UNITED
NATIONS

UNFCCC Framework Convention on Climate Change

Distr.
GENERAL

FCCC/ARR/2005/AUS
7 March 2006

ENGLISH ONLY

Report of the individual review of the greenhouse gas inventory of Australia submitted in 2005*

* In the symbol for this document, 2005 refers to the year in which the inventory was submitted, and not to the year of publication.

CONTENTS

I. Executive summary

1. This report covers the in-country review of the 2005 greenhouse gas (GHG) inventory submission of Australia, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8.[1] The review took place from 22 to 26 August 2005 in Canberra, Australia, and was conducted by the following team of nominated experts from the roster of experts: Generalist – Ms. Riitta Pipatti (Finland); Energy – Mr. Hongwei Yang (China); Industrial Processes – Mr. Mauro Meirelles O. Santos (Brazil); Agriculture – Mr. Haruo Tsuruta (Japan); Land Use, Land-use Change and Forestry (LULUCF) – Mr. Daniel Martino (Uruguay); Waste – Ms. Irina Yesserkepova (Kazakhstan). Ms. Riitta Pipatti and Ms. Irina Yesserkepova were the lead reviewers. The review was coordinated by Ms. Rocio Lichte (UNFCCC secretariat).

2. In accordance with the "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention", a draft version of this report was communicated to the Government of Australia, which provided comments that were considered and incorporated, as appropriate, in this final version of the report.

3. In the year 2003, the most important greenhouse gas in Australia was carbon dioxide (CO_2), contributing 72.1 per cent to total[2] national GHG emissions (expressed in CO_2 equivalent) without the LULUCF sector (73.1 per cent if the LULUCF sector is taken into account in the national total), followed by methane (CH_4), 20.8 per cent (20.1 per cent with LULUCF), and nitrous oxide (N_2O), 5.9 per cent (5.7 per cent with LULUCF). Perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) taken together contributed 1.2 per cent of the overall GHG emissions in the country (1.1 per cent if LULUCF is taken into account). The Energy sector accounted for 72.6 per cent of the total, followed by Agriculture (18.9 per cent), Industrial Processes (6.3 per cent) and Waste (2.2 per cent). The LULUCF sector is a net source of greenhouse gases in Australia, and its contribution to total national emissions including LULUCF was 6.3 per cent in 2003. If LULUCF is included, the Energy sector contributed 68.0 per cent of the national total, Agriculture 17.7 per cent, Industrial Processes 5.9 per cent and Waste 2.1 per cent.

4. GHG emissions in Australia during the period 1990–2003 are shown by gas and by sector in tables 1 and 2 below. Total GHG emissions from all sectors have increased by 4.9 per cent since 1990 (and by 22.7 per cent if the LULUCF sector is excluded). The increase is largely attributable to the Energy sector, with an increase of 30.8 per cent in emissions from the sector since 1990. GHG emissions have also increased in the Industrial Processes sector (+15.2 per cent), the Agriculture sector (+4 per cent) and the Waste sector (+11.1 per cent). Australia also reports an inventory estimated according to the Kyoto Protocol provisions, under which it reports an increase in national GHG emissions of 1.1 per cent. This inventory and any related information were, however, not part of the present review.

5. The LULUCF sector is a source of emissions in Australia and contributes significantly to total GHG emissions. However, the trend in emissions for this sector has been declining. Emissions in the LULUCF sector are mainly due to land-use change from forest land to the other land-use categories (deforestation). Total net greenhouse gas emissions from LULUCF activities amounted to 34,847.2 Gg CO_2 equivalent in 2003, which represented a 67.3 per cent reduction compared with the 1990 level (106,644.3 Gg CO_2 equivalent). The contribution of the sector to total national emissions including LULUCF fell from 20.3 per cent in 1990 to 6.3 per cent in 2003.

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[1] Decision 18/CP.8 on 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" and the subsequent decision on the preparation of annual inventories, 13/CP.9, have also been explicitly taken into account.

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

6. HFC emissions have grown by more than 280 per cent since 1990. This is largely due to the phasing out of the chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) compounds. N_2O and CO_2 emissions also increased significantly, by 40.0 and 32.3 per cent, respectively, between 1990 and 2003. The increase in CO_2 emissions is attributed mainly to increased fossil fuel combustion, whereas the increase in N_2O emissions is due to increases in several sources, in both the Industrial Processes and the Agriculture sectors. PFC and CH_4 emissions have decreased, by 62.6 and 3.8 per cent, respectively. PFC emissions have decreased thanks to technical improvements within aluminium smelting, while CH_4 emissions have decreased due to decreased agricultural production, especially livestock and rice production.

7. Overall, the Australian inventory is of good quality and the institutional arrangements and resources allocated to the inventory preparation show commendable commitment. Australia uses mainly tier 2 or tier 3 methods complemented with or based on modelling to estimate emissions and removals. The methods are advanced and often complex. Australia's national inventory report (NIR) and accompanying methodology workbooks form a comprehensive set of information submitted to the UNFCCC on the preparation of the inventory. Altogether this information is generally transparent and allows for assessment of the underlying assumptions and the rationale for choices of methods, emission factors (EFs) and other inventory parameters. However, given the more complex methods Australia uses in the Agriculture and LULUCF sectors, the provision of more key information on the methods used (such as summaries, key assumptions and key data) in the NIR itself would facilitate the review. To improve the consistency of the reporting with the UNFCCC "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories" (hereinafter referred to as the revised UNFCCC reporting guidelines),[3] the expert review team (ERT) encourages Australia to restructure the information submitted on methodologies by incorporating additional material from the workbooks directly into the respective sectoral chapters of the NIR, including summaries of the methodologies used, information on the choice of methodologies, activity data (AD) and EFs, and key assumptions and parameters used in the country-specific methods and models.

8. Australia's GHG inventory covers the most significant sources and sinks and the coverage of the inventory has been constantly improved. However, in the LULUCF sector, where the inventory was prepared under the trial arrangements set out under decision 13/CP.9, Australia has not yet developed estimates for some categories, such as changes in carbon stocks in soil organic carbon in Croplands Remaining Croplands, as well as Grassland Remaining Grassland, and CO_2 emissions from Liming. The ERT encourages Australia to assess the significance of these sources and sinks of the LULUCF sector and to continue improving the completeness of its reporting by the use of Intergovernmental Panel on Climate Change (IPCC) tier 1 methods and default data as a first step in cases where country-specific methods and parameters are not available. The ERT noted that during the review the Australian experts did not support the development of interim tier 1 methods for incomplete sectors as this would knowingly, and only temporarily, be a source of over- or underestimation that would subsequently require recalculation.

[3] See document FCCC/SBSTA/2005/8.

Table 1. Greenhouse gas emissions by gas, 1990–2003

GHG emissions	Gg CO_2 equivalent														Change 1990–2003 (%)
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
CO_2 (with LULUCF)	382 028	358 701	344 459	336 265	342 328	349 586	355 986	358 152	387 989	388 823	396 438	397 547	404 439	402 282	5.3
CO_2 (without LULUCF)	280 886	282 401	285 217	289 676	295 564	305 606	315 788	322 493	339 716	348 955	354 373	360 633	363 810	371 701	32.3
CH_4	114 633	114 253	113 513	111 205	110 512	111 524	110 303	112 183	113 784	113 050	115 626	115 822	113 717	110 295	–3.8
N_2O	22 292	22 669	22 669	23 188	23 740	23 919	24 004	25 547	26 896	28 477	30 136	30 969	31 573	31 199	40.0
HFCs	1 126	1 126	1 054	1 447	819	924	546	1 026	1 623	2 186	2 716	3 258	3 762	4 309	282.6
PFCs	3 938	3 941	3 935	2 833	1 848	1 309	1 205	1 051	1 397	982	1 103	1 556	1 507	1 472	–62.6
SF_6	521	521	521	521	521	521	530	527	525	525	523	521	521	521	0.0
Total (with CO_2 from LULUCF)	524 538	501 211	48 6152	475 459	479 768	487 782	492 573	498 485	532 213	534 042	546 543	549 673	55 5519	550 077	4.9
Total (without CO_2 from LULUCF)	423 396	42 4912	426 910	428 870	433 004	443 802	452 376	462 826	483 940	494 173	504 478	512 758	514 891	519 496	22.7

LULUCF = Land Use, Land-use Change and Forestry.

Table 2. Greenhouse gas emissions by sector, 1990–2003

Sectors	Gg CO_2 equivalent														Change 1990–2003 (%)
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Energy	286 068	287 933	293 998	296 884	301 910	313 280	322 958	330 743	349 151	356 307	363 563	368 011	370 070	374 283	30.8
Industrial Processes	28 041	27 502	25 495	25 822	26 197	25 936	25 901	26 075	27 743	28 004	28 135	29 726	30 000	32 306	15.2
Solvent and Other Product Use		0	0	0	0	0	0	0	0	0	0	0	0	0	
Agriculture	93 555	93 803	92 287	91 108	90 013	89 614	89 367	91 615	92 834	95 318	98 199	100 114	98 612	97 281	4.0
LULUCF	106 644	81 403	63 663	50 667	50 810	47 716	43 864	39 383	52 021	43 516	45 569	40 476	45 129	34 847	–67.3
Waste	10 230	10 570	10 709	10 977	10 838	11 235	10 484	10 671	10 465	10 896	11 077	11 345	11 709	11 361	11.1
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

LULUCF = Land Use, Land-use Change and Forestry.

9. Australia is improving its inventory on a continuous basis taking into account the findings of the UNFCCC reviews, the uncertainties in the emission estimates, and the results of the key category analysis. The 2005 submission includes new sources, and the structure and transparency of the reporting have been improved. The ERT welcomes the systematic and continuous approach taken in developing the Australian inventory. The inventory would benefit from further enhancements regarding some important elements required by the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance), for example, with regard to the key category analysis (see paragraphs 14–15 below) and the quantitative uncertainty estimates (see paragraphs 27–28 below). Furthermore, additional efforts should be made to avoid instances of discrepancies between the various components of the submission (the NIR, the common reporting format (CRF) and the methodology workbooks) in future.

10. Australia has introduced a new software system, the Australian Greenhouse Gas Emissions Information System (AGEIS), for estimating and reporting emissions and removals. The system is also an archiving system: it tracks any changes made in the methodologies since previous submissions and is a tool for quality assurance/quality control (QA/QC) management. Some aspects of the AGEIS had not been fully implemented for the 2005 submission, but the system was presented to the ERT during the review. The ERT welcomes the system as a significant enhancement in the overall preparation, quality management and archiving of the inventory.

II. Overview

A. Inventory submission and other sources of information

11. Australia submitted an NIR on 27 May 2005. In addition, Australia provided the following reports as part of its 2005 inventory submission: "Australian methodology for the estimation of greenhouse gases and removals by sinks 2003" (consisting of a set of 10 documents, covering all sectors of the inventory), hereinafter referred to as methodology workbooks, and "Greenhouse gas emissions from land use change in Australia: Results from the National Carbon Accounting System 1988–2003", which were also considered by the ERT.

12. In its 2005 submission, Australia has submitted a complete set of CRF tables for the years 1990–2003. For reporting emissions and removals from the LULUCF sector, Australia has used the CRF LULUCF tables, as required by decision 13/CP.9, for all years of the time series. The estimates reported in the CRF LULUCF tables are based on the categories according to the "old" Land-use Change and Forestry (LUCF) tables from the CRF adopted by decision 18/CP.8 (based on the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines)), of which table 5 has been provided. Australia has also mapped the "old" LUCF categories of the Revised 1996 IPCC Guidelines to the appropriate reporting categories of the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF), as described therein. The Australian inventory compilers noted difficulties experienced in this mapping between the reporting categories of the Revised 1996 IPCC Guidelines and the land-use categories of the IPCC good practice guidance for LULUCF, on which the CRF LULUCF tables are based. Australia stated that it will address reporting directly into the CRF LULUCF format as part of its inventory development. Where needed the ERT also used previous years' submissions, including the CRF tables for the years 1990–2002.

13. During the review Australia provided the ERT with additional information sources. These documents are not part of the inventory submission but are in many cases referenced in the NIR. The additional material is also publicly available on the web page of the Australian Greenhouse Office (AGO). The full list of materials used during the review is provided in the annex to this report.

B. Key categories

14. Key category analysis is an important step in guiding Parties to allocate the resources available for the inventory preparation to the most significant emissions and removals categories. Consistent with the IPCC good practice guidance for LULUCF, the revised UNFCCC reporting guidelines[4] require that Parties perform both a key category analysis excluding the LULUCF sector as well as a separate key category analysis including the LULUCF sector.

15. Australia reports a key source tier 1 analysis, both level and trend assessment, as part of its 2005 submission. Australia's key source analysis includes emissions from land-use conversions reported in the LULUCF sector (forest conversion, i.e. deforestation), but does not include removals from the LULUCF sector (Forest Land Remaining Forest Land). In Australia's analysis, solid fuel (coal) combustion in the Public Electricity category, Enteric Fermentation (cattle), forest and grassland conversions, and Road Transportation (passenger cars) were the most important categories according to the level analysis. Forest and grassland conversion (which corresponds to emissions reported by Australia under Land Converted to Grassland in the CRF for LULUCF) contributed most to the trend.

16. The key source analyses performed by Australia and the secretariat[5] produced similar results, even if the basis of the analyses and the level of aggregation of categories were different. The level of aggregation used in the key source analysis by Australia was more detailed than that of the secretariat. Compared to Australia's analysis, the secretariat's analysis identified CH_4 emissions from stationary combustion as an additional key category. The ERT encourages Australia to revise slightly its country-specific approach and perform a key category analysis consistent with the IPCC good practice guidance for emission sources, and to complement this with the key category analysis described in the IPCC good practice guidance for LULUCF, including the LULUCF sector as a whole, in its future submissions.

17. The results of the key source analyses, as well as the results of uncertainty analysis and the comments received from the UNFCCC reviews, are used in prioritizing the development of and improvements to the inventory.

C. Cross-cutting topics

1. Completeness

18. Overall, the Australian inventory covers the most significant source and sink categories in the country. However, for some categories in the LULUCF sector, where the inventory was prepared under the trial arrangements set out under decision 13/CP.9, Australia has not yet developed estimates, such as for changes in carbon stocks in soil organic carbon in Croplands Remaining Croplands, as well as Grassland Remaining Grassland, and CO_2 emissions from Liming. Estimates are provided for all direct (CO_2, CH_4, N_2O, PFCs, HFCs and SF_6) and indirect (carbon monoxide (CO), nitrogen oxides (NO_X) and non-methane volatile organic compounds (NMVOCs)) GHGs, as well as for sulphur dioxide (SO_2). Estimates are provided for the whole time series 1990–2003. The 2005 submission complements the previous submissions with estimates for sources of HFC emissions, CO_2 emissions from synthetic rutile production, full time series for SF_6 emissions, and emissions from manure management for range-kept cattle and sheep. These new sources contribute less than 1 per cent to the estimate of total emissions of

[4] See document FCCC/SBSTA/2005/8.

[5] The secretariat identified, for each individual Party, those source categories which 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. Key categories according to the tier 1 trend assessment were also identified for those Parties providing a full CRF for the year 1990. Where the Party has performed a key category analysis, the key categories presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

the Party. The ERT welcomes the efforts made by the Party to improve the completeness of the inventory and encourages the Party to continue improving completeness, giving priority to the most significant categories.

19. Australia has summarized the sources that are included in the Revised 1996 IPCC Guidelines for which it reports "not estimated" ("NE") in CRF table 9. Potential emissions of PFCs, HFCs and SF_6 (consumption of halocarbons and SF_6) have not been provided. The ERT was informed that the Ozone Protection and Synthetic Greenhouse Gas Management Act of 2003 is expected to provide access to aggregate import data in future that will enable better estimates of consumption data for halocarbons in the coming years. The reporting of HFC emissions will be further developed and complemented as the data become available.

20. N_2O emissions from leaching and run-off (part of indirect N_2O emissions from agricultural soils) are reported as "NE" in the inventory. Australia informed the ERT that, due to national circumstances, these emissions are expected to be less significant for Australia than indicated by the IPCC methodology. However, Australia noted that it has active research programmes in this area and is exploring the possibility of including these categories in the inventory in its future submissions.

21. The reporting of emissions and removals in the LULUCF sector is not yet complete: for example, CO_2 emissions/removals from cropland and grassland remaining in the respective land-use categories, and CO_2 emissions from liming, are not estimated. During the review the Party stated that the contribution of these categories is likely to be small in Australia and that substantial resources will be dedicated to carrying out the data collection and reviewing the methodologies in order to make the reporting complete in response to the elaborations by the IPCC good practice guidance for LULUCF. Australia stated that future inventory development plans will address this issue, but because of the small amount of emissions involved it would not be prudent in terms of strategic inventory development to treat this as immediate priority for Australia.

22. The reference approach has been provided only for the years 1990 and 2003. The ERT noted Australia's intention to develop estimates for the intervening years and encourages Australia to provide the reference approach for the entire time series in its next submission.

2. Transparency

23. Australia's NIR and accompanying methodology workbooks form a comprehensive set of information on the preparation of the inventory. Taken together, this information is mostly sufficient to allow for an assessment of the underlying assumptions and the rationale for choices of methods, EFs and other inventory parameters. However, in some instances the NIR could provide more precise guidance as to where in the accompanying reports the relevant descriptions of the methodologies and key assumptions used in preparing the estimates can be found. Discrepancies between the NIR and the methodology workbooks were also identified in some instances, and in one instance it was not clear which improvements and changes in methodologies have already been implemented and which are still in the planning stage. The ERT recommends that Australia include in the respective sectoral chapters of the NIR a summary of the most important methodological aspects (including choice of method/AD and EFs and/or key assumptions and parameters used in the tier 3 methods) and provide precise references to the more detailed descriptions of the methods in the methodology workbooks.

24. GHG emissions from soda ash production and use, and production of magnesia, ammonia, nitric acid, carbon black, ethylene and styrene, are estimated but are reported as an aggregate emissions estimate due to the confidentiality of the data. Selected members of the ERT were presented with underlying data to demonstrate how the emissions have been estimated, which made it possible to consider these sources. A minor problem relating to double counting of emissions from natural gas used

in ammonia production for combustion and as feedstock was identified (for more details, see the sections on Energy and Industrial Processes). During the review Australia expressed its intention to correct this point.

3. Recalculations and time-series consistency

25. The ERT noted that required recalculations of the time series 1990–2002 have been undertaken as appropriate to take into account the inclusion of new sources as well as revisions in AD and EFs. All changes have been implemented consistently for the whole time series. The effects of the recalculations vary from –1.9 per cent to +4.2 per cent depending on the year (the estimates of emissions (including LULUCF) for the base year, 1990, have increased by 1.7 per cent, and emissions in 2002 have increased by 3.0 per cent compared with the previous submission). The major changes include: updates in the LULUCF sector (mainly due to refinements in methodology based on the availability of improved remote sensing data on land use and land-use conversions, as well as other changes due to increased utilization of the data collected in the national carbon accounting system); the inclusion of new sources in the Industrial Processes sector (CO_2 emissions from synthetic rutile and titanium oxide production, as well as improved coverage of limestone and soda ash production, ammonia production and emissions of fluorinated gases (F-gases)) and the Agriculture sector (CH_4 emissions from manure management of range-kept cattle and sheep); and improvements to the methodology for calculating CH_4 emissions from landfills. The rationale for these recalculations is provided in the NIR and in CRF table 8(b). Details of the reasons and of the changes in specific categories are addressed in the relevant sector sections in this report.

4. Uncertainties

26. Australia has provided quantitative uncertainty estimates (based on the IPCC tier 1 methodology) for total emissions: the uncertainties are estimated at 6.3 per cent in 1990 and 5.2 per cent in 2003. For LULUCF, qualitative uncertainty estimates are also provided. Australia considers the estimates as preliminary as it is moving to undertake a tier 2 uncertainty analysis. Australia considers the declining trend in the uncertainties to be valid, even if the estimated values may change.

27. Australia has reported combined uncertainties for AD and EFs together, and has therefore reported at a higher level of aggregation than would be needed to complete tables 6.1 and 6.2 in the IPCC good practice guidance in their entirety. However, during the review Australia provided the ERT with information on the probability distributions for the AD, EFs and other parameters used to estimate uncertainty for source categories. This facilitated the review of the uncertainty estimates. Australia accepts that comparison with the IPCC default uncertainty values or uncertainty values over time would be assisted by more detailed reporting in the NIR.

28. The ERT welcomes the development in Australia's estimation and reporting of the uncertainties, as well as the planned efforts to develop the analysis further. To achieve greater transparency and adherence with the revised UNFCCC reporting guidelines, Australia should report separate uncertainty estimates for AD and EFs separately using tables 6.1 and 6.2, mentioned above, in its future submissions.

5. Verification and quality assurance/quality control approaches

29. Australia has enhanced its QA/QC procedures with the introduction of the AGEIS. The AGEIS has tier 1 QA/QC procedures built in to the system, as well as a tracking system for changes made in the methodologies. The system includes possibilities for comprehensive archiving of inventory submissions and references used. The AGEIS has reduced the risk of potential errors and time-series inconsistencies in Australia's inventory. It is still in its implementation phase and not all features of the system were ready for use in the 2005 submission. The ERT welcomes the efforts made to enhance the quality management of Australia's inventory preparation. It also noted that the public Internet application of the

AGEIS (<http://www.greenhouse.gov.au/ageis>) has made access by stakeholders and the public to the inventory data easier and more user-friendly.

6. Institutional arrangements

30. During the in-country visit, Australia explained the institutional arrangements for preparation of the inventory. The Australian Greenhouse Office (AGO) under the Department of the Environment and Heritage has overall responsibility for its compilation. Other research organizations and consultants are also involved in the preparation: Energy Strategies Pty Ltd, George Wilkenfeld and associates Pty Ltd, Burbank Consulting Pty Ltd and CSIRO Atmospheric Research. The organizations and consultants contribute to AD collection, methodological development and the estimation of emissions for specific sections. The Australian Bureau of Agricultural and Resource Economics (ABARE), the Australian Transport Energy Data and Analysis Centre (ATEDAC), Coal Services Pty Ltd, the Australian Petroleum Exploration Association, the Australian Government Department of Environment and Heritage, the Australian Bureau of Statistics (ABS), the National Carbon Accounting System (NCAS) and the state and territory government waste agencies are the principal data providers. The details of the preparation process are also given in the NIR.

31. During the review, the data collection systems in the different sectors were presented in detail. The data are collected for the fiscal year in Australia (1 July to 30 June) for other sectors than LULUCF; for LULUCF, most of the data come from the NCAS, which collects them on a calendar-year basis. According to the NIR, the data are used in such a way as to maintain time-series consistency, and converting the data to a calendar-year basis would reduce their accuracy.

32. The principal data source for the Energy sector is ABARE. For thermal power generation, plant-specific data are collected for all larger plants (> 0.5 PJ fuel use). The data collection frequency was changed recently. Previously, data were collected on a biannual basis, the AD for the inventory year were estimated as a mean of previous-year data and projected data for the year after, and the estimates were recalculated for the following submission when the statistical data became available. Currently the AD are collected on an annual basis in order better to meet the data needs of the GHG inventory.

33. For the Industrial Processes sector, the AD are largely based on plant-specific data, which in some cases are confidential. Data collection on the F-gases has improved substantially with processes established under the Ozone Protection and Synthetic Greenhouse Gas Management Act of 2003.

34. For the Agriculture sector, the bulk of the data come from the ABS. Census data (coverage 150,000–190,000 farms) are available until 1996–1997; since then the censuses have been performed at four-year intervals. Surveys (coverage 30,000–35,000 farms) are done annually. Not all the AD needed to estimate emissions, for example, data on manure management, are covered by the censuses and surveys, and some estimates are therefore based on separate studies and expert judgement. The data on fertilizer use are based on sales statistics.

35. The AD in the LULUCF sector are largely derived from the NCAS, which builds on remote sensing data combined with ground data and process-based ecosystems modelling.

36. AD for the Waste sector come from state government agencies, complemented with information surveys and analyses for the historical data (back to 1960). The methods for data collection vary between the states from weighing at landfill sites to estimates based on surveys of waste generation.

37. The AGEIS also plays a central role in the institutional arrangements, as it centralizes the inventory compilation, stores all the data in a database, and plays a significant part in quality management.

38. Overall, the Australian institutional arrangements and the resources used show a commendable commitment to the inventory process. The inventory preparation process is advanced, but also complex. The complexity has in some cases resulted in complex structures for the description of methodologies, which could be streamlined.

7. Record keeping and archiving

39. Australia is in the process of implementing a centralized archiving system. The AGEIS system records all data entries (AD, EFs and parameters) and includes codes for the methodologies. When changes are made, these as well as the old methodologies are archived in the system. References used in the NIR and accompanying documents are also archived in the system as PDF documents. The ERT considered the archiving features of the system to be very comprehensive, although not all features had been implemented at the time of the review.

8. Follow-up to previous reviews

40. Australia has implemented many of the proposals for improvement indicated by previous review teams. For some sources and sinks, where Australia has limited data available and/or where it considers that the IPCC tier 1 methodology is not suitable to Australian circumstances, estimates have not been provided although they were identified as missing by previous reviews.

D. Areas for further improvement

1. Identified by the Party

41. The NIR identifies several areas planned for inventory development as part of a programme of continuous improvement. The AGEIS will continue to be developed to enhance the integration of Australia's GHG inventory data management and accessibility of the inventory methodology, the data and the emission estimates. In the planning and implementation of the improvements, prioritization is done taking into account the results of the uncertainty and key source analyses as well as comments received from previous reviews. The NIR sets out Australia's programme for inventory improvement, including methodology development and enhanced data collection. Australia will continue complementing the inventory with new data (such as improved data for HFCs and SF_6) and estimates for sources not yet included in the inventory (such as CO_2 from liming) to the extent possible. Australia also noted during the review that significant resources will continue to be directed to the development of the NCAS, given the key importance of the LULUCF sector in the Australian inventory. The development of the NCAS and the priorities for inventory development are outlined in a 10-year development plan that spans the years 1998–2008.

2. Identified by the ERT

42. In its response to the issues raised by the ERT during the in-country review, Australia indicated that it is working to further develop its estimates of N_2O emissions from agricultural soils (a review of the methodology), and that it will change the method used to derive AD and resulting estimates of emissions from biomass burning in the Agriculture and LULUCF sectors (use of three-year instead of 10-year averages for AD: for further details see below under the sector sections on Agriculture and LULUCF). In addition, the ERT identified the following cross-cutting issues for improvement. The Party should:

(a) Provide in the respective sectoral chapters of the NIR summaries of the methodologies used, including information on the choice of methodologies, AD and EFs, as well as the key assumptions and parameters used in the country-specific methods and models.

These summary descriptions should in all instances include precise references to the relevant sections in the accompanying methodology workbooks;

(b) Continue improving the completeness of its reporting by considering the use of IPCC tier 1 methods and default data as a first step in cases where country-specific methods and parameters are not available;

(c) Perform the key category analyses as proposed by the IPCC good practice guidance and the revised UNFCCC reporting guidelines, instead of using the country-specific approach (see paragraphs 14 and 15); and

(d) Continue its plans for developing the uncertainty estimates and using tables 6.1 and 6.2 in the IPCC good practice guidance in order to report a greater level of disaggregation of the underlying data that lie behind the estimated uncertainties.

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

III. Energy

A. Sector overview

44. Total emissions from the Energy sector for 2003 are estimated to be 374,283 Gg CO_2 equivalent, making it the largest source of GHG emissions in that year. It contributed 72.6 per cent to total national emissions. The Energy Industries category contributed 40.6 per cent and Transport 15.5 per cent of total national GHG emissions. Energy sector emissions increased by 30.8 per cent between 1990 and 2003. Emissions from fuel combustion increased by 37.9 per cent, mainly caused by increasing fuel combustion within Energy Industries and Transport. N_2O emissions from transport increased by 212.6 per cent between 1990 and 2003, and CH_4 emissions from Energy Industries increased by 452.6 per cent over the same period.

45. The reporting of the Energy sector is transparent. Extensive summaries of the calculation methodologies are documented in annex 3 to the NIR, and detailed descriptions can be found in the methodology workbooks (Stationary energy, Transport, Fugitive fuel emissions) which formed part of Australia's submission. The regularly updated methodology workbooks provide country-specific EFs and sources of references for all sources of emissions.

46. Recalculations have been done for the whole time series in the Energy sector. For the year 2002, after recalculation the changes of GHG emissions from manufacturing industries and construction were much larger than the changes in the other years of the time series: they are 8.98 per cent for CO_2, –13.20 per cent for CH_4, and –9.89 per cent for N_2O. During the review Australia indicated that this is because of the reallocation of fuel use across stationary energy as a result of the use of the newly released ABARE energy statistics in this submission, instead of the ABARE energy projections which were used in Australia's previous submission.

47. A tier 2 method has been used to estimate the uncertainties. An aggregate uncertainty has been given for each gas, but no uncertainty on AD and EFs has been provided. During the review Australia provided additional information on uncertainty estimates of AD and EFs based on expert judgement. The ERT encourages Australia to provide the necessary information in the NIR.

48. The AD in the Energy sector are mainly based on statistics from ABARE, which became available later than the reporting time for the national GHG inventory for this submission. Because of

this, Australia has first reported estimates based on the ABARE projection data and stated that it will recalculate them for the next submission.

B. Reference and sectoral approaches

1. 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 and the sectoral approaches. For the year 2003 there is a difference of –1.8 per cent in the CO_2 emission estimates between the reference and the sectoral approaches, which is explained in the documentation box of table 1.A(c) of the CRF and the NIR.

50. Estimates by reference approach have been provided only for 1990 and 2003, although reference approach calculations were reported for the year 2002 in the previous submission. Australia explains that the previous year's figures under the reference approach are being recalculated. For purposes of verification of the national energy estimates for years in between, and in accordance with the revised UNFCCC reporting guidelines, the ERT encourages Australia to complete the reference approach estimates for the whole time series and to include a description of the differences between the two approaches over time.

2. International bunker fuels

51. Data on international and domestic aviation and navigation fuel consumption are collected separately by ABARE in its energy statistics, so the correct domestic/international split is applicable. The inconsistencies identified in the previous review regarding fuel quantities for bunkers (i.e. fuel quantities reported in table 1.A(b) did not correspond to those given in table 1.C for gas/diesel oil, residual fuel oil and jet kerosene) have now been resolved.

3. Feedstocks and non-energy use of fuels

52. For some fuels, quantities of feedstocks and non-energy use of fuels (table 1.A (d)) are much higher than the apparent consumption figures (reference approach, table 1.A (b)). These include ethane, bitumen, lubricants, other oil and coking coal. During the review, Australia indicated that this was due to some reallocations in the reference approach (table 1.A (b)) for bitumen, lubricants and other oil, which were included in crude oil; ethane, which was included in natural gas (dry); and coking coal, which was included in other bituminous coal. The ERT encourages Australia to report these emissions according to the fuel types as given in the CRF.

C. Key categories

1. Stationary combustion: solid, gas, oil – CO_2

53. Australia calculates emissions from large power stations (over 0.5 PJ fuel use) through a "bottom–up" approach using specific AD and EFs where possible. Smaller power stations are grouped and their emissions are estimated using aggregated AD inferred from the difference between the total of reported values and the ABARE Energy Supply and Demand Statistics for Australia and New Zealand Standard Industrial Classification (ANZSIC) class 361, and default IPCC EFs.

54. The CO_2 implied emission factors (IEFs) for Manufacturing Industries and Construction for 1999 and 2000 are lower by about 10 per cent than for the rest of the time series due to increased use of coke oven gas in those years: coke has a significantly lower EF than other solid fuels used in the Iron and Steel subsector.

55. The IEF for CO_2 from chemicals is higher than those of other reporting Parties for many years of the time series, including 1990 and 2003, because for ammonia Australia includes in the Energy sector both emissions from natural gas combustion and emissions from natural gas used as feedstock. It was noted that CO_2 emissions from natural gas combustion in part of Chemical Industries (Ammonia Production) are also reported under Industrial Processes (2.G Other), and thus double counted, which leads to a minor overestimation of emissions in the inventory. The ERT suggests that all natural gas supplied to ammonia plants should be counted as energy consumption in the Energy sector rather than as feedstock in the Industrial Processes sector until the shares of natural gas used as fuel and as feedstock in Ammonia Production become available in future.

2. Mobile combustion

56. The N_2O IEF increased significantly over the time series (from 8.5 in 1990 to 25.7 in 2003, which corresponds to a 203 per cent increase). Australia explained this as being mainly due to the introduction of three-way catalytic converters, which influence the country-specific EF over time. The ERT encourages Australia to continue to use country-specific EFs, but recommends that the applicability of the EFs currently used be reviewed as they no longer appear representative of the Australian fleet. As Australia indicated during the review, these EFs will be improved by more field measurement data, which the ERT strongly supports.

57. For the inventory year 2003 and for a number of relatively minor CO_2 emission sources, including compressed natural gas for buses, waterborne navigation and the use of solid fuels in railways, the emission estimates have been calculated based on preliminary ABARE energy data in the form of ABARE projections. For 2001–2002, the ABARE data were subject to a benchmarking exercise by the ABS and, as a consequence, the data for that and earlier years will be revised and the emission estimates will be recalculated. The ERT noted that Australia plans to recalculate its estimates for the next NIR once the final AD statistics become available.

3. Fugitive emissions: coal mining and handling – CH_4

58. CH_4 emissions from post-mining activities of surface mines have not been estimated. The IPCC good practice guidance assumes that these emissions are negligible, as the gas contents of surface coal are typically very low. Emissions can be viewed as being accommodated within the EF for surface mines.

59. The CH_4 IEF for underground mines decreased by 47 per cent over the period 1990–2003 (with some inter-annual decreases of 13 per cent), driven mainly by changes in the mix of Class A (gassy mines) and Class B (non-gassy) mines, and partly by the introduction of CH_4 drainage systems at some of the most gassy mines, which makes it possible to use the extracted CH_4 for power generation.

4. Fugitive emissions: oil and gas operations – CO_2, CH_4

60. At points the notation keys concerning natural gas have not been used appropriately. Through the discussion between the ERT and the Australian inventory team during the review process, it was clarified that CO_2 and CH_4 from 1.B.2.b Natural Gas Exploration should be noted as “included elsewhere” (“IE”) instead of “not available” (“NA”), as the emissions are included under Exploration in 1.B.2.a Oil; and CO_2 from 1.B.2.b.i Production/Processing of Natural Gas should be noted as “IE” instead of “NE”, as they are included under Venting Emissions. The ERT suggests that Australia correct these notation keys and provide the amended information in the CRF and the NIR.

D. Non-key categories

1. Non-CO_2 stationary combustion: biomass – CH_4

61. CH_4 from stationary combustion of biomass was identified as a key source by the secretariat. Reflecting its significance, Australia uses a tier 2 approach or model to estimate CH_4 EFs for biomass combustion. During the review Australia demonstrated the model and provided a background technical report for the model. The declining trend observed for CH_4 emissions from biomass burning is mainly due to the decline in the proportion of households choosing firewood as their main heating fuel: new appliances with lower CH_4 emissions have gradually been replacing older heaters since the early 1990s.

2. Fugitive emissions: coal mining and handling – CO_2

62. Fugitive CO_2 emissions from coal mining and handling have not been estimated because there is no appropriate methodology in the Revised 1996 IPCC Guidelines. Oxidation of coal in the atmosphere (producing CO_2) does occur, but this source will be insignificant when compared with the total emissions from coal mines.

E. Areas for further improvement

1. Identified by the Party

63. During the review Australia indicated that several improvements will be made for the next submission, including:

(a) The 2003 energy inventory, which is currently based on ABARE projections, will be recalculated as the ABARE statistics were not available in time for the inventory compilation;

(b) The energy inventory for 1990–2002 will be recalculated in accordance with a recalculation by ABARE in the national energy statistics to account for some minor time-series inconsistencies noted by the ABS benchmarking;

(c) The CO_2 EFs will be reviewed, for example, those for brown coal for non-electricity use, brown coal briquettes and bagasse; and some non-CO_2 EFs will be updated by using more country-specific data where possible; and

(d) Direct measured underground coal methane data will be integrated on an individual mine basis; natural gas distribution AD will be obtained from state authorities; and further use will be made of pipeline-specific natural gas composition data where data are available from companies.

2. Identified by the ERT

64. Given the new timing of the release of the ABARE statistics and because of the importance of these data for the Energy sector, as well as for the sectoral allocation of fuels, the time-series consistency of minor sources and recalculations of the estimates from the sector, Australia is encouraged to provide in its next NIR detailed information on the revisions of the ABARE statistics (e.g. reallocations of fuels between sectors) and details of any impacts on time-series consistency, as well as additional information on the procedures in place for verifying the ABARE data.

IV. Industrial Processes and Solvent and Other Product Use

A. Sector overview

65. In 2003, the Industrial Processes sector accounted for 6.3 per cent of total national GHG emissions in Australia, higher than in 2002 (when it was 5.9 per cent). According to the 2005 submission, emissions from the sector increased by 15.2 per cent between 1990 and 2003, and by 7.7 per cent since 2002. Almost half of the increase of last year is due to an increase in iron and steel production.

66. Underlying the 1990–2003 increase, there are different fluctuations: the most significant are a 142 per cent increase in CO_2 equivalent emissions from category 2.G Other, followed by a 283 per cent increase in consumption of HFCs, partially compensated by a reduction of 63 per cent in PFC emissions and a reduction of 5 per cent in CO_2 emissions from metal production. This 5 per cent decrease in CO_2 emissions from metal production is the result of a 14 per cent decrease in emissions from iron and steel production, compensated by a 50 per cent increase in emissions from aluminium production.

67. The work on this sector was undertaken for the AGO by Burnbank Consulting using data published or held by governmental agencies, such as ABARE and the ABS, and industrial associations (e.g. the Cement Industry Federation, the Australian Aluminium Council and the Australian Paint Manufacturers' Association).

1. Completeness

68. The inventory includes estimates of most sources of emissions from the Industrial Processes sector, as recommended by the Revised 1996 IPCC Guidelines. A number of categories are reported as "NE" either because Australia considers them to be insignificant or because methodologies for these sources are not covered by the Revised 1996 IPCC Guidelines or the IPCC good practice guidance. These sources include CO_2 emissions from 2.A.6 Road Paving with Asphalt, 2.A.7 Glass Production, CO_2 emissions from 2.C.5 Other Metal Production, and CO_2 from 2.D.2 Food and Drink Production, as well as indirect GHGs for 2.D.1 Pulp and Paper Production, and CO_2 and N_2O emissions from Solvent and Other Product Use, for which only NMVOC emissions have been reported. For Consumption of halocarbons and SF_6, no estimates have been provided for PFCs (e.g. from refrigeration, fire extinguishers) as PFC consumption in air-conditioning, and thus PFC emissions, are negligible. HFC emissions from Consumption of halocarbons and SF_6 have been estimated for HFC-125, HFC-134a and HFC-143a, while emissions of other HFCs occurring from this activity are not separately identified.

69. CO_2 emissions from the sources 2.A.6 Road Paving with Asphalt and 2.B.4 Carbide Production are not covered because of lack of data. For carbide, there should be only emissions from its use in acetylene production, as all carbide is imported. The ERT recommends that Australia make efforts to obtain these data. Australia stated that it continues to pursue data for acetylene production and that it will investigate CO_2 emissions from 2.A.6 Road Paving with Asphalt.

2. Transparency

70. Due to confidentiality concerns, emissions from soda ash production and use, magnesia production, nitric acid production and ammonia production have been estimated together and reported in an aggregated manner in CO_2 equivalent under category 2.G Other. For this reason, these estimates could not be reviewed individually. These sources contributed 17.7 per cent of the sector's emissions in 2003 and constitute an important key category.

71. The IEF for CO_2 in Pig Iron Production could not be assessed because Australia has integrated plants for pig iron and steel.

3. Recalculations and time-series consistency

72. Significant recalculations have been done in 2.G Other, 2.F Consumption of Halocarbons and SF_6, and 2.A.3 Limestone and Dolomite Use. Emissions from 2.B.5 Synthetic Rutile and Titanium Dioxide have also been included, for the whole time series: their inclusion accounts for 26 per cent of the increase in the estimates for the base year. These recalculations have led to an increase of 1,905 Gg CO_2 equivalent (7.3 per cent) in the estimates of industrial processes emissions in the year 1990, according to the Party's 2005 submission, and an average increase of 9.4 per cent over the whole time series 1990–2003.

73. Emissions from soda ash production and use, magnesia production, ammonia production and nitric acid production (reported in an aggregated manner in Gg CO_2 equivalent under 2.G Other) have been recalculated for the whole time series, with an average increase of 40 per cent. This is accounted for by improved data coverage for ammonia production, the inclusion of a plant that had previously been omitted, and an improved EF for nitric acid production, based on analysis by a significant producer. Following the recommendation from the previous review, the Party has removed the estimates of CO_2 uptake in soda ash production, with a small impact in the inventory. The recalculations in the source category 2.G account for 33 per cent of the increase in the base year.

74. SF_6 emissions have been calculated for the whole time series, with the inclusion of emission estimates from leakage in the electricity supply and distribution industry (a constant value of 521 Gg CO_2 equivalent has been reported for the entire time series). The inclusion of these SF_6 leakage emissions accounts for 27 per cent of the increase in the base year.

75. Other recalculations which had an impact on the estimates for the base year are those for CO_2 emissions under 2.C.3 Aluminium Production (accounting for 10 per cent of the increase). The calculations of CO_2 from 2.A.2 Lime Production, and 2.A.3 Limestone and Dolomite Use (accounting for 3 per cent of the increase) are based on improved data, with greater source coverage for 2.A.3 Limestone and Dolomite Use. The lime production time series saw an overall decrease of 6 per cent, and that for limestone and dolomite use saw an average increase of 8 per cent (not 4 per cent as stated in the NIR).

76. HFC emissions have been recalculated on the basis of new data submitted under the Ozone Protection and Synthetic Greenhouse Gas Management Act, 2003. On average the estimates have been revised upwards by 11 per cent, although the availability of new data does not affect the base year. Estimates from 1996 to 2003 have been made based on a linear growth rate. The ERT recommends that Australia endeavour to improve the data for these years.

77. Estimates of N_2O emissions from 2.C Metal Production for 2002 have been revised downwards by 7.1 per cent, but no corresponding explanation is provided in table 8(b); an explanation is only provided in the NIR.

4. Uncertainties

78. Overall uncertainty for the Industrial Processes sector is estimated to be +/- 7 per cent, based mostly on expert judgement, although key sources such as Iron and Steel (CO_2) and Nitric Acid (N_2O) had uncertainties of +/–11, and +/–16 per cent, respectively.

5. Verification and quality assurance/quality control approaches

79. The general QA/QC procedures for the GHG inventory have been applied for the Industrial Processes and Solvent and Other Product Use sectors. Nevertheless, as some inconsistencies have been found between the NIR and the CRF tables as well as in the methodology workbook for the Industrial Processes sector, and there have been significant recalculations, the ERT recommends Australia to

strengthen its QA/QC activities for the most important categories within the sector and to keep the underlying documentation up to date.

B. Key categories

1. Iron and steel production – CO_2

80. CO_2 emissions are estimated based on coke consumption in iron and steel production, as well as natural gas in hot briquetted iron production. As the chemical process is the principal one, emissions from both feedstock use and energy consumption are reported together in Industrial Processes. The ERT recommends that Australia reflect this in the NIR accordingly.

81. The methodology used is tier 2, with country-specific EFs, relating emissions to energy content in reducing agents, not to iron production AD, as normally defined. The AD for coke (in PJ) used for crude steel produced in integrated iron and steel plants show high values in 1990 and 1991 which do not correspond well to the relatively constant production of crude steel. The IEFs for coke in crude steel emissions, extracted from the CRF, are almost constant and equal to 117.1 Gg CO_2/PJ, except for the year 2000. The ERT recommends the Party to investigate the discrepancy in the estimates for the years 1990 and 1991 as it affects the base year estimates of total emissions, and to clarify the change in the EF for crude steel emissions in 2000.

2. Other

82. As noted in paragraph 70, this key category includes emissions from various sources, including from ammonia production. CO_2 emissions from the latter were found to be double counted because, while all natural gas used both in the combustion portion and in the feedstock portion is reported in the Energy sector as natural gas combustion, in category 2.G Other the feedstock portion is counted in as well.

3. Refrigeration and air conditioning – HFCs

83. IPCC methodologies and default assumptions have been used to estimate actual HFC emissions, which, apart from HFC-125, HFC-134a and HFC-143a, are reported in an aggregate manner in terms of CO_2 equivalent. A tier 2a bottom–up approach has been used for this source, according to the IPCC good practice guidance. Australia is committed to estimating this source, as is seen by the entry into force of the Ozone Protection and Synthetic Greenhouse Gas Management Act 2003, which obliges industries to report on theses gases. However, for reasons of confidentiality, the Act places limits on the level of disaggregation by HFC species required to be reported by industry under those processes.

84. As noted in the previous review, potential emissions have not yet been estimated ("NE" is reported). The ERT recommends Australia to make efforts in this direction.

4. Cement production – CO_2

85. The EF used (0.518 t CO_2/t clinker) is slightly higher than the IPCC default (0.51) due to the higher lime content; the cement kiln dust (CKD), however, is not considered separately, so that the estimates are not compiled in accordance with the IPCC good practice guidance. Australia has undertaken to discuss with the industry changes to the method and the EF that takes emissions from CKD explicitly into account. Revisions are expected to be implemented in the 2006 submission.

5. Aluminium – CO_2

86. According to the methodology workbook, the EF is reported to be 1.629 t CO_2/t Al; however, with carbon consumption from the anode equal to 0.413 t C/t Al, as stated above in the methodology

workbook, based on stoichiometry, the EF for carbon consumption is 1.514. The difference is accounted for by the emissions associated with the production of the carbon anode, which can explain the fluctuations in the CO_2 IEF between 1994 and 1996. More information is needed in the description of the methodology to explain the basis of this higher EF.

6. Aluminium – PFC

87. For tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6), the EF decreased significantly (by about 75 per cent) over the period 1990–2003. This conforms to the general trend in PFC emissions in aluminium industries.

88. The methodology workbook provides different values for the EFs for both CF_4 and C_2F_6 in 2003 compared to the data reported in the CRF. During the review Australia concluded that the data reported in the CRF represent the correct data and that the methodology workbook had not been updated from the previous year.

C. Non-key categories

1. Iron and steel production – CH_4

89. Although a description of the methodology used for calculating CH_4 emissions from iron and steel production is provided, it does not sufficiently facilitate a full understanding of the calculation method. The ERT would welcome improvements to this description of the methodology in the Party's next NIR.

2. Other production: food and drink

90. The EF used for NMVOCs in bread production (2.D.2 Food and Drink) is not equal to the IPCC default, as stated in the methodology workbook, but is derived from the industry.

D. Areas for further improvement

1. Identified by the Party

91. The EF for cement production will be reviewed to explicitly identify the minor source of emissions resulting from CKD, as required by the IPCC good practice guidance.

92. There is some limestone use yet to be included, for instance, for desulphurization in power plants.

93. HFC emissions are to be improved with the Ozone Protection and Synthetic Greenhouse Gas Management Act, which entered into force in 2003. This legislation will give Australia more accurate data on HFC emissions related to equipment manufacturing, use and disposal.

94. Work towards producing better estimates of SF_6 emissions from the electricity supply industry will continue.

95. Better data for the Solvent and Other Product Use sector will be collected, subject to broader inventory priorities and the availability of the necessary resources.

2. Identified by the ERT

96. The ERT supports the improvements highlighted in paragraphs 91 to 95.

97. The ERT recommends that Australia give particular attention to the Iron and Steel Production subsector, its principal key source, in order to collect more detailed data (e.g. separating pig iron and

steel production), and to make the descriptions of the methodologies used clearer in order to achieve greater comparability and transparency. The high estimates for the years 1990 and 1991 and the change in the EF for crude steel for the year 2000 should be clarified in the Party's next submission.

98. The ERT suggests that natural gas used as feedstock in ammonia production could be assessed in future in order to allow proper allocation of CO_2 emissions.

99. The ERT also anticipates that in future, with the help of the Ozone Protection and Synthetic Greenhouse Gas Management Act of 2003, Australia will be able to assess potential emissions of F-gases and to achieve a greater coverage of actual F-gas emissions from refrigeration and air conditioning.

V. Agriculture

A. Sector overview

100. In 2003, the Agriculture sector emitted 97,281 Gg CO_2 equivalent, which corresponds to 18.9 per cent of total GHG emissions in Australia. CH_4 emissions amounted to 73,625 Gg CO_2 equivalent, or 68.8 per cent of total national CH_4 emissions, and N_2O emissions to 23,656 Gg CO_2 equivalent, 78.1 per cent of total national N_2O emissions. GHG emissions from this sector increased by 4.0 per cent between 1990 and 2003, while they decreased slightly, by 1.3 per cent, from 2002 to 2003. Emissions from prescribed burning of savannas increased by 46.6 per cent between 1990 and 2003 due to an increase in fire activity.

101. Four key sources were identified by the Party – enteric fermentation for CH_4 (especially from cattle and sheep), manure management for N_2O, agricultural soils for N_2O, and prescribed burning of savannas for CH_4 and N_2O. CH_4 emissions from enteric fermentation amounted to 62,748 Gg CO_2 equivalent, or 12.2 per cent of total national emissions.

1. Completeness

102. The inventory includes estimates of all GHGs and sources from the Agriculture sector as recommended by the Revised 1996 IPCC Guidelines; N_2O from Nitrogen leaching and run-off in the category Indirect N_2O Emissions from Soils has been reported as "NE"; and new sources of CH_4 emissions from manure management for range-kept beef cattle and sheep have been included in the 2005 submission for the first time.

2. Transparency

103. Australia's documentation for the Agriculture sector is generally transparent because the Party supplements the NIR with a methodology workbook covering all sources in the Agriculture sector.

3. Recalculations and time-series consistency

104. Emissions for the most recent year are recalculated each year due to the recalculation of the three-year average of emissions for most categories once the final data for the third year become available from the ABS and other sources. New sources have been included in the 2005 submission: CH_4 emissions from manure management for range-kept beef cattle and sheep. Full time series have been provided for these sources. This has resulted in an increase in the estimates of CH_4 emissions from manure management in 2002 from 95.5 (in the 2004 submission) to 97.4 Gg CH_4 (in the 2005 submission).

B. Key categories

1. Enteric fermentation – CH_4

105. Australia uses country-specific methods, similar to the tier 2 methods, to estimate CH_4 for cattle, sheep and swine. For the other categories the IPCC tier 1 method is used. The EF for CH_4 for dairy cattle is much higher than the IPCC default value for Oceania. The ERT noted that one of the major reasons for this is the large volume of milk production – 5,077 kg $head^{-1}$ y^{-1}, three times higher than the IPCC value for Oceania – the result of modern management regimes for dairy cattle which are similar to those in use in, for example, Western Europe. The ERT recommends Australia to expand the Agriculture section of its NIR by providing information regarding its large amounts of milk production.

106. In response to the previous review, Australia has provided in the methodology workbook for the Agriculture sector a detailed description of the country-specific methods used for calculating CH_4 emissions from enteric fermentation in cattle. According to the NIR, methodologies developed by Blaxter and Clapperton (1965) and Kurihara et al. (1999) were used to estimate the CH_4 emissions from cattle grazing on pasture in temperate and tropical regions in Australia, respectively. The ERT noted that the IEF for non-dairy cattle is much higher than the IPCC default EF value because the method of Kurihara et al. (1999), which is based on measurements of Bos indicus (Brahman) cattle on tropical feeds, estimates a higher CH_4 conversion factor.

107. Australia describes in the NIR the methodology used to calculate CH_4 emissions from sheep. This is based on equations by Howden et al. (1994), who reported a close relationship between feed intake and CH_4 emissions for Australian sheep fed diets typical of the range found in Australia, based on respiration chamber experiments. The ERT examined this paper, which the Party provided in response to the ERT's request, and found that it provided little detail about the source of the experimental data and the development of the relationship. The ERT requests the Party to provide a more detailed explanation of the sheep methodology in the NIR or in the workbook. During the review, Australia also provided the ERT with the results of a verification study by Leuning et al. (1999) which found close agreement between the inventory methods and direct field measurements using SF_6 and micrometeorological mass-balance techniques.

2. Manure management – N_2O

108. In response to the request by the previous (2004) review, Australia states in the NIR that the increase in N_2O emissions from manure management (by 147 per cent between 1990 and 2003) is attributed to the increase in intensification of the livestock industries (319 and 47 per cent increases in feedlots and poultry, respectively).

3. Agricultural soils – Direct N_2O emissions

109. Australia reports N_2O emissions from agricultural soils for synthetic fertilizers, and animal wastes applied to soils and excreted on pasture (equal to the source Animal Production defined by the IPCC good practice guidance and in the CRF); and, under the category Other, it provides an estimate for soil disturbance, which includes the IPCC source category of N-fixing Crops, Crop Residues, and Atmospheric Deposition. Australia explained that this source is the change in emissions due to agricultural management in the absence of inorganic fertilizer addition or N deposition from grazing animals and animal manure. It is, however, different from the process-based categories in the IPCC good practice guidance, which makes it difficult to compare estimates with those of other Parties. The ERT encourages Australia to move to reporting these emissions using the IPCC source categories and methodologies for N_2O emissions from agricultural soils in its future submissions.

110. Australia reports in the methodology workbook that the N_2O EFs used for animal production are 0.4 and 0.5 per cent for urine and faeces, respectively, derived from recent experiments. The ERT, however, found that the experiments for faeces were not carried out in Australia, while only one of the experiments for urine was carried out in Australia (Galbally et al., 1994). The results of the latter experiment were found to be comparable to findings on similar soil types in other countries. Although the EF for faeces is based on studies on soils similar to those of Australia, the ERT recommends that Australia provide a more detailed explanation of why these were considered appropriate for Australian conditions or to carry out field research in Australia, as this is a key source.

4. Prescribed burning of savannas – CH_4, N_2O

111. Burning activity in Australia varies greatly from year to year depending on the climate, and a 10-year average was estimated as representative to correct for the short-term variability in fire activity from the trend analysis. Australia has made considerable efforts to establish a consistent time series of fire scars for the whole of Australia for the necessary time periods, although it has not been possible so far to utilize satellite imagery for some regions prior to 1989. A background report (Meyer, 2004) points out from detailed analysis that the interval of fire activity depends on the region, for example, a three- to four-year average for the Top End region but a 10-year average for Central Australia. Hence, the ERT concluded that fire activity in Australia is complex and has high variability, year by year and region to region, but that there is no reliable justification for using a 10-year average instead of a three-year average as recommended by the Revised 1996 IPCC Guidelines. The ERT recommends Australia to recalculate the CH_4 and N_2O emissions by using three-year averaged AD, to be consistent with the Revised 1996 IPCC Guidelines (see also paragraph 149 in the LULUCF section). Australia agreed to change the method accordingly in its next submission.

C. Non-key categories

1. Manure management – CH_4

112. CH_4 emissions from manure management for range-kept beef cattle and sheep have been estimated by using the EFs measured by González-Avalos and Ruiz-Suárez (2001), under conditions in Mexico (which are similar to those in Australia), while CH_4 emissions for dairy cattle have been estimated by using a combination of default IPCC and country-specific values. As a result, the weighted CH_4 EFs for range-kept beef cattle and sheep in the warm and temperate regions of Australia, reported in the NIR, are estimated to be 0.04 and 0.002 kg CH_4/head/yr, respectively. These values are much smaller than the IPCC default values of 6–7 kgCH_4/head/yr for Oceania, and 0.28–0.37 kg CH_4/head/yr for developed countries. The study by the Mexican researchers found that the CH_4 EFs for manure of dairy and beef cattle collected in Mexico were at least a factor of 5 smaller than the IPCC default value for Latin America. The ERT encourages Australia to re-evaluate whether it is reasonable to apply the CH_4 EF from manure management for range-kept beef cattle to sheep.

2. Indirect emissions from soils – N_2O

113. Australia has not estimated N_2O soil emissions from leaching and run-off. During the review, Australia explained that these emissions are assumed to be small on the basis that the ratio of N output to the major Australian catchment areas is very low (e.g. Seitzinger and Kroeze, 1998). During the review Australia indicated that it plans to include an estimate of N_2O from leaching in its next submission. The ERT encourages Australia to use a country-specific EF if possible.

3. Field burning of agricultural residues – CH_4, N_2O

114. For trace gases (CH_4, N_2O, NO_X, CO and NMVOCs) from Field Burning of Agricultural Residues, Australia has used the same EFs as for Savanna Burning, which were derived based on field

measurements for Australian savanna fires. The ERT noted that this approach is consistent with the Revised 1996 IPCC Guidelines taking also into consideration that Field Burning of Agricultural Residues is not a key source. Because some parameters such as the burning efficiency and the C/N ratio differ between savanna and agricultural residue burning, the ERT encourages Australia, if possible, to give further consideration to these parameters and the EF of field burning of agricultural residues. In response to this review, Australia noted that reconsidering its approach could have considerable resource implications for this very small source of emissions.

115. The notation key "NE" is reported for pulse production in CRF table 4.F. While data on the production of beans and peas are available through the Food and Agriculture Organization of the United Nations (FAO) database, they do not include information on the amount of burning pulse biomass. The ERT encourages Australia to ask agricultural experts or farmers in Australia if the residues of pulse are burned, and revise the reporting accordingly.

D. Areas for further improvement

1. Identified by the Party

116. Australia is reviewing the following three categories for planned improvements:

(a) The methodology for estimating N_2O emissions from agricultural soils;

(b) The estimation of prescribed burning of savannas; and

(c) The Analysis of indirect N_2O emissions from leaching.

117. Australia is also undertaking research programmes to analyse the N_2O emissions from a variety of crops and pasture following application of fertilizers.

2. Identified by the ERT

118. In addition to the recommendations laid out under the respective source categories above, the ERT recommends that Australia recalculate trace gas emissions from prescribed burning of savannas by using a three-year averaged AD instead of 10-year averages.

VI. Land Use, Land-use Change and Forestry

A. Sector overview

119. Australia is one of only a few Parties included in Annex I to the Convention (hereinafter referred to as Annex I Parties) in which the LULUCF sector is a net source of GHGs, and its emissions in this sector have been among the highest since 1990. Total net GHG emissions from LULUCF activities amounted to 34,847.2 Gg CO_2 equivalent in 2003, which represented a 67 per cent reduction compared with the 1990 level (106,644.3 Gg CO_2 equivalent). The contribution of the sector to total national emissions including LULUCF fell from 20.3 per cent in 1990 to 6.3 per cent in 2003.

120. Australia has mapped the inventory categories required by the Revised 1996 IPCC Guidelines to the appropriate reporting categories of the IPCC good practice guidance for LULUCF, as described therein. Australia stated that it has a 10-year development plan to respond to the newly elaborated reporting provisions of the IPCC good practice guidance for LULUCF which progressively addresses the inventory components according to their significance. Australian experts noted the difficulties experienced in mapping the Revised 1996 IPCC Guidelines reporting structures to the IPCC good practice guidance for LULUCF.

121. The key category analysis performed by Australia included the emissions from forest conversion to other land-use categories in the LULUCF sector, but not the emissions and removals reported in the Forest Land category. In this analysis, CO_2 and CH_4 emissions from forest conversion have been identified as key sources, both by level and by trend.

122. CO_2 had the highest share of emissions from the sector in 2003, with a total of 30,582 Gg CO_2, or 87.8 per cent of total LULUCF net emissions. Corresponding values for CH_4 and N_2O were 3,351 Gg CO_2 equivalent (9.6 per cent of sectoral emissions) and 914 Gg CO_2 equivalent (2.6 per cent of sectoral emissions), respectively. The relative importance of non-CO_2 GHGs in the sector's total emissions increased from 5.2 per cent in 1990 to 12.2 per cent in 2003.

123. The decrease in emissions observed since 1990 was largely driven by a 70 per cent decrease in the area of forest land converted annually to other land uses (deforestation). The maximum annual rate of this land use conversion, 468.4 kha per year, occurred in 1990, and most of the decrease in this rate was observed during the period 1990–1995. Emissions due to forest land conversion decreased from 126,175 Gg CO_2 equivalent in 1990 to 49,617 Gg CO_2 equivalent in 2003, that is by 61 per cent.

124. The forest plantation area has increased by more than 60 per cent since 1990. The annual increment in carbon stocks in plantations increased from 10,186 to 18,173 Gg CO_2 equivalent between 1990 and 2003 (a 78 per cent increase), and this also contributed to the observed reduction in net GHG emissions from the LULUCF sector during that period.

125. There was an increase in the emissions associated with commercial wood harvest (from 46,430.9 to 57,234.3 Gg CO_2 equivalent – a 23 per cent increase) and in emissions from forest fires (from 1,552.1 to 2,323.9 Gg CO_2 equivalent – a 50 per cent increase) between 1990 and 2003.

126. Australia uses country-specific methods (tier 3) for estimating emissions from all LULUCF categories included in the NIR. These emission estimates are largely derived from the NCAS, which integrates field measurements, modelling and remote sensing into a tool with a targeted full coverage of Australia's land territory and capability for spatial and temporal tracking of land use activities and the associated emissions and removals of GHGs. The NCAS is supported by the publication of a detailed technical report series, the public release of the data and tools used for inventory compilation, and publication in the peer-reviewed literature of the methods used and the results. The ERT noted the substantial effort put in and the large amount of resources devoted by Australia to implement this highly sophisticated and very advanced accounting system.

1. Completeness

127. Australia has provided a complete set of CRF tables for the LULUCF sector in their new format as required by decision 13/CP.9, covering the entire period 1990–2003. Estimates have so far been provided for categories 5.A Forest Land and 5.C Grassland as well as corresponding emissions from biomass burning, and the corresponding sectoral background tables 5.A, 5.C, and 5(V) been completed accordingly. Categories for which no numerical data are provided are reported using the notation keys.

128. The data reported in the NIR and the CRF tables cover only 16,549.9 kha of forest land (equivalent to ca. 10 per cent of the total forest land area) and 128.0 kha of grassland (equivalent to 0.03 per cent of total grassland area). These areas combined account for 2 per cent of Australia's total land territory. The NIR does not specifically address the remaining 98 per cent of the total land area, as now encompassed through the elaborations by the IPCC good practice guidance for LULUCF. The information on the full national land area available through the NCAS will enable fuller treatment in future submissions. During the review, the Party stated that no significant land-use or management changes have taken place in these excluded areas and therefore no significant changes in carbon stocks

are expected to have occurred. Accordingly, this has not been an immediate priority for inventory development as set out in the NCAS development plan.

129. The NCAS results will eventually cover the country's land territory fully for all carbon stocks and GHG emissions. The ERT encourages Australia to continue its efforts to acquire the necessary AD to provide a complete and consistent representation of the broad-scale lands, in line with the elaborations of the Revised 1996 IPCC Guidelines provided in the IPCC good practice guidance for LULUCF. According to the elaborations by the IPCC good practice guidance for LULUCF, all land areas, even those that are unmanaged, should be reported under category 5.F as a part of the QA/QC procedures. In addition, the ERT suggests that, in the case of categories for which no country-specific AD or emission/removal factors are available, Australia should consider using tier 1 methods to achieve completeness of reporting and improve comparability. It is noted that, in response to this suggestion, Australian experts did not support the development of interim tier 1 methods for sectors that are currently incomplete as they are of the view that this would knowingly, and only temporarily, be a source of over- or underestimation in reporting that would subsequently require recalculation.

2. Transparency

130. For the LULUCF sector, Australia has provided, as part of its 2005 submission, descriptions of the NCAS and forest conversion methodology. They are included in annex 3 to the NIR and a number of separate methodology workbooks[6] with details of the methodologies used and the underlying assumptions for different parts of the sector. This suite of methodology reports reflects the rapid and incremental development of Australia's technical methods.

131. Australia undertakes extensive public documentation of its inventory development in a detailed technical report series, summary methods and results reports. This aims at achieving scientific and public transparency in the development of the inventory and the reporting for LULUCF. Australia has also publicly released the data and tools used for inventory compilation, and has promoted the publication of technical material in the peer-reviewed literature.

132. The structure of the sectoral chapter of the NIR itself could be improved by including methodological descriptions and sufficiently precise references to where the description of the methodologies and assumptions can be found in the methodology workbooks. In addition, sometimes (e.g. for emissions from wood harvesting) the description of the methodology is not clear. It is recommended that in future submissions Australia include a clearer description of the methods and assumptions used directly in the LULUCF chapter of the NIR, including more precise references to annexes or methodology workbooks in which the methodologies could be explained in detail, organized according to the LULUCF categories.

133. Australia has provided a definition for forest land in the report describing the NCAS and a description of the category of "managed forests" in Australia in the methodology workbook on land use, land-use change and forestry (plantations). The ERT welcomes this information and encourages Australia to provide it in future in its NIR in line with the requirements of the revised UNFCCC reporting guidelines, and to complement it with definitions for the other categories as well.

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[6] The following methodology reports for LULUCF were provided: (1) Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Land use, land use change and forestry; (2) Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Land use, land use change and forestry (forest land conversion); and (3) Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Land use, land use change and forestry (plantations). An additional report, "Greenhouse gas emissions from land use change in Australia: Results from the National Carbon Accounting System 1988–2003", was also provided as part of the 2005 submission.

134. Australia has provided limited information on the AD used and their sources in the NIR and methodology workbooks but has published the detailed annual results in associated documents. This issue was raised in the 2004 review report, and remains unresolved. Given the complexity of the country-specific methods used, Australia reports much of this detail in supplementary material. Australia is encouraged to improve the description of AD and their sources in the NIR itself in future submissions. The ERT also recommends the Party to include in the NIR more tables with complete time-series data for key AD (e.g. annual area of plantation, annual volume of wood harvest, etc.).

135. Some seeming inconsistencies in the time-series data (e.g. an 89 per cent decrease, accelerating after 1998, in net CO_2 removals by forests at the same time as the forest area increased by 4 per cent) were identified by the S&A (synthesis and assessment) report and the ERT. The reasons for these were properly explained and documented by the Party during the review, but the ERT recommends that, in future submissions, Australia provide clear explanations in the NIR itself for any such large fluctuations in the trend when they are due to policy changes or other factors.

3. Recalculations and time-series consistency

136. Because new remote sensing data and techniques (i.e. deployment of corrections for terrain illumination) have become available, the areas of forest land conversion have been recalculated for the period 1990–2002. This, along with other minor changes, has resulted in an increase in the estimated total net GHG emissions for LULUCF from 13,113 to 40,629 Gg CO_2 (in inventory year 2002) and from 85,370 to 101,142 Gg CO_2 (in inventory year 1990). The reasons for this recalculation are provided in the NIR and in CRF table 8(b), and the data in the methodology workbook on land use, land-use change and forestry (forest conversion).

B. Sink and source categories

1. Forest land

137. The area of forest land remaining forest land increased from 15.91 Mha in 1990 to 16.55 Mha in 2003. In addition, a land area of nearly 0.8 Mha (figure not included in the NIR but provided to the ERT during the review) has been converted to forest since 1990. Policies implemented during the period led to a sharp reduction in the harvesting of native forests and an increase in the annual rate of establishment of plantations. Wood harvest tended to increase during the period, with plantations having an increasing share of total harvested volumes. The Forest Land category was a net sink in every year during the period 1990–2003, with net annual CO_2 removals tending to decrease during the period, from 21.5 Mt CO_2 in 1990 to 17.0 Mt CO_2 in 2003. The share of post-1990 plantations in this net CO_2 removal reached 87 per cent by 2003.

138. Australia has reported all forest plantations established after 1990 under the category Land Converted to Forest Land, and all previous plantations under Forest Land Remaining Forest Land. While this criterion seems suitable for the purpose of reporting under the Kyoto Protocol, it does not seem to be adequate for UNFCCC reporting, and impairs the comparability of data. The ERT suggests that Australia adopt 20 years as the period during which a specific piece of land which is afforested remains in the category Land Converted to Forest Land. The cumulative area of plantations established during the 20 years immediately prior to inventory year should be included in the column for “total area” in the CRF (i.e. the corresponding cells in column C of table 5.A). Alternatively, a country-specific time period more appropriate to the rotation lengths prevailing in Australia could be selected.

139. Changes in soil organic carbon (C) stocks are reported as “NE”. Australia stated that it is well advanced in developing a capability to do so. The FullCAM model developed by Australia includes a component (Roth-C) for estimating changes in soil organic carbon stocks, and the ERT recommends that,

when this is fully calibrated and verified for forest soils nationally, Australia report changes in soil carbon separately from changes in living biomass.

140. In CRF table 5.A for 1990, no stock changes in total C stocks are reported for the Land Converted to Forest Land category, which, as the documentation box states, only includes plantations established in and after 1990 (defined as afforestation). According to the relevant scientific literature and to the concept described by Australia's inventory team during the review, soil organic carbon losses occur due to site preparation. This should have been reflected in net emissions in year 1990. Likewise, changes in soil organic carbon stocks associated with afforestation should have been reported for the rest of the years in the time series reported. In addition, no emissions due to decreases in living biomass stock (e.g. due to wood harvest) are reported for plantations established in or after 1990. It is, however, highly unlikely that wood harvesting did not occur in these plantations. Australia is encouraged to improve the transparency of its future reports by including estimates of C stock changes in all relevant pools (i.e. dead organic matter, soil organic carbon, and both increases and decreases in living biomass).

141. Australia has developed a country-specific method for estimating emissions due to wood harvest. This method follows a so-called "simple decay" approach and assumes that emissions from harvested wood occur over time after harvest. The values reported for emissions from commercial harvest include all wood harvested since 1970. This represents an improvement in accuracy with regard to the underlying assumptions used compared to the IPCC default, which assumes that all carbon in harvested wood is oxidized in the year of harvest and that there are no emissions from products made of wood harvested in the past.

142. An inconsistency in the description of the methodology used for estimating emissions from wood harvest was detected in Australia's LULUCF methodology workbooks. During the review, the Party stated that the methodology is currently being reviewed and the method described in the plantations workbook is yet to be implemented. It is recommended that Australia provide a more transparent and consistent description of the methodology for estimating emissions from harvested wood in its future submissions.

143. Emissions due to wood harvest are reported implicitly within living biomass in the categories Forest Land Remaining Forest Land, Forest Land Converted to Other Land Uses (reported under 5.C.2 Land Converted to Grassland) and Land Converted to Forest Land. While the ERT understands that the structure of the CRF tables for LULUCF (which were designed for the IPCC default) is not fully compatible with the approach selected by Australia for harvested wood products (HWP) (a simple decay approach), emissions from HWP could be more clearly identified by reporting them separately under category 5.G in table 5. One possible option for Australia would be to report explicitly all wood harvested in the reporting year as a specific component (i.e. as a category subdivision) of decrease in living biomass carbon stock under each relevant land-use category (in the respective sectoral background data table), and to report separately annual additions to the HWP carbon pool (from wood harvested in reporting year), and annual emissions from the wood products carbon pool (both from wood harvested in the current year and from wood products derived from previous harvests) under Harvested Wood Products in category 5.G in table 5.

2. Cropland and Grassland

144. Australia has not reported carbon stock changes in the category Croplands Remaining Croplands and Grassland Remaining Grassland, which are flagged in CRF table 5.B as "NE". The item "Minimum Tillage", which was reported in previous submissions as a net carbon sink of nearly 4 Mt CO_2/yr, has been eliminated due to the high level of uncertainty associated with the estimate, according to the NIR. During the review the Party stated that, on the basis of several NCAS technical reports, these lands are assumed to be in equilibrium. This determination should be noted in the NIR. Work is proceeding

through the NCAS on mapping areas of both Cropland Remaining Cropland and Grassland Remaining Grassland through the NCAS, and the ERT recommends the Party to produce estimates for this category in its future submissions.

145. Carbon stock changes for forest land converted to cropland are included in the category Forest Land Converted to Grassland. As the Party explained during the review, this was due to the mapping between the Revised 1996 IPCC Guidelines structures and those of the IPCC good practice guidance for LULUCF. When the NCAS completes the land-use time-series mapping capability Australia will be able to discriminate between these two categories in its future submissions.

3. Mineral N fertilization and soil disturbance by conversion to cropland – N_2O

146. Emissions from mineral N fertilizer are reported as "NE". During the review, the Party indicated that direct emissions from nitrogen fertilizers are included in the estimates for the Agriculture sector. Australia should report emissions as "IE" and include an explanation in the corresponding documentation box in table 5(I), in CRF table 9 and in the NIR. The Party indicates in table 9 that this source is under review by the NCAS. It is recommended that Australia continue with the effort to collect data on the amounts of N fertilizer applied to forest lands, in order to reflect this elaboration of the Revised 1996 IPCC Guidelines provided in the IPCC good practice guidance for LULUCF.

147. Emissions from disturbance of soils by conversion to cropland have not been estimated. The Party stated during the review that the NCAS is currently undergoing development to incorporate this source category and the ERT noted this.

4. Agricultural lime application – CO_2

148. Emissions from liming have not been estimated. CRF table 9 indicates that no data are available to make it possible to estimate these emissions. The Party explained during the review that liming in Australia is generally uncommon or insignificant, although the NCAS will undertake a survey in late 2005–early 2006 to check this.

5. Biomass burning – CH_4 and N_2O

149. Australia has estimated non-CO_2 emissions due to forest and grassland burning taking 10-year averages of AD (i.e. area burned). The Party stated during the review that the use of 10-year averages is intended to smooth out data that have a particularly high inter-annual variability, presenting long-term cycles (i.e. up to 25 years) associated with climatic variations. While the reasons for using 10-year averages may be well based, this is a departure from the suggested three-year averages of the Revised 1996 IPCC Guidelines (with explicit mention of the case of biomass burning in savannas (p. 4.75) in the Agriculture Sector). It is recommended that the Party use three-year averages instead of 10-year averages in its future submissions.

C. Areas for further improvement

1. Identified by the Party

150. The Party states in its NIR that, due to its importance, future improvements to the national inventory will be concentrated in the LULUCF sector. The ERT encourages Australia to continue its efforts to further develop the NCAS according to its development plan, which will include emissions from fertilizer use in forests and lime use in agriculture, among others. Australia recognizes the elaborations of the Revised 1996 IPCC Guidelines by the IPCC good practice guidance for LULUCF and has responded during the trial application period of the new CRF tables (that reflect the elaborations) that it will put in place additional inventory methods that deal with these elaborations.

2. Identified by the ERT

151. The ERT encourages Australia to pursue efforts to consolidate its reporting of methods used in its NIR in future. This would include:

(a) Improved descriptions of methods, AD used and their sources, in the NIR and in any methodology workbook referenced;

(b) The reporting of carbon stock changes separately for soil organic carbon, dead organic matter and living biomass;

(c) The separate reporting of forest land conversions to cropland and to grassland; and

(d) Structuring the report according to the LULUCF categories.

152. To make the LULUCF inventory more complete, to take account of the additional land areas and emission sources included in the LULUCF inventory because of the changes made to the Revised 1996 IPCC Guidelines by the IPCC good practice guidance for LULUCF, the ERT recommends that Australia progressively:

(a) Provide a more complete and consistent representation of land use in the country;

(b) Report carbon stock changes in land-use categories covering large areas (e.g., grassland, cropland) using tier 1 methods if country-specific AD or EFs are not available;

(c) Include estimates of emissions from use of N fertilizers in forests, and from liming in agricultural soils; and

(d) Progress the development of the NCAS as the basis for improving the completeness of the LULUCF inventory.

VII. Waste

A. Sector overview

153. In 2003 the Waste sector in Australia was responsible for emissions of 10,785.6 Gg of CH_4 (expressed in CO_2 equivalent), 558 Gg of N_2O (expressed in CO_2 equivalent) and 16.3 Gg of CO_2. The share of the sector in total national emissions (without LULUCF) has fluctuated slightly and increased from 2.0 per cent to 2.2 per cent between 1990 and 2003. In 2003 total sectoral emissions were 11.1 per cent above the 1990 level. The major contribution to the sector comes from CH_4 emissions from solid waste disposal on land: its share in sectoral emissions was 71.7 per cent in 2003. Both CH_4 and N_2O emissions from waste-water handling increased by 16.6 per cent between 1990 and 2003. However, the relative shares of these sources in the Waste sector were lower in 2003 than in 1990, being 23.3 per cent and 4.9 per cent, respectively. CO_2 emissions from waste incineration account for only 0.1 per cent of total emissions from the Waste sector because a large amount of waste is recycled or disposed in landfills, and only solvents are burnt. That is why the CO_2 emissions from waste incineration are the lowest among Annex I Parties.

1. Completeness

154. The CRF includes estimates of most gases and sources of emissions from the Waste sector, as recommended by the Revised 1996 IPCC Guidelines, namely CH_4 emissions from solid waste disposal on land and waste-water handling, N_2O emissions from waste-water handling and CO_2 emissions from waste incineration. CH_4 and N_2O emissions from waste incineration are not included. The ERT

recommends that Australia provide information on clinical waste utilization as most Parties include emissions from their incineration in their inventories.

2. Transparency

155. The NIR and CRF tables 6, 6.A–6.C provide information on AD and EFs, which is, however, not sufficiently transparent, and therefore refer to the methodology workbook on waste. The ERT recommends that Australia provide information in the background data tables in the CRF and use the documentation boxes of the CRF to provide additional information and /or references to the relevant sections of the NIR, in order to provide more underlying information to support the estimates. If any additional information and/or further details are needed to facilitate an understanding of the inventory, they can be included, for example, data on degradable organic carbon dissimilated (DOC_F) for different types of municipal solid waste (MSW) may be presented in the documentation boxes.

3. Recalculations and time-series consistency

156. The recalculated data and explanatory information are reported in tables 8(a) and (b) of the CRF. Australia has recalculated CH_4 emissions from MSW for the entire time series since 1990 because the first-order decay (FOD) model has been applied in the 2005 submission for the first time instead of the tier 1 (default) method. Following comments from the UNFCCC expert review of the 2004 submission, CH_4 emissions from waste-water handling have also been recalculated and the EF has been revised. After the recalculation the trend remains practically unchanged.

4. Uncertainties

157. The uncertainties have been estimated based on default uncertainties from the IPCC good practice guidance. If the Party used national uncertainty estimates for the many parameters of the model, for example, for the amount of municipal solid waste (MSW_t) and the fraction of municipal waste disposed in landfills (MSW_f), the uncertainty could be reduced, as the NIR notes. The estimated uncertainty for CH_4 emissions from MSW is estimated at ±50 per cent, which is close to the uncertainty in countries whose data on CH_4 generation per tonne of waste are of poor quality. Annex 7 of the NIR provides information to the effect that the uncertainty could be lower than 50 per cent assuming that per capita waste, methane potential and methane recovered have an overall uncertainty of ±23.6 per cent. To improve the estimation of uncertainty, the ERT recommends using chapter 6 of the IPCC good practice guidance, which provides advice on quantifying uncertainty in practice.

5. Verification and quality assurance/quality control approaches

158. QA/QC for solid waste disposal on land is provided by comparing the AD used with published data from waste agencies. For waste-water handling the IPCC check method has been used. It gives emissions from this sector 21 per cent lower than the CH_4 emissions calculated in the inventory. The difference is explained by the fact that industrial waste water is treated with municipal waste water in Australia.

B. Key categories

1. Solid waste disposal on land – CH_4

159. Australia has used the IPCC (tier 2) FOD model for estimating emissions from solid waste disposal on land. A description of the methodology is provided in the methodology report on waste. The methodology requires historical data on waste disposal, and a number of state government agencies have provided waste data for the GHG inventory. When historical data have not been available, a growth rate has been used (0.73 per cent per year). The growth rate is based on surveys and research. The Party does not indicate for what part of the years historical data are not available. The methodology is

appropriate and in line with the IPCC good practice guidance. The model parameters are listed in the methodology workbook. For waste composition the Party has used national values; other parameters used are taken from the IPCC good practice guidance. The CRF tables provide values for most of the parameters, but not for all: for example, degradable organic carbon (DOC) and DOC_F are reported as "NA" and "NE", respectively. The ERT recommends that the Party use the documentation box to refer to the section of the NIR or a methodology workbook where these data can be found, and report the necessary additional data in the CRF tables.

160. Applying the FOD model gives more realistic estimates of emissions compared to the default methodology (tier 1) that was used previously. According to the IPCC good practice guidance, the use of the FOD method reflects the emission trend more accurately. This constitutes a major improvement in the 2005 submission.

2. Waste-water handling – CH_4

161. Emissions of methane from waste-water handling are estimated using the IPCC default methodology combined with country-specific EFs. Most industrial, commercial and domestic waste water is treated by the municipal waste-water treatment plants. The methodology is described in the methodology workbook. The CRF table does not provide information on the CH_4 EF. The methodology workbook states that the Party uses the IPCC default EF of 0.50 kg CH_4/kg biochemical oxygen demand (BOD) instead of the 0.25 kg CH_4/kg of chemical oxygen demand (COD) because the measurement of the organic content of waste water in Australia is characterized by a BOD which is twice as high as the COD. The ERT encourages Australia to include more detailed explanations and values of parameters in the documentation box.

C. Areas for further improvement

1. Identified by the Party

162. The Party plans to review the methodology used for the decay of wood in landfills. Further investigations are planned to obtain more realistic DOC_F values for wood. DOC_F values for other types of waste may also be reconsidered if improved data become available. Waste-water methodologies and waste-water biological loads will be revised in order better to reflect Australia's waste-water treatment process.

2. Identified by the ERT

163. The approaches used to estimate emissions from waste-water handling are presented in the methodology workbook in detail. The methodology is presented for four sources of methane emissions (industrial waste water, disposal of sludge, commercial and domestic waste water, and municipal waste water). However, the choice of the parameters is not quite clear. CRF table 6.B contains only one parameter – DC, which is equal to 22,500 kg BOD/1,000 person/yr. The ERT recommends Australia to provide more information on the choice of parameters. The sectoral background data tables in the CRF should be used to provide the values of the parameters used in the estimation. Australia is also encouraged to indicate in the documentation boxes where in the NIR and the accompanying methodology workbook information describing the methodology can be found.

Annex

Documents and information used during the review

A. Reference documents

2004 and 2005 Inventory submissions of Australia. 2005 submission including a set of CRF tables for 1990–2003 and an NIR (National Greenhouse Gas Inventory 2003) including the following series of methodology workbooks:

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Energy (Stationary sources)

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Energy (Transport)

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Fugitive fuel emissions

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Industrial processes

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Solvents and other product use

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Agriculture

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Land use, land use change and forestry

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Land use, land use change and forestry (forest land conversion)

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Land use, land use change and forestry (plantations)

Australian methodology for the estimation of greenhouse gas emissions and sinks 2003: Waste

"Greenhouse gas emissions from land use change in Australia: Results from the National Carbon Accounting System 1988–2003".

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

IPCC. Good practice guidance for land use, land-use change and forestry, 2003. Available at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

IPCC/OECD/IEA. Revised 1996 IPCC Guidelines for national greenhouse gas inventories, volumes 1–3, 1997. Available at <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>.

UNFCCC. Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories. FCCC/SBSTA/2004/8. Available at <http://unfccc.int/resource/docs/2004/sbsta/08.pdf>.

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

UNFCCC secretariat. Status report for Australia. 2005. Available at <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/2005_status_report_australia.pdf>).

UNFCCC secretariat. "Synthesis and assessment report of the greenhouse gas inventories submitted in 2005. Part I": FCCC/WEB/SAI/2005. Available at <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/sa_2005_part_i_final.pdf>.

UNFCCC secretariat (2005). Australia: Report of the individual review of the greenhouse gas inventory submitted in the year 2004". FCCC/WEB/IRI/2004/AUS. Available at <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/2004_irr_centralized_review_australia.pdf>).

B. Additional information provided by the Party

Responses to questions during the review were received from members of the Australian Greenhouse Gas Office and experts participating the data collection and inventory calculations, including additional material on the methodology and assumptions used.

Mr. Rob Sturgiss, Ms. Penny Reyenga, Mr. Jeremy O'Keefe, Mr. Steven Oliver, Mr. Mark Hunstone AGO-DEH; Dr. Gary Richards, AGO-NCAS; Mr. Charles Jubb, Mr Hugh Saddler, Mr. Mick Meyer, external consultants; Kim Donaldsson, ABARE; a representative from the ABS.

Additional materials (provided by Australia during the in-country review) used for the review of the Energy sector inventory

Australian Bureau of Agricultural and Resource Economics (ABARE), Australian Energy Supply and Disposal – from 1973 to 2002 (Australian energy balance tables, an Excel file.)

"Australian energy consumption, by industry and fuel type", 2002 and 2004 ("2002 FES.xls" and "2004 FES.xls".

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