



Australian Government
Department of the
Environment and Heritage
Australian Greenhouse Office

AUSTRALIA'S NATIONAL
GREENHOUSE ACCOUNTS



Australia's 108% Kyoto Target

Report on Australia's National Greenhouse Gas Accounting Systems

Australian Greenhouse Office
Department of Environment and Heritage
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This document and supporting methodology workbooks are available on the Internet at the following address:

<http://www.greenhouse.gov.au/inventory>.

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December 2006

Designed by Roar (DEH 3872)

TABLE OF CONTENTS

1. AUSTRALIA'S NATIONAL GREENHOUSE INVENTORY SYSTEMS: INTRODUCTION _____	1	7. INVENTORY PREPARATION: CONSISTENCY WITH GOOD PRACTICE _____	19
1.1 Background Information on Greenhouse Gas Inventories _____	1	Appendix 7.A.1: Key Source Categories _____	19
1.2 Features of the Australian National Inventory System _____	2	8. INVENTORY PREPARATION: INVENTORY IMPROVEMENT _____	21
2. ESTIMATION OF AUSTRALIA'S KYOTO TARGET AND KEY EMISSIONS INVENTORY INFORMATION _____	4	8.1 Inventory Improvement Plan _____	21
3. NATIONAL SYSTEM: INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS _____	8	BOX: Long Term Planned Development of the National Carbon Accounting System _____	23
3.1 Single Agency _____	8	9. INVENTORY MANAGEMENT: ARCHIVAL AND DOCUMENTATION SYSTEMS _____	24
3.2 Frameworks for Co-operation on Data collection _____	8	9.1 The Australian Greenhouse Emissions Information System (AGEIS): Archival of emissions estimates, data and methods _____	24
3.3 Centralised Emissions Estimation _____	9	9.2 Documentation of Australia's Emissions Estimation Methodologies _____	24
3.4 Process for official consideration and approval of the inventory and responses to inventory review processes _____	9	10. PROGRESS TOWARDS A SYSTEM OF NATIONAL EMISSION ACCOUNTS _____	25
3.5 Contact Details _____	9	BOX: An integrated framework of national emission accounts _____	26
4. NATIONAL SYSTEM: CAPACITY FOR TIMELY PERFORMANCE OF INVENTORY FUNCTIONS _____	10	1) By IPCC Classifications (type of process) _____	27
4.1 Resources _____	10	2) By jurisdiction _____	27
4.2 Capital Assets - The Australian Greenhouse Emissions Information System (AGEIS) and The National Carbon Accounting System (NCAS) _____	10	3) By type of economic transactor (institutional sector in National Income accounts) _____	27
BOX: Australia's National Carbon Accounting System _____	12	4) By Economic Sector _____	27
4.3 Timelines _____	12	5) By product or group of products (Production Basis) _____	27
5. INVENTORY PLANNING _____	13	6) By product or group of products (Consumption Basis) _____	28
6. INVENTORY PLANNING: QUALITY CONTROL AND ASSURANCE PLANS _____	14	7) Indirect accounts _____	28
6.1 Quality Control Systems _____	14	REFERENCES _____	28
6.2 Quality Assurance Systems _____	16		
BOX: National Carbon Accounting System: Overview of Quality Assurance and Quality Control _____	17-18		
Appendix 6.A.1 Inventory Preparation: Uncertainty _____	18		

1. AUSTRALIA'S NATIONAL GREENHOUSE INVENTORY SYSTEMS: INTRODUCTION

This document sets out the National Inventory Systems that support the preparation of *Australia's National Greenhouse Accounts*, which include Australia's *National Greenhouse Gas Inventory* and *National Inventory Report* to the UN Framework Convention on Climate Change, together with certain additional information designed to support the determination of Australia's 1990 emissions base estimate and Australia's Kyoto emissions target.

The Australian Greenhouse Office has adopted internationally-specified provisions as the basis for the development of Australia's national inventory systems. This approach ensures that the Australian *National Greenhouse Gas Inventory* used for the purpose of meeting Australia's domestic 108% Kyoto target meets the standards of international best practice.

A national inventory system includes all institutional, legal and procedural arrangements ...for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information. Australia's national inventory systems are applicable to the full range of *National Greenhouse Accounts* that are produced each year by the Australian Greenhouse Office.

Australia's *National Inventory Report - Revised 2004* has been published simultaneously with this report and provides a full time series of greenhouse gas emission estimates for Australia for the period 1990 - 2004. This inventory determines Australia's base year (1990) estimate of emissions and has been submitted for international expert review. Some additional information is required to support the estimation of this inventory, and the process of reconciling future inventories with the Kyoto target, and this information is set out in Section 2.

1.1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES

Australia's *National Greenhouse Gas Inventory* provides annual estimates of Australia's net greenhouse gas emissions and is prepared under the reporting provisions applicable to the Kyoto Protocol. This inventory will be used to assess progress towards Australia's Kyoto emissions target.

In conjunction with the *National Greenhouse Gas Inventory*, the Australian Greenhouse Office simultaneously publishes a range of supporting emission estimates that, together, constitute *Australia's National Greenhouse Accounts*. In 2007, in addition to the *National Greenhouse Gas Inventory 2005*, the Australian Greenhouse Office will also prepare:

- > the *National Inventory Report 2005*, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) each year as part of Australia's reporting obligations under that Convention.
- > *State and Territory Greenhouse Gas Inventories*;
- > the *National Inventory by Economic Sector 2005*, comprising emission estimates by economic sector rather than by IPCC sectors at both national and State levels, and ;
- > and analyses of the allocation of 'Scope 2' indirect electricity emissions by end user.

These documents are prepared under the AGO Emissions Data Management Plan and will be available on the AGO website www.greenhouse.gov.au/inventory. They provide additional information with respect to Australia's emissions on both a regional and industry basis, as well as with respect to Australia's domestic policy commitments.

¹ IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (IPCC 2000); IPCC *Good Practice Guidance on Land Use, Land Use Change and Forestry* (2003) and the IPCC *Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories* (IPCC 1997).

Some of the key features of the System include:

- i) the development and deployment of an AGO software system known as the **Australian Greenhouse Emissions Information System (AGEIS)** to support the production, publication and archiving of the Accounts;
- ii) the application of **international guidelines**¹ for the preparation of Inventories, where the aim is to ensure that the estimates of emissions are accurate, transparent, consistent through time and comparable with those produced in the inventories of other countries;
- iii) the high level of **transparency** of Australia's methodologies, which are published on the AGO website, and the level of public access to detailed emissions estimates through the online interactive AGEIS webpage; and
- iv) the emphasis placed on **Quality Assurance**: - in particular, the *National Inventory Report* and the National Inventory Systems are subject to annual international review through the UNFCCC, with the UNFCCC review reports published at www.unfccc.int.

The Australian Greenhouse Office has developed its National Inventory Systems with the aim of conforming with the international specifications set out in COP Decision 19/CMP.1 Annex (reported in FCCC/KP/CMP/2005/8/Add.3) as part of its efforts to support the preparation of the *National Greenhouse Gas Inventory* and the *National Greenhouse Accounts* more generally.

The objectives of national systems for the estimation of emissions and removals include:

- > to enable parties to estimate emissions and removals and to report them in accordance with COP decisions;
- > to facilitate the review of inventory information; and
- > to assist parties to ensure and to improve the quality of their inventories.

This document aims to elaborate Australia's inventory institutions and inventory planning, preparation and documentation systems and to provide assurance as to the quality of Australia's national greenhouse accounts.

1.2 FEATURES OF THE AUSTRALIAN NATIONAL INVENTORY SYSTEM

The Australian inventory is supported by a set of institutional arrangements which is designed to facilitate close co-ordination of the compilation of the inventory, efficient emissions data management, broadly based quality assurance processes and secure and reliable data collections.

The compilation of Australia's greenhouse gas inventory is undertaken by the Australian Greenhouse Office (AGO) in the Department of the Environment and Heritage using the Australian Greenhouse Emissions Information System (AGEIS). The AGEIS centralises emissions estimation, inventory compilation, reporting and data storage processes into a single system. It has been used to consolidate Australia's emissions estimation methodologies and fully-integrated quality control procedures into the compilation process. The AGEIS provides high transparency levels for the inventory, with emissions data from the AGEIS database for the set of National Inventory accounts publicly accessible through a dynamic web interface at: www.greenhouse.gov.au/inventory.

The National Greenhouse Gas Inventory Committee, which comprises representatives of the Australian, State and Territory governments and which has been in place since the early 1990s, is the principal mechanism of review for the report prior to its release. The report is also circulated prior to submission to other Australian government departments and agencies and relevant state experts through the National Greenhouse Gas Inventory Committee.

Originally, expert working groups developed the Australian emission estimation methodologies. Their work has been subsequently reviewed by a wide range of technical experts in research institutions, governments and industry on a rolling basis and in accordance with the AGO's Inventory Improvement Plan (section 8). Key modifications or refinements to the methodology are adopted following consultation with the National Greenhouse Gas Inventory Committee.

Reliability of data collection processes is an important consideration for inventory preparation to ensure accurate and time series-consistent emissions data (section 3). The Australian inventory is well served in this regard. The major sources of activity data are published by key national economic statistics agencies: - the Australian Bureau of Statistics (ABS) and the Australian Bureau of Agricultural and Resource Economics.

Features of the Australian System

- > *The National Greenhouse Gas Inventory is embedded within an integrated set of national greenhouse accounts*
- > *The Australian Greenhouse Office acts as the single agency designated to compile the inventory*
- > *Inventory processes are sufficiently resourced and staffed*
- > *The AGO has invested in capital asset structures - the Australian Greenhouse Emissions Information System (AGEIS) and the National Carbon Accounting System (NCAS) - for estimation, quality control and archiving of emissions and input data and methodology*
- > *Transparency has been maximised through the release of a publicly accessible interactive emissions database at www.greenhouse.gov.au/inventory and documented estimation methodologies*
- > *Input data collection is supported by Australia's major economic statistics organisations, supplemented by AGO collections for certain sectors*
- > *The inventory has been developed under a continuous improvement plan, with prioritization of resources allocated to key categories with relatively high uncertainty (in particular, LULUCF)*
- > *The Inventory is subject to regular review, including by independent international experts through the UNFCCC Expert Review Teams*

The AGO has instituted an annual cycle of evaluation through the preparation of an *Evaluation of Outcomes* document, providing a process for quality assurance and feedback for improvement to the *National Greenhouse Accounts*. The *Accounts* are assessed against explicit quality objectives which take into account, *inter alia*, detailed estimates of uncertainty surrounding Australia's emissions data; UNFCCC Expert Review processes, which aim to review and improve the quality of all Annex I inventories in an open and facilitative manner on an annual basis; and an assessment of Australia's estimation methodologies against IPCC guidelines, international practice and available data (see sections 6, 7 and 8).

The AGEIS is facilitating the continued development of the National Greenhouse Accounts for Australia with the aim of providing additional information for users and has the benefit of enhancing the transparency, consistency and comparability of the national inventory. The national emissions accounting framework which supports the construction of the accounts is set out in section 10.

2. ESTIMATION OF AUSTRALIA'S KYOTO TARGET AND KEY EMISSIONS INVENTORY INFORMATION

This section provides information required to support the estimation of Australia's 1990 base emissions estimate.

Complete inventories of anthropogenic emissions by source and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for all years from 1990 to the most recent year available.

Australia's most recently completed inventory - the *National Inventory Report : 2004 Revised* - and associated Common Reporting Format Tables have been submitted to the UNFCCC along with this document. It reports emissions estimates for the period 1990-2004.

Identification of the selected base year for hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆).

Australia will use 1990 as the base year for all of these gases.

Reporting of Australia's base year aggregate emissions, from which the national emissions target for the period 2008-2012 may be determined.

From the data contained in Australia's *National Inventory Report: 2004 Revised* Australia's estimated emissions for 1990 is determined to be 547 127 Gg. Details are provided in Table 2.1.

Table 2.1: Determination of Australia's base year (1990) emissions estimate

REPORTING OF AUSTRALIA'S EMISSIONS IN THE BASE YEAR	
Sector	Gg
Energy	286 969
Industrial Processes and Solvents	25 282
Agriculture	87 716
Waste	18 308
Aggregate for the above sectors	418 275
Land use change (Deforestation)*	128 852
Base year emissions estimate	547 127
CALCULATION OF 108% TARGET	
108% of base year estimate	590 897
Australia's cumulative emissions target for 2008-2012 (5 times 108% of base year estimate)	2 954 483

* Under the 1996 IPCC Guidelines for the Preparation of National Inventories, 'Land Use Change' is defined as including IPCC sectors 5.B-D. To facilitate the introduction of new reporting structures, the IPCC provided guidance on the mapping of these sectors to equivalent 'Land Use, Land Use Change and Forestry' categories - see the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry 2003 page 3.12. In Australia's reporting, 'Forest Lands Converted to Grasslands' and 'Forest Lands Converted to Croplands' categories under IPCC 2003 have been mapped back to 'Land Use Change' under the 1996 IPCC Guidelines. Consequently, the combined estimated net emissions from 'Forest Lands Converted to Grasslands' and 'Forest Lands Converted to Croplands' categories in Australia's National Inventory Report 2004 Revised are equal to the estimated emissions from 'Land Use Change' sectors as classified under IPCC 1996.

Source: Emissions estimates derived from Australia's National Inventory Report - 2004 Revised, Australian Greenhouse Office, Department of the Environment and Heritage, 2006.

Supporting calculations for Australia's emissions base

Under article 3.7, countries for whom land use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from Land Use Change for the purpose of calculating their emissions target.

In the Report of the UNFCCC Conference of the Parties at its seventh session, which contain the 'Marrakech Accords', it was recognised that Australia was eligible to address land use change emissions minus removals by sinks under the second sentence of Article 3.7, using 1990 as the base (FCCC/CP/2001/13, paragraph 93.)

Australia's eligibility was based on estimates of Australia's net source of emissions from the Land Use Change and Forestry sector for 1990 current at the time of the Conference (2001). This estimate is reported in Table 2.2.

As the Land Use Change and Forestry sector constituted a net source of emissions in 1990, Australia will include the

estimated net emissions from Land Use Change in 1990 in the base that is used to determine the emissions target for the period 2008-2012 (see Table 2.1). This approach ensures that net emissions from Land Use Change are included in both Australia's reported inventory for those years and in Australia's emissions target.

Australia's most recent inventory, published in 2006, also reports the Land Use Change and Forestry sector as a net source for 1990 - see Table 2.3. Since the 2001 report was released, the reporting structures applicable to Land Use Change and Forestry have been refined, requiring the Land Use Change and Forestry sub-sectors under the *1996 IPCC Guidelines for the Preparation of National Inventories* to be mapped to the Land Use, Land Use Change and Forestry categories by the *IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry* - see IPCC 2003 page 3.12. In Australia's reporting, net emissions from the Land Use, Land Use Change and Forestry (LULUCF) categories under *IPCC 2003* are equal to the net emissions from Land Use Change and Forestry (LUCF) sectors under the *1996 IPCC Guidelines*.

Table 2.2: Australia's net emissions from Land Use Change and Forestry, 1990, Gg

	Net emissions (emissions by sources less removals by sinks)
Land Use Change and Forestry (LUCF)	103 500 Gg

Source: Australia's National Greenhouse Gas Inventory, 1999, Australian Greenhouse Office, April 2001.

Table 2.3: Australia's revised net emissions from Land Use Change and Forestry, 1990, Gg

	Net emissions (emissions by sources less removals by sinks)
Land Use Change and Forestry (LUCF)	81 629 Gg*

* This is the sum of net emissions from categories 5.A 'Forest lands'; 5.B.2 'Land Converted to Cropland'; 5.C.2 'Land Converted to Grassland'; and '5.G. Other' from Australia's National Inventory Report 2004 Revised and associated CRF tables. Estimated emissions from all other LULUCF sectors are reported in the National Inventory Report to be equal to zero.

Source: *Australia's National Inventory Report - 2004 Revised*, Australian Greenhouse Office, Department of the Environment and Heritage, 2006

Identification of selected values for tree crown cover, land area and tree height for use in accounting for activities under Article 3, paragraphs 3 and 4

Australia has identified the following selected values for use in accounting for its land use, land use change and forestry activities under Article 3.3 and Article 3.4:

- > Tree crown cover: 20% canopy cover
- > Minimum land area: 0.2 hectares
- > Tree height: 2 metres

These characteristics align with the definitions of forest used by Australia in the compilation of its National Forest Inventories and in its reporting to the FAO. The definition has been extended to add a minimum area criterion, as required. The use of remote sensing techniques through the deployment of Australia's National Carbon Accounting System has facilitated the identification of forest cover to an area of 0.2 hectares.

Identification of selected sinks activities under Article 3.3 and 3.4 for accounting in the period 2008-2012

Australia will use Australia's National Carbon Accounting System (NCAS) to identify land areas associated with the following activities under Article 3.3:

- > Deforestation or Land Use Change;
- > Afforestation and reforestation since 1990.

The NCAS is described in detail in Australia's National Inventory Report - 2004 Revised and in numerous publications cited in that document. Australia applies a spatially explicit, time-series approach to track forest cover through time. This allows for the separate identification of land use changes from disturbance events and harvests, and also from any forest re-establishment.

Australia will not account for any activities under Article 3.4.

Identification of the accounting period (annual or for the period 2008-2012), for each activity under Article 3.3

Australia will publish annual estimates of emissions and removals from activities identified under Article 3.3.

Identification of Australia's National Inventory System

Australia's national inventory systems have been elaborated in this document in sections 3-10 and are evidenced in the National Inventory Report - 2004 Revised. The cross references to the relevant parts of this document for each of the requirements of national inventory systems as set out in Decision 19/CMP.1 Annex within FCCC/KP/CMP/2005/8/Add.3 are reported in Table 2.4.

Table 2.4: Detailed cross referencing of national inventory system characteristics

Decision 19/CMP.1 Annex paragraph number	Description of national inventory system characteristic	Cross reference to this document
General functions		
10a	Establish and maintain the institutional, legal and procedural ...	Section 3
10b	Ensure sufficient capacity	Section 4
10c	Designate a single national entity	Section 3.1
10d	Prepare national annual inventories	See Section 1
10e	Provide information necessary to meet the reporting requirements defined in the guidelines under article 7	See Section 1
Specific functions		
12a	Designate a single national entity	Section 3.1
12b	Make available postal and electronic addresses	Section 3.5
12c	Define and allocate specific responsibilities	Section 3
12d	Elaborate a QA/QC plan	Section 6
12e	Establish process for official consideration	Section 3.4
13	Improve quality of the inventory	Section 7
14a	Identify key source categories	Section 7.A.1
14b	Prepare estimates in accordance with methods described by the IPCC	Section 8
14c	Collect sufficient activity data to support the methods	Section 3
14d	Estimate inventory uncertainty	Section 6.A.1
14e	Ensure recalculations are prepared in accordance with IPCC guidance	Section 8
14f	Compile the national inventory in accordance with Article 7 and COP decisions	See Section 1
14g	Implement general inventory QC (tier 1) procedures in accordance with the QA/QC plan	Section 6.1
15a	Apply source specific QC (tier 2) procedures	Section 6.1
15b	Provide for basic review of the inventory by personnel not involved in the inventory development	Section 6.2
15c	Provide for more extensive review for key source categories	Section 6.2
15d	Re-evaluate inventory planning process in order to meet quality objectives established under 12d	Section 5
16a	Archive inventory information	Section 9.1
16b	Provide access to review teams to archived information	NA. In practice, compliance.
16c	Respond to requests for additional information	NA. In practice, compliance.
17	Gather archived information at a single location	Section 9

3. NATIONAL SYSTEM: INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS

The National Inventory Report and CRF Tables are prepared each year as part of Australia's reporting obligations under the UN Framework Convention on Climate Change and to support domestic policy. The inventory is prepared in accordance with international guidelines and is subject to international expert review.

Australia is well served by the institutional, legal and procedural arrangements that underpin the performance of functions required to meet the National Systems Guidelines. This section sets out the main components of Australia's National System which address the specific elements of Decision 19/CMP.1 Annex paragraphs 10(a) and 10(c) and paragraphs 12(a), 12(c) and 12(e).

3.1 SINGLE AGENCY

The compilation of *Australia's National Greenhouse Accounts* is undertaken centrally by a single agency, the Australian Greenhouse Office (AGO) in the Department of Environment and Heritage, the Australian Government. The AGO is responsible for all aspects of emissions estimation; the preparation of the reports and for their submission to the UNFCCC on behalf of the Australian Government.

3.2 FRAMEWORKS FOR CO-OPERATION ON DATA COLLECTION

Data collection to support the preparation of the *Accounts* is managed centrally by the AGO, utilising a mix of approaches to ensure the reliable flow of data from other agencies to support inventory preparation.

The data collection process is well-integrated with the objectives of other programmes, with a strong reliance on data collected and published by Australia's principal economic statistics agencies: the Australian Bureau of Statistics and the Australian Bureau of Agricultural and Resource Economics. The Australian Bureau of Statistics (ABS) is the national statistical agency with legislative backing for its collection powers. It is the source of agricultural activity and some energy related data. The energy consumption data are sourced from the Australian Bureau of Agricultural and Resource Economics, which publish data from a survey of energy use that has operated for 30 years and which are used to fulfill Australia's reporting requirements to the International Energy Agency.

For industrial processes, the AGO employs consultants to collect data directly from companies. Company

Table 3.1: Principal data sources and collection mechanisms for the estimation of Australia's national greenhouse gas inventory

Category (UNFCCC sector)	Principal activity data sources	Principal collection mechanism
Energy sector (1A1, 1A2, 1A4, 1A5)	Australian Bureau of Agricultural and Resource Economics (ABARE), AGO collections	Published AGO programmes, Voluntary AGO survey
Energy sector, (1A3)	ABARE, Australian Bureau of Statistics	Published
Energy sector (1B)	Coal Services Pty Ltd, Australian Petroleum Exploration Association	Published
Industrial processes (2) and solvents (3) HFCs	AGO collection Australian Government Department of Environment and Heritage	AGO survey Mandatory reporting under import licensing arrangements
Agriculture (4)	Australian Bureau of Statistics	Published
Land Use Change and Forestry (5)	National Carbon Accounting System, ABARE	AGO
Waste (6)	State and Territory government waste agencies	Exchange of letters between government agencies

co-operation with the AGO survey is high. The collection of solid waste data from State and Territory Government agencies is supported by an exchange of letters between Australian and State Government agencies.

3.3 CENTRALISED EMISSIONS ESTIMATION

Estimation of emissions is conducted by the Australian Greenhouse Office utilising the Australian Greenhouse Emissions Information System (AGEIS) and, for LULUCF estimates, the National Carbon Accounting System (NCAS). Emission methodologies selected are consistent with those identified by the Intergovernmental Panel on Climate Change (IPCC 2003, IPCC 2000, IPCC 1997) and are being continually improved under the Inventory Improvement and NCAS Development Plans. All other activities associated with the preparation of the emission estimates are co-ordinated by the AGO.

The Council of Australian Governments (CoAG) is currently considering options for streamlining energy and greenhouse emissions data collection processes by Australian Governments. In terms of the *National Accounts* the benefits are likely to derive from improved coverage and data quality for Account data inputs. The direct impacts of any changes to collection processes on data quality would not be expected to be significant in the short term as coverage and levels of company co-operation with AGO collections are already high. Rather, the short term benefits will arise from streamlined data collections across a range of government programmes and reduced company reporting administrative costs overall. This change should bring long term benefits to the *Accounts* by ensuring that the broader processes of company energy and emission reporting are placed on secure and sustainable paths into the future.

3.4 PROCESS FOR OFFICIAL CONSIDERATION AND APPROVAL OF THE INVENTORY AND RESPONSES TO INVENTORY REVIEW PROCESSES

The *National Inventory Report* is prepared by the Australian Greenhouse Office. Prior to finalisation, each annual report is considered by the *National Greenhouse Gas Inventory Committee*, which comprises representatives of the Australian, State and Territory governments and has been in place since the early 1990s. The Committee is the principal mechanism of review for the *National Inventory Report* prior to its release. The *National Inventory Report* is also circulated prior to submission to other Australian government departments and agencies and relevant state experts through the National Greenhouse Gas Inventory Committee.

Release of the inventory and submission to the UNFCCC is approved by the Minister for the Environment and Heritage of the Australian Government.

3.5 CONTACT DETAILS

Postal and electronic contact details of the national entity responsible for the inventory are:

The Manager

Inventory unit

Australian Greenhouse Office

Australian Government Department of the Environment and Heritage

GPO Box 787

Canberra ACT 2601

AUSTRALIA

or electronically at:

greenhouseassessmentmail@deh.gov.au

4. NATIONAL SYSTEM: CAPACITY FOR TIMELY PERFORMANCE OF INVENTORY FUNCTIONS

The production of high quality and timely greenhouse gas inventories is a resource-intensive process. To meet these objectives of quality and timeliness, Australia has ensured that sufficient capacity - in terms of financial and human resources; the technical competence of staff; and capital assets - has been made available for the production of greenhouse inventories with the aim of ensuring that they meet the standards required by the UNFCCC review processes. This section addresses the elements of Decision 19/CMP.1 Annex paragraph 10(b) which specify that sufficient resources are made available for the timely performance of national inventory system functions.

4.1 RESOURCES

Australia's National Greenhouse Gas Inventory is prepared under the Australian Government's Emissions Measurement and Analysis Programme. The programme supports the Inventory, the AGO's emissions projections activity; and the National Carbon Accounting System, which is designed, *inter alia*, to estimate greenhouse emissions and removals from the Land Use, Land Use Change and Forestry sector.

Prioritisation of the Inventory's available resources to areas of development with highest payoffs in terms of improvements to inventory quality and timeliness is necessary to ensure that inventory quality continues to match international expectations and standards. For this reason, over half of the available funds from the programme are allocated to the National Carbon Accounting System.

The AGO maintains a unit of five staff to manage the National Inventory Systems required to deliver *Australia's National Greenhouse Accounts*. Support for the AGO inventory staff comprises a pool of 16 expert consultants

from which the AGO selects experts to undertake specific inventory preparation and review tasks. The pool is designed to foster a broad base of understanding of Australia's inventory systems and also to ensure that the AGO meets the competition principles of the Australian Government's procurement guidelines.

AGO staff and external consultants have extensive experience in inventory preparation. The AGO aims to maximise the number of staff that have been trained in order to qualify for the UNFCCC Roster of Experts for review of national inventories and to participate in UNFCCC Expert Review Team processes. All senior staff have been accepted onto the UNFCCC Roster of Experts and the AGO has strongly supported the participation of Australian experts in UNFCCC review exercises.

4.2 CAPITAL ASSETS - THE AUSTRALIAN GREENHOUSE EMISSIONS INFORMATION SYSTEM (AGEIS) AND THE NATIONAL CARBON ACCOUNTING SYSTEM (NCAS)

The AGO introduced the Australian Greenhouse Emissions Information System (AGEIS) into the inventory production process in 2005. This was an important innovation for the Australian inventory and has made the simultaneous production of the *National Accounts* feasible. The AGEIS was designed to meet the requirements for national inventory systems, and is an integral part of the *Accounts* preparation and publishing processes. In particular, it fully integrates quality control procedures into the compilation process as well as centralising emissions estimation, inventory compilation and reporting and data storage activities.

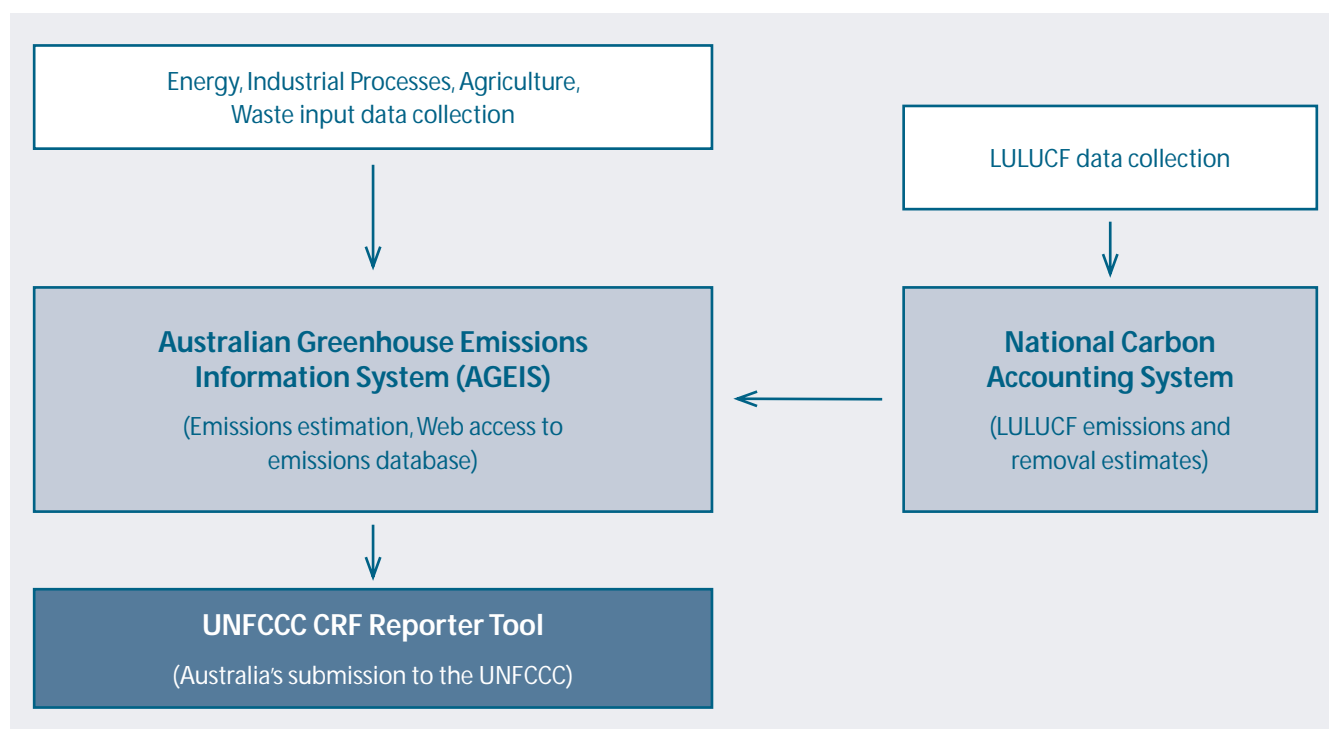
The AGEIS was developed over three years and was subjected to rigorous testing by both external and internal

reviewers testing prior to deployment. The system is designed to receive input and activity data; generate emissions estimates; and then to provide secure access to the public to the emissions database. A new feature of the AGEIS introduced in 2006 is its full integration with the UNFCCC CRF Reporter Tool. This enables the smooth transfer of emissions data to the UNFCCC and reduces data handling with the aim of improving the timeliness and quality of Australia's inventory submissions.

The AGEIS is continuing to be expanded and refined to ensure the support of the range of National Greenhouse Accounts. Investment in 2006-07 includes development of the National Greenhouse Accounts to incorporate State inventories by Economic Sector; National and State 'Scope 2' electricity end use accounts and preliminary work on facilitating earlier production of emissions estimates.

While the AGEIS is used for final preparation of the National Greenhouse Accounts, the National Carbon Accounting System (NCAS) plays a critical role in delivering the emission and removal estimates for the Land Use, Land Use Change and Forestry sector (as illustrated below).

Figure 4.1: AGO inventory asset structures and relationships



AUSTRALIA'S NATIONAL CARBON ACCOUNTING SYSTEM

Australia has embarked on a 10 year development program for a National Carbon Accounting System (NCAS) to provide a complete accounting capability by 2008 (AGO 2005). With a current annual investment of approximately AUD \$4 million per year, the NCAS will be progressively developed to provide a complete (all carbon pools, gases, lands and land use activities) greenhouse gas accounting capability for agriculture, forestry and land use. The eventual capacity will be a full spatial enumeration with emissions and removals calculated using a process-based, mass balance, carbon and nitrogen cycling, ecosystem model.

The full spatial enumeration is achieved through an extensive remote sensing program that uses medium resolution (50m and 25m) Landsat satellite data in a time-series since 1972 (Furby 2002; Caccetta et. al., 2003). There are currently fourteen national coverages in the time-series. The medium resolution data is used to determine change in forest and sparse woody vegetation, and to determine plantation area, age and type. Land use is being mapped using a coarse 1km resolution (NOAA) satellite, with a higher temporal resolution time-series (16 day) and constrained to agricultural survey statistics.

Monthly climate maps at 1km resolution since 1968 have been derived to provide the annual variability due to climatic process drivers (Kesteven et. al., 2004). Coupled with management practices, the vegetation cover change and climate variability are together the principal causes of emissions, and source of annual variability in emissions.

The progressive development of the NCAS is set around priorities according to the scale of emissions from either the land use activity or carbon pool. For Australia, by far the largest component of emissions is the conversion of forests to cropland and grassland. In the 2004 national inventory, only the forest to cropland and forest to grassland conversions are reported using the full Tier 3, Approach 3 capability of the NCAS.

The other principal reporting elements, forests remaining forests and land converted to forest are reported using interim methods that, as yet, have not been fully spatially developed within the NCAS framework. This is also the case for harvested wood products.

As the NCAS operates under a tightly integrated singular framework, and generates the bulk of its required input data, specifications can be applied that ensure that the collection of data and analysis meet both technical and policy specifications. This has led to the development of detailed methods and protocols to ensure that all

data meets quality and consistency standards. These specifications and protocols have been published and are publicly available through the internet, library deposits and circulation on compact disk as part of the free-of-charge distribution of the National Carbon Accounting Toolbox (NCAT).

The National Carbon Accounting System (NCAS) uses Tier 3 methods (ecosystem model) of emissions estimation and an Approach 3 (full spatial enumeration) method of representing land (IPCC 2003). Unlike the Tier 1 and Tier 2 methods, Tier 3 uses complex modelling to estimate emissions in a way that fully represents both annual and spatial variability. Tier 3 methods do not use the emissions factors approaches of Tier 1 and Tier 2 inventory methods.

Tier 1 and Tier 2 methods do not represent annual variability in emissions (except in activity data) with the same emissions factor being used over time, and encompass limited spatial variability.

Tier 3 and Approach 3 methods were chosen because the causes of most emissions in Australia (forest conversion) are from rare events (a small fraction of the forest estate). A simple and generalised emissions factor approach cannot, with confidence, reliably estimate emissions from rare events in a spatially and temporally variable overall 'population'.

Tier 3 methods are more complex, and therefore require different, yet more intensive, attention to quality control, quality assurance, sensitivity and uncertainty analysis, and verification. The checking of emissions estimates can still be facilitated by transparency and peer review.

4.3 TIMELINES

The timelines for the submission of the National Inventory Report to the UNFCCC generally drive the data collection, estimation and report preparation processes. The Submission timelines for the National Inventory Report include a nominated date for submissions (15 April of the year following the inventory year plus one), with a six week grace period (27 May) - after which time submitted inventories may not be reviewed by the UNFCCC processes. Earlier production of emission estimates is possible, although at a cost of greater uncertainty and increased likelihood of subsequent revision to initial estimates. The AGO is evaluating the benefits of a move in the direction of earlier production of greenhouse accounts.

5. INVENTORY PLANNING

Key steps in the annual inventory preparation process (with indicative dates in parentheses) are determined by the needs of the system and output and quality objectives. The timing is determined by the UNFCCC Submissions timelines and data availability. Steps 1-18 provide an overview of the general inventory cycle. The cycle commences with the preparation of an evaluation of outcomes from the previous year, and the development of Inventory Improvement and QA-QC plans; and the preparation of the AGEIS for the compilation of the forthcoming inventory. The cycle is completed by external independent review provided by the UNFCCC Expert Review Teams. This section sets out those aspects of Australia's National System which address the elements of Decision 19/CMP.1 Annex paragraph 12(c).

1. Preparation of *Evaluation of Outcomes* document for the previous year.
2. Preparation of *QA-QC* and *Inventory Improvement* plans, taking into account AGO review of methodologies, activity data and UNFCCC expert review recommendations.
3. Selection of expert consultants for preparation and review processes (May-June).
4. Development of investment and maintenance plan for the AGEIS. Compliance with procurement guidelines (June).
5. Methodology development & review. Incorporation into AGEIS (June - October)
6. Activity data collection – conducted annually by a panel of external consultants and by the Australian Greenhouse Office (AGO) (June - October). Heavily reliant on published data from Australia's premier statistical agencies and subject to quality control checks.
7. Activity data entry into the AGEIS input database - by the AGO through predefined data entry templates (August - October).
8. Activity data verification and quality control - the AGO uses the AGEIS to systematically report a range of diagnostic statistics on the activity data to facilitate identification and correction of anomalous entries to ensure time-series consistency and consistency across sectoral emissions estimates.
9. A designated analyst (known as a Supervisory user) records an assessment of the quality of the activity data in the system, where questions arise.
10. The data quality is checked and internally audited by designated AGO staff (known as the Database Manager DBM) to provide quality control. Only when the DBM is satisfied is the input data transferred to the core database where emissions estimation are undertaken.
11. Emissions estimation – the AGEIS is used to generate emission estimates for all inventory years using consistent methodologies.
12. Emissions estimates verification – the AGO analysts repeat the range of tests on emissions estimates generated by the AGEIS to ensure time-series consistency and consistency across sectoral emissions estimates and accuracy of recalculations.
13. Checking and internal audit procedures on emission estimates by designated AGO staff to provide QC (DBM and the "Emissions Analysis Team Manager").
14. Automated population of reporting (CRF) tables (February).
15. The compiled inventory is circulated to Australian Government departments and the NGGI Committee of State and Territory government representatives for comment prior to public release (February).
16. The inventory is available for public release.
17. Release of Australia's National Greenhouse Accounts and release of the AGEIS database of emission estimates and background data at www.greenhouse.gov.au/inventory (April-May).
18. UNFCCC Expert Review of the National Inventory Report and CRF Tables (August-November).

6. INVENTORY PLANNING: QUALITY CONTROL AND ASSURANCE PLANS

Australia's National Inventory Systems QA/QC processes are outlined in *Australia's National Greenhouse Accounts: QA-QC Plan 2006-07*, which aim to conform with IPCC Good Practice Guidance, and to contribute to the production of inventories that are accurate, in which uncertainties are reduced to the extent practicable, and in which the inventories are transparent, documented, consistent over time, complete and internationally comparable.

The IPCC defines quality control as being a system of routine technical activities to measure and control the quality of the inventory as it is being developed. A basic QC system should provide routine and consistent checks to ensure data integrity, correctness, and completeness, identify and address errors and omissions, and document and archive inventory material and record all QC activities.

Quality assurance comprises a planned system of review procedures conducted by personnel not directly involved in the inventory compilation and development process.

This section outlines the major elements of the Australian Greenhouse Office's QA/QC plan for the national greenhouse gas inventory and representative details of the plan's implementation. It addresses the elements of Decision 19/CMP.1 Annex paragraphs 12(d), 13, 14(g), 15(a), 15(b), 15(c) and 15(d).

6.1 QUALITY CONTROL SYSTEMS

The key elements of the AGO quality control structures include:

- > establishment of explicitly-defined quality **objectives** for the National Greenhouse Accounts;
- > **automated and systematised** quality control processes built within the AGEIS for all data handling and emission estimation procedures, principally aimed at ensuring time series consistency and accuracy;
- > **prioritisation** of quality control processes built within the AGEIS to ensure effort is principally directed toward key categories;

- > **separation** of data handling and data approval roles within the AGO to improve accountability;
- > **auditability** of QC controls to improve accountability;
- > additional reconciliation checks for emissions data with reference to Australia's **national greenhouse accounts structure** - national emission estimates are reconciled with the aggregation of State and territory emission estimates; and IPCC emission estimates are reconciled with economic sector classification estimates;
- > additional reconciliation checks for emissions data to ensure **completeness** of activity data for fossil fuels and carbonates.

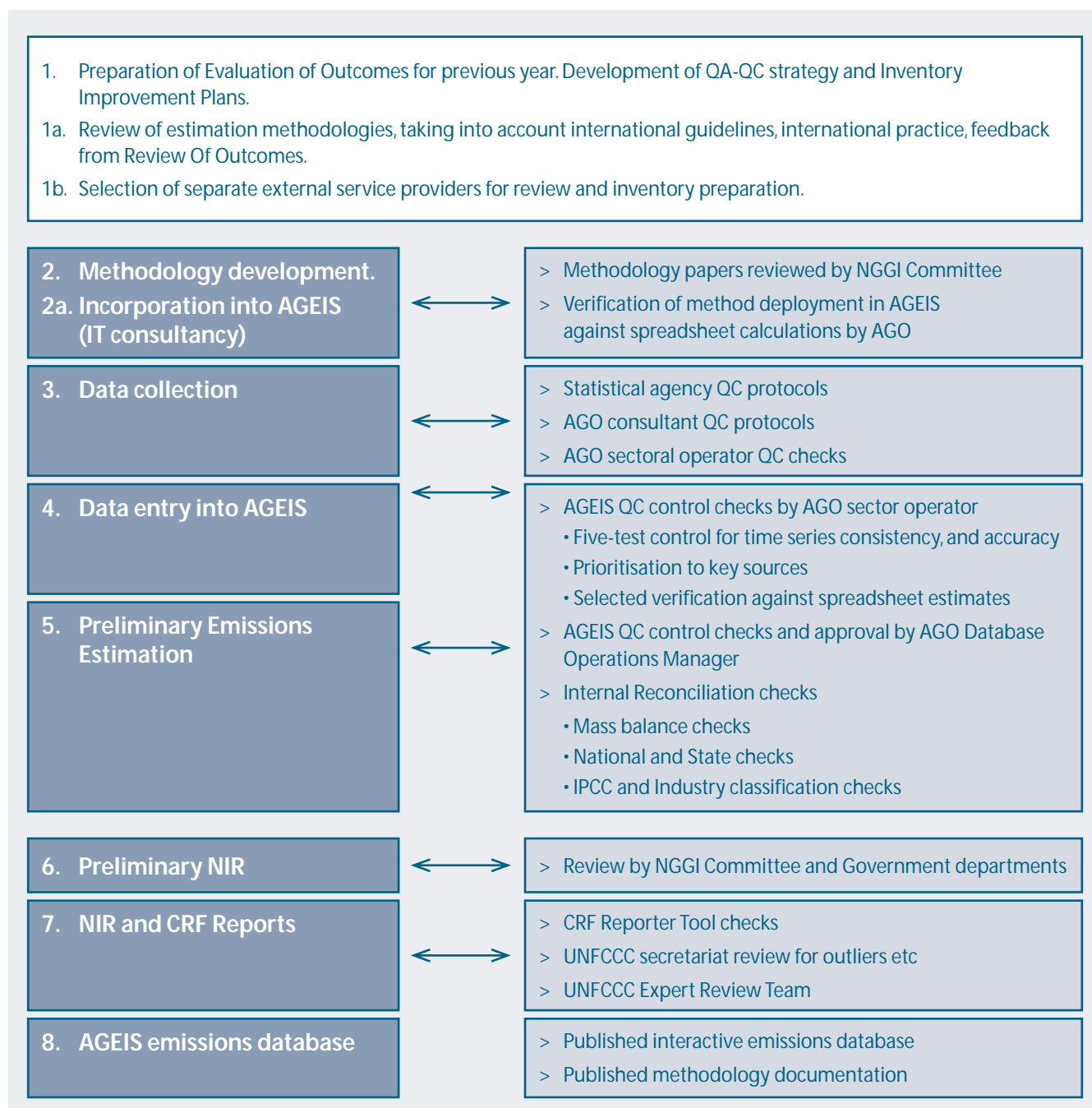
The ultimate objectives of the QA/QC activities are to ensure that the national inventory is of high-quality, transparent and amenable to review. To this end, the AGO has established quality objectives for the national greenhouse account emission estimates and for the National Inventory Report itself. The quality indicators comprise a mix of self-assessment (ie by the AGO itself) and external assessment (in particular, by external consultants, the National Greenhouse Gas Inventory Committee, and the UNFCCC Expert Review Teams).

The Australian Greenhouse Emissions Information System plays a key role in facilitating the quality control of the national inventory. Key Tier 1 QC procedures for the inventory compilation process have been systematically built into the operation of the AGEIS. Standardised and auditable checks are undertaken *inter alia* to reduce the risks of errors associated with the input of activity data, missing data, the implementation of estimation methodologies, recalculations and the time series consistency of generated emission estimates.

Systematic Tier 1 checks go beyond the operation of the AGEIS, and comprise systems for:

- > the review of emission estimation methodologies;
- > the pre-processing of input data;
- > the validation of AGEIS estimation processes;
- > and internal reconciliation checks.

Figure 6.1: Overview of the principal annual QA/QC processes utilised for each step in the preparation of National Inventory data



Tier 2 QC checks are sector-specific QC exercises and comprise emission factor and activity data review.

Australia extensively uses country-specific emission factors. The use of IPCC default emission factors for emissions estimation in some IPCC sectors is not common and is reviewed whenever new country-specific data become available. In 2006, following a review of liquid fuels used within Australia and the collection of new data, country-specific emission factors were deployed for the combustion of most liquid fuels to replace the previous default factors.

National level energy activity data are produced by the Australian Bureau of Agricultural and Resource Economics on the basis of its annual Fuel and Electricity Survey. Quality control of the activity data is managed by the source agencies. In addition, the ABARE data was reviewed and 'benchmarked' by the ABS in its role of national statistics co-ordinator in 2004 (*ABS 4648.0.55.001 Detailed Energy Statistics Australia*). With respect to electricity, explicit reconciliations of energy data are undertaken comparing data collected through AGO Programs and supplemented by survey and the estimates produced by ABARE, the Energy Supply Association of Australia and the National Electricity Market (NEMMCO) (which are all undertaken for slightly differing reasons and with slight differences in coverage).

The Australian Bureau of Statistics (ABS) publishes assessments of data quality and quantitative estimates of sampling errors for transport and agricultural activity data. Transport activity data are also produced by Apelbaum consulting and published in *The Australian Transport Facts*, which provides quality control for ABS transport data.

Tier 2 QC checks on domestic wastewater emissions are also performed and reported in the National Inventory Report. For the National Carbon Accounting System, see Box.

6.2 QUALITY ASSURANCE SYSTEMS

Australia's quality assurance systems utilises a mix of approaches which, when taken together, provide a powerful incentive structure for maintaining and enhancing the overall quality of the inventory. These quality assurance actions are undertaken by individuals not involved in the preparation of the inventory.

- 1) The national greenhouse inventory is reviewed each year by the National Greenhouse Gas Inventory Committee and by Australian Government departments prior to its release.
- 2) *Specific reviews of sectoral methodologies are regularly performed by expert consultants that are not involved in the inventory preparation process.* For example, in 2003-04, the livestock methodologies were reviewed by a committee of experts established for the purpose. Since then, smaller, more targeted reviews have been implemented. In 2005-06, external consultants have reviewed the use of emission factors for liquid fuels and in 2006-07, reviews have been completed by external consultants for the methodologies in the iron and steel, petroleum refining, industrial wastewater and waste incineration methodologies.
- 3) A wide range of QA processes have been employed for the National Carbon Accounting System (see Box);
- 4) *Uncertainty* estimates were reviewed in 2005 by the Commonwealth Science and Industry Organisation (CSIRO) Atmospheric Research Division according to strict review protocols.
- 5) The *transparency* of inventory emission estimates and methods published by the AGO ensures that the inventory is open to public review each year.
- 6) *UNFCCC expert review team processes* provide a level of scrutiny that provides valuable input into the overall quality of the inventory. Australia has sought to have the inventory reviewed by in-country international expert teams where possible - in 2002 and 2005 - while there have been centralised reviews in other years.

Australia is committed to ensuring that the inventory data and methods are transparently reported as a means to ensuring that strong incentive structures are in place to maintain inventory quality. The emissions data for the Australian inventory is openly and transparently reported and made accessible on the AGEIS webpage. All emissions data reported to the UNFCCC, and also component emission estimates are accessible through an interactive search facility. Data are downloadable by the public through an email export function from the AGEIS. Industry and public feedback is encouraged through an email facility to the Inventory contact point ageis@greenhouse.gov.au.

NATIONAL CARBON ACCOUNTING SYSTEM: OVERVIEW OF QUALITY ASSURANCE AND QUALITY CONTROL

The verification processes of the NCAS focus on the detailed checking of land areas and modelled emissions estimates. That is, the testing of the NCAS results is typically against actual measures that have a 'certain' outcome.

Extensive application of this approach provides benefits that cannot be derived from other approaches such as model inter-comparison. The benefits of verification by direct measurement are, first, the detailed data derived can be used to determine the model and land area estimation performances in general (e.g., by region, soil type, vegetation type) and in detail, for example, by carbon pool (e.g., litter, fast turnover soil organic matter). Second, having actual measures allows for continuous improvement whereby the verification data can subsequently be used to enhance calibration, which is then tested again in subsequent verification. This ensures a growing base of data for model calibration while also ensuring that calibration and verification data remain independent. A snapshot of each of the NCAS verification program areas is described below.

Land Cover Change and Plantation Classification

Extensive independent verification programs of the land cover change and plantation mapping via remote sensing techniques have been continuously applied throughout the time-series updates. The methods applied to verification of the land cover change results are published in the NCAS Technical Reports (Lowell et. al., 2003 and Jones et. al., 2004) and in peer review literature (Lowell et. al., 2005). This program initially relied on verification against historic air photographs, and more recently, by using very high resolution satellite data (1m). The verification of the plantations mapping (MBAC Consulting in prep.) was based on on-site field inspection. This alternative approach was used because it was able to provide a definite date of planting (from signage or company records) and could accurately provide parameters such as species, stocking rate, condition etc. that could not be derived with certainty from remote techniques. This program was based on several hundred sites throughout Australia, selected to be representative of geographic regions, plantation types and plantation ages.

Forest Growth

The direct measurement of forest biomass is rare, and as destructive sampling is required, no time-series growth data based on whole mass measurement is available.

However, through the use of allometric equations from measurable forest stand parameters of basal area, height etc. it is possible to model total stand biomass. As these measures are widely used in forest inventory, there is a wealth of industry data available as both single point in time and time-series (permanent plot) measurements against which growth and biomass estimates have been verified. In addition, research site data comparisons and select whole-stand mass measurements have been applied. The benefits of comparisons with research data has been that additional to commonly available stand biomass estimates are data on site conditions and management. Because of the cost and logistical difficulty in actually measuring total stand biomass, the approach taken was to destructively sample and weigh forest plots of a single species across a productivity gradient (Ximenes et. al., 2005). This approach could then test both the biomass predictions and replication of the gradient in forest productivity and carrying capacity by model estimates.

Soil Carbon

Much like the verification activities for forest biomass, a tiered approach was applied to the verification of modelled soil carbon change estimates. Most geographically widespread and representative data were taken from paired site samples, before and after land use change. The change in total soil organic carbon was compared to modelled estimates. Soil fractionations were also completed to test the model performance in predicting turnover in various soil carbon pools. Wherever possible, models were also compared to research site data (Skjemstad and Spouncer 2002). This again had the benefit of multiple pool, time-series measurements for comparison, along with the recorded impacts of detailed site condition and management.

TRANSPARENCY AND PEER REVIEW

As with the methods for uncertainty and sensitivity analysis, the approach to transparency and peer review will differ for a Tier 3 (spatially explicit) approach from those used in a Tier 1 or Tier 2 (area by emissions factor) approach. For Tier 1 and Tier 2 the focus is on the determination of area estimates and the selection of appropriate emissions factors. For the complex methods, models and large datasets used in Tier 3 systems, different approaches to transparency and peer review are required.

continued page 18

The basis of transparency and peer review for the NCAS are founded on:

- published specifications, protocols and methods;
- published verification results;
- public release of models, tools and data; and,
- publication in peer reviewed literature.

APPENDIX 6.A.1 INVENTORY PREPARATION: UNCERTAINTY

Uncertainty is inherent within any kind of estimation. While it is in some cases possible to continuously monitor emissions, it is not usually practical or economic to do so. This leads to estimations based on samples or studies being used which carry a degree of additional uncertainty attached to them. Uncertainty also arises from the limitations of the measuring instruments, and over the complexities of the modelling of key relationships between observed variables and emissions.

The purpose of estimating the uncertainty attached to emissions estimates is principally to provide information on where inventory resources should be allocated to maximise the future improvements to inventory quality.

Australia has conducted an uncertainty analysis for the individual sectors in line with the IPCC *Good Practice* guidelines. Monte Carlo and Latin Hypercube approaches were used to estimate emission uncertainty in some sectors, which is equivalent to the IPCC Tier 2 methodology.

The estimates have been mainly prepared by the judgement of the sectoral expert consultants. These estimates of uncertainty were reviewed in 2005 by independent experts under protocols developed by the Australian CSIRO Atmospheric Research Division. The CSIRO report confirmed, with one or two exceptions, the quantitative judgements made in relation to uncertainty of inventory estimates and provide a strong basis for confidence in the assessments reported in this chapter.

In general, the estimated uncertainties for individual sectors tend to be low for carbon dioxide from energy consumption as well as from some industrial process emissions. Uncertainty surrounding estimates from these sources are typically as low as ± 4 –5%. Uncertainty surrounding estimates of emissions are higher for agriculture, land use change and forestry, reflecting inherently high uncertainty due to the very nature of the processes involved (e.g. biological processes). A medium

band of uncertainty applies to estimates from fugitive emissions, most industrial processes and non-CO₂ gases in the energy sector. The ranges presented are broadly consistent with the typical uncertainty ranges expected for each sector, as identified in the IPCC *Good Practice Report*.

The estimates of uncertainty surrounding the emissions estimates for individual sectors may be combined to present an estimate of the overall uncertainty for the inventory as a whole. Following the recommendations of the IPCC Good Practice Guidance, the emission estimates across the energy sector have been aggregated because of the hidden dependencies that exist between sectoral activity levels as a result of the constraint of overall consumption and since aggregate fuel consumption is more accurately known than the consumption in individual sectors. The results of the application of the IPCC Tier 1 approach to estimating the uncertainty of the inventory as a whole, which identifies separately estimates of uncertainty for both activity and emission factors where available, and which does not account for correlations between variables (unlike some of the sectoral analyses), are presented in the National Inventory Report - 2004 Revised.

As indicated in the IPCC *Good Practice Guidance* the Tier 1 approach is valid as long as a number of restrictive assumptions are met. An alternative, more flexible approach, which relies on Monte Carlo analysis and a more detailed specification of the sources of uncertainty, is currently under consideration for development by the Australian Greenhouse Office for use in future national inventory reports. This analysis would be equivalent to the IPCC Tier 2 approach and would take into consideration a number of refinements proposed by the CSIRO independent review.

The *National Inventory Report* results show the estimated uncertainty surrounding the aggregate inventory estimate for 2004 to be ± 4 %. The reported estimated uncertainty for the trend in emissions is ± 2 %. This estimate has been calculated on the assumption that the total uncertainty for parts of agriculture, land use, land use change and forestry, and the waste sectors are uncorrelated through time. The overall estimate of uncertainty in the trend is sensitive to this assumption. If the alternative assumption was applied, that of full correlation in the total uncertainty of these sectors over time, the uncertainty in the trend estimate is estimated at ± 6 %. Further analysis will be conducted into this issue for future inventories.

7. INVENTORY PREPARATION: CONSISTENCY WITH GOOD PRACTICE

This section addresses the requirements of Decision 19/CMP.1 Annex paragraphs 14(a) and 14(b) which requires the identification of key categories, and the use of appropriate methods for the estimation of emissions from key source categories.

The identification of key categories is necessary to ensure prioritisation of research efforts and the use of appropriate methods - generally more complex, higher tier methods which in principle will provide more accurate emission estimates. The full analysis of the key categories is available in the *National Inventory Report - 2004 Revised*. Australia's most important key categories include public electricity (solid fuel); forest conversion to grasslands; enteric fermentation (sheep) and road transportation (passenger cars). A summary of the results presented in the *National Inventory Report - 2004 Revised* is included at appendix 7.A.1.

In general, Australia uses tier 2 methods for the estimation of emissions. The methods selected are appropriate and consistent with IPCC Guidelines and, where possible, make use of capital stock models; disaggregated, dynamic models and country-specific parameters where available. In important sectors in the Australian inventory, like forest conversion, Australia deploys Tier 3 models to provide the best possible emissions estimates.

The full description of the methods used by Australia in the estimation of emissions is provided in the series *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005* and in the *National Inventory Report - 2004 Revised*.

APPENDIX 7.A.1: KEY SOURCE CATEGORIES

Table 7.1: Key source categories for Australia's inventory—summary

A IPCC Source Categories		B Direct Greenhouse Gas	C Key Source Category Flag	D If Column C is Yes, Criteria for Identification
1.A.1.a	Public Electricity and Heat Production - Gaseous Fuels	CO ₂		Level, Trend
1.A.1.a	Public Electricity and Heat Production - Liquid Fuels	CO ₂		Level, Trend
1.A.1.a	Public Electricity and Heat Production - Solid Fuels	CO ₂		Level, Trend
1.A.1.b	Petroleum Refining - Liquid Fuels	CO ₂		Level, Trend
1.A.1.c	Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO ₂		Level, Trend
1.A.1.c	Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO ₂		Level, Trend
1.A.1.c	Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CO ₂		Level, Trend
1.A.2.a	Iron and Steel - Solid Fuels	CO ₂		Level, Trend
1.A.2.a	Iron and Steel - Gaseous Fuels	CO ₂		Level, Trend
1.A.2.b	Non-Ferrous Metals - Gaseous Fuels	CO ₂		Level, Trend
1.A.2.b	Non-Ferrous Metals - Liquid Fuels	CO ₂		Level, Trend
1.A.2.b	Non-Ferrous Metals - Solid Fuels	CO ₂		Level
1.A.2.c	Chemicals - Gaseous Fuels	CO ₂		Level, Trend
1.A.2.c	Chemicals - Liquid Fuels	CO ₂		Level, Trend
1.A.2.c	Chemicals - Solid Fuels	CO ₂		Trend
1.A.2.d	Pulp and Paper - Gaseous Fuels	CO ₂		Trend
1.A.2.e	Food Processing, Beverages and Tobacco - Gaseous Fuels	CO ₂		Level
1.A.2.f	Other - Gaseous Fuels	CO ₂		Level, Trend
1.A.2.f	Other - Liquid Fuels	CO ₂		Level, Trend
1.A.2.f	Other - Solid Fuels	CO ₂		Level

continued page 20

Table 7.1: Key source categories for Australia's inventory—summary (continued)

A IPCC Source Categories		B Direct Greenhouse Gas	C Key Source Category Flag	D If Column C is Yes, Criteria for Identification
1.A.3.a	Civil Aviation - Liquid Fuels	CO ₂		Level, Trend
1.A.3.b	Road Transportation - Liquid Fuels	CO ₂		Level, Trend
1.A.3.b	Road Transportation - Liquid Fuels	N ₂ O		Level, Trend
1.A.3.c	Railways	CO ₂		Level
1.A.3.d.ii	Navigation (domestic)	CO ₂		Trend
1.A.4	Other Sectors - Biomass	CH ₄		Level, Trend
1.A.4	Other Sectors - Gaseous Fuels	CO ₂		Level, Trend
1.A.4	Other Sectors - Liquid Fuels	CO ₂		Level, Trend
1.B.1.a.i.	Fugitive Emissions - Underground Coal Mines	CH ₄		Level, Trend
1.B.1.a.ii.	Fugitive Emissions - Surface Coal Mining	CH ₄		Level, Trend
1.B.1.c.	Fugitive Emissions - Other	CH ₄		Level, Trend
1.B.2.b.	Oil and Natural Gas - Natural Gas	CH ₄		Level, Trend
1.B.2.c.	Oil and Natural Gas - Flaring	CO ₂		Level, Trend
1.B.2.c.	Oil and Natural Gas - Venting	CO ₂		Level, Trend
1.B.2.c.	Oil and Natural Gas - Venting	CH ₄		Level, Trend
2.A.1	Cement	CO ₂		Level
2.C.1	Iron and Steel Production	CO ₂		Level, Trend
2.C.1	Iron	CO ₂		Level, Trend
2.C.3	Aluminium Production	CO ₂		Level, Trend
2.C.3	Aluminium Production	CF ₄		Level, Trend
2.F.1	Refrigeration and Air Conditioning Equipment	HFCs		Level, Trend
2.G.	Other: Confidential emissions reported as CO ₂ e	CO ₂		Level, Trend
4.A.1	Enteric Fermentation - Cattle	CH ₄		Level, Trend
4.A.3	Enteric Fermentation - Sheep	CH ₄		Level, Trend
4.B	Manure Management	CH ₄		Level, Trend
4.D	Agricultural Soils	N ₂ O		Level, Trend
4.E	Prescribed Burning of Savannas	CH ₄		Level, Trend
4.E	Prescribed Burning of Savannas	N ₂ O		Level, Trend
5.A	Forest Land converted to Cropland	CO ₂		Level, Trend
5.B	Forest Land - Remaining Forest Land	CO ₂		Level, Trend
5.B	Forest Land - Remaining Forest Land	CH ₄		Level, Trend
5.C	Forest Land converted to Grassland	CO ₂		Level, Trend
5.C	Forest Land converted to Grassland	CH ₄		Level, Trend
5.D	Other	CO ₂		Level, Trend
6.A	Solid Waste Disposal on Land	CH ₄		Level, Trend
6.B	Waste-water Handling	CH ₄		Trend

8. INVENTORY PREPARATION: INVENTORY IMPROVEMENT

Greenhouse gas emissions are generated from a large number of processes and from a range of often diffuse sources. Emissions are not usually monitored directly but are generally estimated through the application of models and methodologies that link emissions to data on observable activities.

Expert Working Groups were formed to develop the Australian emission estimation methodologies in the early 1990s. The resulting Australian methodology for estimating greenhouse gas emissions and sinks uses a combination of country-specific and IPCC methodologies and emission factors. Australia predominantly uses Tier 2 approaches to estimate emissions. These methods are consistent with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 1997) and *IPCC Good Practice Guidance* (IPCC 2000 and IPCC 2003) and are comparable with international practice.

This section addresses Decision 19/CMP.1 Annex paragraph 13 which states that, as part of inventory planning, ways should be considered to improve the quality of activity data, emissions factors, methods and other relevant technical elements of inventories.

8.1 INVENTORY IMPROVEMENT PLAN

In line with the international guidelines for the preparation of the national greenhouse gas inventory, the methodologies used to estimate greenhouse emissions have been refined as new information emerges. The need for refinement arises from the range and complexity of greenhouse gas emission processes, the need to improve understanding of some of the relationships between activities and emissions through empirical research (especially in processes outside fossil fuel combustion) and the need to enhance data collection procedures. The scope of planned future refinements are set out in the *Inventory Improvement Plan* and will be informed by the ongoing technical review of sectoral methodologies and data sources undertaken by the Australian Greenhouse Office as part of Australia's efforts to comply with inventory good practice.

Priorities for the inventory development process are informed by:

- > the need to reduce uncertainty of the national emission estimates - a formal UNFCCC reporting requirement includes the estimation of the level of uncertainty of the national inventory as a whole. The Inventory Improvement Plan is aimed at reducing these uncertainties as much as possible, with development focused on key categories (see Appendix 7.A.1), sources with high uncertainties (see the National Inventory Report) and where implementation of new methods is feasible (eg new data has become available),
- > responses to international reviews,
- > changing international practice and changing IPCC methodologies – changing international practices and new guidelines that have been developed under the 2006 IPCC review of National Inventory Guidelines may provide opportunities to refine Australia's methodologies; and
- > the need to continue to review completeness of the inventory and to identify and estimate minor additional sources. This part of the Inventory Improvement programme has steadily enhanced the overall completeness of the inventory. The impacts of these new sources are minor (less than 1% of the total inventory) and have had negligible impact on overall emission trends or on overall uncertainty of the inventory.

All improvements to methods or data require recalculations of emissions estimates for the entire time series, from 1990 onwards, to ensure time-series consistency of emission estimates. These recalculations are conducted in accordance with IPCC Guidelines and are reported in Australia's National Inventory Reports.

Short-term tasks have been identified in some but not all IPCC sectors in response in part to previous UNFCCC reviews and ongoing efforts to enhance overall completeness. Longer-term tasks that have been identified

are focused in the Agriculture, Forestry and Land Use Change sectors where payoffs from reduced uncertainty for the overall inventory are expected to be highest.

Significant methodological development has been undertaken in the last two years under the current funding of the Inventory aspect of the Emissions Measurement and Analysis programme and has had the following broad aims:

- > Increased use of capital stock models over simple activity data models;
 - for example in the electricity, stationary energy, road transport, air transport and HFC consumption IPCC sectors;
- > Increased emphasis on spatial disaggregation of models, in particular state-based models;
 - for example, in the transport, agriculture and waste sectors;
- > Increased use of country-specific parameters;
 - for example for solid, gaseous and liquid fossil fuels; cement; aluminium and agriculture sectors.
- > Increased use of dynamic models - where current emissions depend on past activity data;
 - for example, for the road transport and waste sectors;
- > Enhanced internal consistency;
 - in the cross sectoral treatment of wood products; steel and petroleum refining;
- > Increased use of completeness reconciliation checks for carbon supply and use in fossil fuels; for carbonates; and for harvested wood products.

Together, these developments have ensured a significant enhancement in the level of dynamic complexity of the estimation methodologies across the National Greenhouse Accounts with the aim of enhancing the level of user confidence in the emission estimates.

LONG TERM PLANNED DEVELOPMENT OF THE NATIONAL CARBON ACCOUNTING SYSTEM

The National Carbon Accounting System is systematically addressing key sectors in the Land Use Change & Forestry and Agriculture sectors. The work plan for the NCAS is detailed in National Carbon Accounting System, Development Plan 2004-8, Australian Greenhouse Office, January 2005.

- 1) Provide updates of Land Use Change Emissions (Article 3.3/Land Use Change) to end 2003 and for a further 2 periods prior to 2008:
 - introduce strategic improvements to method (e.g., terrain correction)
 - provide basis for calculating 'last step underestimate' arising from non-confirmation of tree removal as a definite land use change in the last time iteration (interval) of the change analysis)
 - update climate surfaces
- 2) Provide spatially based reforestation account (Article 3.3/Changes in Woody Biomass) (on the same cycles as Land Use Change):
 - develop methods and implement a remotely sensed identification of commercial and environmental plantations and their type
 - develop and verify growth models for areas of reforestation
 - develop relevant FullCAM relational database tables to support full C-cycle accounting
 - carry out further studies on soil carbon change in a variety of reforestation activities
 - revise annual projections estimates and current accounting for reforestation activity
- 3) Develop a non-CO₂ (N-cycle) capability for both forest and agricultural systems (Article 3.4/Agricultural Soils):
 - continuous model development and site calibrations
 - move model to a daily time-step for continental application
 - develop methods to estimate soil temperature
- refine/review water balance models
- derive 'daily' rainfall, temperature, evaporation etc. as distribution patterns from monthly grids (by climate region)
- move crop growth from a yield based survey to a process driven base
- collect, by survey, information on rates, types and timing of fertiliser application (1990-present)
- incorporate results from incubation studies into the boundary line emissions estimation
- construct relational database tables to enable spatial simulation of non-CO₂ gases.
- further investigate the effects of conservation practices in agriculture for their effects on carbon and nitrogen cycling and subsequent emissions.
- 4) Provide an updated and upgraded modelling and accounting capability for Harvested Wood Products and Bioenergy (policy support/Changes in Woody Biomass)
 - develop and independently quality assure a Harvested Wood Products (HWP) model (life cycle) at a national scale using ABARE forest products data
 - incorporate the revised approaches to HWP in FullCAM to provide synergy between top-down and bottom-up accounting
 - align the current displacement (bioenergy and wood products) modelling incorporated in FullCAM (adoption of GORCAM) with the revised approach to wood products life cycle

9. INVENTORY MANAGEMENT: ARCHIVAL AND DOCUMENTATION SYSTEMS

Proper documentation is a critical component of national inventory systems. The Australian documentation systems aim to both manage and retain all data used in the estimation of emissions and to provide a means for knowledge management to ensure continuity and security of the National Inventory Systems. This section addresses the specifications of Decision 19/CMP.1 Annex paragraphs 16 and 17.

9.1 THE AUSTRALIAN GREENHOUSE EMISSIONS INFORMATION SYSTEM (AGEIS): ARCHIVAL OF EMISSIONS ESTIMATES, DATA AND METHODS

The AGEIS is at the heart of Australia's documentation systems. The AGEIS allows efficient electronic data management and archiving of the vast quantities of data needed to generate an emissions inventory. AGEIS data management functions include:

- > Archival and storage within the AGEIS database of the emissions estimates of past Submissions;
- > Archival and storage within the AGEIS of past activity data, emission factor and other parameters and models;
- > Archival and storage of data source descriptions; methodology descriptions and source reference material; and
- > Integrated access to the documentation of data sources; methodology description and source reference material.

The aims of these systems include giving Inventory staff ready access to all related materials that underpin the emissions estimates and to provide the means for replication of emission estimates from past Submissions.

9.2 DOCUMENTATION OF AUSTRALIA'S EMISSIONS ESTIMATION METHODOLOGIES

The AGEIS functions are supported by some additional important elements of the documentation system:

- > Documentation of the Inventory's emission estimation methodologies;
- > Maintenance of a National Inventory library of source material documents.

Australia's estimation methodologies are documented both in the National Inventory Report and in a comprehensive series Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks. This series covers each UNFCCC sector in detail. The 2005 Inventory will be accompanied by a revised and updated series, Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005. These titles will include:

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Energy (Stationary Sources)

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Energy (Transport)

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Energy (Fugitive Fuel Emissions)

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Industrial Processes

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Solvents

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Agriculture

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Land use, land use change and forestry

Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Waste.

10. PROGRESS TOWARDS A SYSTEM OF NATIONAL EMISSION ACCOUNTS

The AGO has embedded the national inventory within a set of national emission accounts that will provide more information for users and provide critical additional quality control for the inventory in terms of enhanced consistency, transparency and comparability.

In 2005-06 the Australian Greenhouse Office published for the first time the Australian National Greenhouse Accounts. The National Greenhouse Accounts are a set of integrated national and State greenhouse inventories prepared using the Australian Greenhouse Emissions Information System and comprising

1. *The National Greenhouse Gas Inventory;*
2. *State and Territory Greenhouse Gas Inventories;*
3. *National Inventory by Economic Sector; and,*
4. *National Inventory Report (2 volumes).*

The *National Greenhouse Gas Inventory* provides the latest estimates of Australia's greenhouse gas emissions based on the accounting rules that apply to Australia's Kyoto emissions target.

The *State and Territory Inventories* provide for the first time in 2006 a complete time-series of emissions estimates from 1990 to 2004.

The *National Inventory by Economic Sector* was a new product in 2006 and reported all emissions attributable to the key sectors of Australia's economy. Emissions are disaggregated according to the Australia and New-Zealand Standard Industrial Classification (ANZSIC) system. It complements the National Greenhouse Gas Inventory, based on IPCC classifications, which provide estimates of emissions classified according to process-based emission categories.

The *National Inventory Report* is prepared according to UNFCCC accounting provisions and is submitted as part of Australia's reporting obligations under the UNFCCC.

The latest data are viewable online through the Australian Greenhouse Emissions Information System (AGEIS) at www.greenhouse.gov.au/inventory.

The feasibility of regular production of additional accounts, consistent with the national emission accounting framework set out below, is currently being examined.

In particular, the AGO is planning to extend the National Inventory by Economic Sector to the States (a combination of (2) and (4) below), and National and State inventories of electricity end-use accounts (see (7) below) in 2006-07. Additional methodological work will be required before production of other accounts could commence.

Background

The AGO produces emissions estimates for a variety of applications – national and state, companies, industries, local government, products and physical sites. The relationships between the emission estimates of each of these quite different types of applications can be defined through the specification of a national accounting framework. This yields:

- > a basis for consistent classification of emissions data (ie the allocation of data within a complete, non-overlapping framework);
- > enhanced confidence of users in inventory data by improving the comparability and consistency of emission estimates;
- > enhanced potential for aggregation, multiple use and streamlining of data collection by government; and
- > additional information on Australia's emissions that is regularly demanded by stakeholders and public users of emissions data.

The NGGI is the cornerstone of the national greenhouse accounts. It enables Australia to meet its international reporting obligations and provides information at a sectoral level according to the classification system of the Intergovernmental Panel on Climate Change (IPCC).

The IPCC classification, however, was designed with ease of estimation and verification of national emissions in mind. It does not always reveal information that readily relates to all of entities with which policy makers commonly deal. Consequently, complementary classifications of emissions within the national inventory that better address the needs of users are needed.

The classifications for the accounting framework can be described by a set of integrated national accounting identities centred on the national emissions inventory (see Box). Examples include classification by IPCC sector, by jurisdiction, by institutional sector (eg corporate, household or government), by legal entity or by product. For the most part the classifications would be analogous to those used in national income account systems.

AN INTEGRATED FRAMEWORK OF NATIONAL EMISSION ACCOUNTS

Direct source accounts

(1) BY IPCC CLASSIFICATIONS (TYPE OF PROCESS)

$NGGI = \text{Energy} + \text{Fugitives} + \text{Industrial processes} + \text{Agriculture} + \text{LULUCF} + \text{Wastes}$

(2) BY JURISDICTION

$NGGI = \Sigma \text{State inventories} + \Sigma \text{local government area inventories}$

(3) BY TYPE OF ECONOMIC TRANSACTOR (INSTITUTIONAL SECTOR IN NATIONAL INCOME ACCOUNTS)

$NGGI = \Sigma \text{Corporations} + \Sigma \text{Households} + \Sigma \text{General Government}$

(4) BY ECONOMIC SECTOR

$NGGI = \Sigma \text{Industry sectors (ANZSIC codes)} + \Sigma \text{Households} + \Sigma \text{General Government}$

(5) BY PRODUCT OR GROUP OF PRODUCTS (PRODUCTION BASIS)

$NGGI = \Sigma z_j * Z_j$

where Z_j is the value of a good or group of goods produced and z_j is an emissions input-output multiplier

(6) BY PRODUCT OR GROUP OF PRODUCTS (CONSUMPTION BASIS)

Emissions embodied in consumption $C = NGGI - X + M$
 $= z_j (Z_j - X_j + M_j)$

where Z_j is the value of a group of goods j produced, X_j is the value of goods j that are exported and M_j is the value of goods j that are imported and z_j is an emission input-output multiplier.

(7) INDIRECT ACCOUNTS

$NGGI \text{ Electricity Sector} = \Sigma \text{Indirect emissions defined by the WRI/WBCSD 'Scope 2'}$

The Rubik's Cube (invented 1974): a three dimensional object; one, self-contained whole throughout its manifold transformations.

The major classifications can be grouped according to source of emissions or by indirect emissions.

A.1 CLASSIFICATION SYSTEMS

(1) IPCC classifications

The National Greenhouse Gas Inventory is compiled according to IPCC guidelines. The reporting structures provide for disaggregated emission reporting according to type of emission process and by sector, as defined by the IPCC. These divisions are designed to facilitate estimation of emissions.

Emissions reported at a sectoral level under IPCC classifications do not correspond to the full emissions that might be monitored by the kinds of entities (ie level of government, business or industry) or the boundaries governing a particular project that many government programs are designed to address.

For example, emissions for the IPCC's agriculture sector include only non-CO₂ emissions from certain kinds of agricultural activity (such as enteric fermentation from livestock). The IPCC classification does not include emissions from the combustion of fossil fuels by establishments in the agriculture sector, as these are included under the Energy sector. Similarly, emissions from the cement industry are spread across two sectors – energy (fuel combustion) and industrial process emissions.

(2) National accounts, classified by jurisdiction

The national inventory may be divided into estimates of emissions from sub-jurisdictions. The national inventory should equal the sum of State and Territory accounts. In principle, the accounts for Local Government Areas could also be summed to equal the national inventory. As for the national inventory, estimates are of emissions generated at the source of the production activity within a jurisdiction's border.

(3) National accounts, classified by type of economic transactor (institutional sector in national income account systems)

The national inventory emissions may be disaggregated by emissions generated by type of organisational economic

unit. Following the national income account classifications, organisations in the economy may be grouped into three institutional sectors:–

- > corporations,
- > households; and
- > general government.

These descriptors can be applied in broad terms. The inventory for a corporation would include all direct emissions generated by activities within the boundaries of the organisation. In principle, the national inventory would equal the sum of the inventories of corporations, households and general government.

(4) National accounts, classified by economic sector

The level of emissions from corporations may be allocated by sector and industry (say, by Australia and New Zealand Standard Industry Classification (ANZSIC) code). In this structure, for example, emissions from agriculture include all emissions sourced from the activities of agricultural establishments including from the combustion of fossil fuels, enteric fermentation and deforestation etc. Consequently, these sectoral estimates provide a better indication of total emissions generated by type of economic activity than do the IPCC sectoral classifications.

(5) National accounts, classified by product or group of products

In principle, the emissions generated by the production of a final good or service can be summed at every point along the production chain so that national emissions may be allocated by the full range of final products and services or groups of final products and services (equivalent to cradle-to-gate in life cycle analysis terminology). These estimates may be estimated using emission input-output multipliers. This analysis can be extended to take account of consumption and disposal characteristics of a product to produce full life-cycle analysis (although with additional complications from an accounting perspective).

Emissions embodied in consumption of a good or group of goods

(6) *National account of emissions associated with consumption*

An alternative approach to measuring the impact of a country's economic activities on emissions is to estimate an account of the emissions generated globally as a direct consequence of Australia's national *consumption* of goods and services. In contrast, the NGGI is, broadly, an estimate of emissions generated within Australia's geographic boundaries by Australia's *production* of goods and services (with one or two exceptions, such as emissions from direct household consumption).

Under this kind of approach, the estimation of emissions is not restricted to those occurring within Australia's territorial boundaries, but includes emissions generated overseas in the production of goods and services imported into Australia. Similarly, emissions generated in the production of goods for export would be excluded from such an inventory.

As an identity, emissions associated with the national consumption of goods and services equals the NGGI minus emissions generated in Australia in the production of goods and services for export plus emissions generated overseas in the production of goods and services for import.

The analysis required for this inventory is closely related to the analysis required under identity (5) as, broadly speaking, the set of goods and services produced in (5) is replaced by the set of goods and services consumed.

(7) *Indirect emissions*

The estimation of indirect emissions from electricity consumption or from activities such as waste disposal are commonly made estimates across government programmes.

In the case of electricity, such estimates provide an account for emissions associated with demand for electricity where each indirect emission has a counterpart in a direct emission within an electricity generator's or distributor's account. In principle, a national account of indirect emissions can be constructed which is equal to an account of direct emissions associated with the production of that electricity. The AGO will shortly release an account based on the definitions contained in the WRI/WBCSD Greenhouse Reporting Protocol for 'Scope 2' indirect emissions.

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