraph 3, annually and has not elected any activities to account for Article 3, paragraph 4.

154. During the in-country visit, the tender for the establishment of the national registry was still under preparation and additional information on the registry was provided after the visit. On the basis of this additional information and the technical assessment, as reported in the independent assessment report, the ERT concluded that Australia's national registry is compliant with the registry requirements as defined by decisions 13/CMP.1 and 5/CMP.1.

155. Australia has made improvements since its 2006 submission. Some major improvements include the use of tier 3 methods for heavy vehicles, refined methodology for halocarbons to incorporate country-

specific data on the capital stock of stationary air conditioners, the inclusion of CO_2 emissions from agricultural lime application, revisions of AD and EFs, the inclusion of additional sources of data to refine the estimation methodology and the inclusion of external territories.

B. Recommendations

156. In the course of the review, the ERT formulated a number of recommendations relating to the completeness and transparency of Australia's GHG inventory submission. Several of the recommendations were implemented during the review process and the potential problems in the agriculture and LULUCF sectors, that could have led to an overestimation of emissions, were resolved. The remaining key recommendations[7] are that Australia:

(a) Further enhance the completeness of its inventory by including missing GHG emission estimates and parameters in the LULUCF sector and minor emissions from missing sources in the energy and industrial processes sectors, and by continuing to report on the new categories that were included in the current inventory to ensure time-series consistency;

(b) Improve its QA/QC by establishing additional QA checks in some areas, such as carbon balance for the iron and steel sector, and by systematically analysing fluctuations in IEFs;

(c) Reconcile the data to compile the inventory with that provided by ABARE to the IEA;

(d) Implement tier 2 uncertainty analyses for all sectors;

(e) Continue reporting N_2O emissions from soil disturbance under the LULUCF sector;

(f) Improve the transparency of the inventory by:

(i) Including in the NIR additional information on emission allocation between the energy and the industrial processes sectors, trends of emissions and EFs in the agriculture sector;

(ii) Providing in the NIR a description of how the data collected under the NGER Act are included in the GHG inventory and how time-series consistency is assured;

(iii) Enhancing explanations of the differences between the reference approach and the sectoral approach;

(iv) Reporting the confidential emissions at a more disaggregated level;

(v) Enhancing the explanation of the IEFs and parameters used in the agriculture sector;

(vi) Validating the HWP model used to estimate the amount of wood and paper sent to landfill;

(vii) Including information on country-specific data in the waste sector;

(viii) Validating remote sensing data for forest land area identification with field data;

(ix) Checking the impact of the resolution of satellite images used on the net emission estimates and, if the impact is relevant, revising the estimates;

[7] For a complete list of recommendations, the relevant sections of this report should be consulted.

(x) Exploring the effects of application of the "steady state" starting assumption used in FullCAM model on estimates for lagged emissions and for carbon stock changes in forest land converted to cropland and in forest land converted to grassland;

(xi) Providing clear explanations of carbon stock changes between the reported years for the different carbon pools;

(xii) Using annual data for forest area burned, in its reporting under the Kyoto Protocol.

(g) Improve comparability by reviewing the disaggregation level used for the analysis of key categories and by correctly reporting notation keys in the industrial processes and agriculture sectors.

C. Questions of implementation

157. No questions of implementation have been identified by the ERT during the initial review.

Annex I

Documents and information used during the review

A. Reference documents

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B. Additional information provided by the Party

Responses to questions during the review were received from Ms. Shayleen Thompson, Ms. Bridget Brill, Mr. Greg Pick, Mr. Stephen Bygrave, Mr. Rob Sturgiss, Ms. Penny Reyenga, Mr. Gary Richards, Mr. Robert Waterworth, Mr. Mark Hunstone, Mr. Steven Oliver, Mr. Glen Whitehead (Department for Climate Change), Mr. Mick Meyer (Commonwealth Scientific and Industrial Research Organization), Mr. Kim Donaldson (Australia Bureau of Agricultural and Resource Economics) and

Ms. Karen Connaughton (Australian Bureau of Statistics), including additional material on the methodology and assumptions used.

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Annex II

Acronyms and abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AD	activity data
BIa	the age of maximum aboveground biomass increment
CAI	maximum current annual increment
CSIRO	Commonwealth Scientific and Industrial Research Organization
CH_4	methane
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CPR	commitment period reserve
CRF	common reporting format
DOC	degradable organic carbon
DCC	Department of Climate Change
EF	emission factor
ERT	expert review team
ETS	emissions trading scheme
Gg	gigagrams
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 without GHG emissions and removals from LULUCF
GWP	global warming potential
ha	hectare
HFCs	hydrofluorocarbons
IEA	International Energy Agency
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram (1 kg = 1 thousand grams)
kha	kilo hectares
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
NA	not applicable
NCAS	Australia's National Carbon Accounting System
NE	not estimated
NGER	National Greenhouse and Energy Reporting Act
NIR	national inventory report
NO	not occuring
N_2O	nitrous oxide
PFCs	perfluorocarbons
PJ	petajoule (= 10^{15} joule)
QA/QC	quality assurance/quality control
SF_6	sulphur hexafluoride

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