

Green Institute Working Paper 4

Australia's national greenhouse accounts re-arranged for policy coherence

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The aim of this paper is to present Australia's greenhouse gas accounts in a way that facilitates policy debate. The most recent set of accounts for Australia is for calendar year 2006, released in June 2008. These accounts are used in this paper (see [Hwww.greenhouse.gov.au](http://www.greenhouse.gov.au)H - emissions monitoring).

Reviewers for the United Nations Framework Convention on Climate Change regularly assess Australia's greenhouse gas accounts. Their most recent report, released in January 2009, and the previous one (2007) point to the need to upgrade the comprehensiveness and transparency of the Land Use, Land-Use Change and Forestry accounts ([Hhttp://unfccc.int/resource/docs/2009/arr/aus.pdf](http://unfccc.int/resource/docs/2009/arr/aus.pdf)H). The changes they recommend would greatly improve the quality of Australia's reporting.

This is a working document; comments are appreciated.

The standard accounts

Australia's greenhouse gas accounts report annual changes in greenhouse gas emissions and uptake (sequestration), in the same way as cash flow accounts are prepared for a business. (There is as yet no formal accounting for carbon stocks – the amounts stored in fossil fuel deposits, the landscape (soil and vegetation), or the ocean.) The accounts are prepared in accordance with the regularly upgraded international rules set by the Intergovernmental Panel on Climate Change (IPCC) and form the basis for Australia's formal reports to the UNFCCC.

Australia prepares two sets of accounts – the more comprehensive 'UNFCCC' accounts and the 'Kyoto' accounts against which Australia's Kyoto target is measured. The difference between the two is in the Land Use, Land-Use Change and Forestry (LULUCF) sector. Under Kyoto accounting, only the impacts of land-use changes since 1990 are measured: that is, emissions caused by clearing (deforestation) and uptake following replanting (reforestation). 'Forests remaining forests' are not counted, which means emissions from native forest logging and uptake by regrowing forests are absent.

Presented in the standard fashion, Australia's 2006 greenhouse accounts look like this:

Sector	UNFCCC Mt CO ₂ -e	Kyoto Mt CO ₂ -e
1 All energy (combustion + fugitive)	400.9	400.9
<i>Stationary energy</i>	287.4	287.4
<i>Transport</i>	79.1	79.1
<i>Fugitive emissions from fuel</i>	34.5	34.5
2 Industrial Processes	28.4	28.4
3 Solvent and other product use		
4 Agriculture	90.1	90.1
5 Land use, land-use change and forestry	13.8	39.9
6 Waste	16.6	16.6
Net emissions	549.8	575.9

This format is a poor basis for policy development or debate. Emissions are netted off against uptake, there are major data gaps, and the reliability of the data is widely divergent. This may cause the relative importance of different emission sources to be misunderstood and result in flawed policy analysis.

The accounts re-arranged

Australia's greenhouse accounts are presented in Tables 1–3, re-arranged to make them easier to understand, more transparent in relation to non-fossil fuel emissions, and policy-relevant.

The main differences from the standard format are:

1. Fossil carbon (from coal, oil and gas) is reported separately from biocarbon (carbon associated with living systems). This emphasizes the fact that, generally, fossil carbon gives rise only to emissions while biocarbon is part of living ecosystems which both emit and sequester greenhouse gases.¹
2. Biocarbon is separated into 'green carbon', associated with natural ecosystems, and 'production carbon', primarily in agricultural systems (including tree plantations). Waste and wood products are included in the production carbon account. Green carbon is essentially permanently stored because natural ecosystems are self-regenerating and resilient. Production carbon is a by-product of management for some other purpose (mainly food and fibre production).
3. Where possible, biocarbon emissions and uptake (sequestration) are reported separately, instead of being combined and reported as net figures as they are in the standard accounts.
4. Major data gaps are highlighted in the tables (n.r. = not reported, n.o. = not occurring).²

Tables 1–3 present Australia's 2006 UNFCCC and Kyoto accounts using this framework. All figures are derived from Australia's 2006 greenhouse gas accounts.³ The notes explain and comment on each component.

Table Notes

1. The primary accounting sectors in the tables are the standard ones used by the IPCC and Australia's official greenhouse accounts: 1 Energy, 2 Industrial Processes, 3 Solvent and other product use (not separately reported for Australia), 4 Agriculture, 5 Land Use, Land-Use Change and Forestry, 6 Waste (the numbering system is standard also).
2. Tables 1(a), 1(b) 2 and 3, include all greenhouse gases, standardised to million tonnes of carbon dioxide equivalent (Mt CO₂-e). Table 1(c) presents carbon dioxide (CO₂) emissions and uptake only.
3. Except where otherwise stated, the tables present Australia's 2006 UNFCCC accounts, the most comprehensive figures currently available.
4. By convention, greenhouse gas fluxes are reported relative to the atmosphere – emissions are positive numbers, uptake (sequestration) is negative.

Table 1a. Australia's 2006 UNFCCC greenhouse accounts re-arranged, Mt CO₂-e

5. Total fossil fuel emissions in 2006 were 429 Mt CO₂-e. In 1990 (Kyoto baseline year) they were 310 Mt CO₂-e, meaning Australia's fossil fuel emissions increased by 38% over 16 years.
6. Total biocarbon emissions were reportedly 205 Mt CO₂-e in 2006 while uptake (sequestration) totalled 72 Mt CO₂-e. Only a fraction of Australia's land area is included in these accounts.⁴
7. According to the official figures, green carbon emissions in 2006 totalled 94 Mt CO₂-e, comprising 63 Mt CO₂-e from land clearing (deforestation) and 31 Mt CO₂-e from native forest degradation (native forest logging, fuelwood burning, biomass burning). This is a significant under-estimate for the reasons given in notes 8 and 9 below – in round figures, it is likely to be at minimum 100 Mt CO₂-e per annum.
8. Land-clearing emissions are underestimated. The reported figure (63 Mt CO₂-e) nets out carbon sequestration on land that was cleared after 1990 but

then allowed to regrow. It should be noted also that the 2006 figures are 'interim' and will be revised when better estimates become available.

9. Emissions from native forest degradation⁵ (mainly logging) are severely under-estimated. Recent work by ANU scientists shows that eucalypt forests in south-eastern Australia store considerably more carbon than previously estimated – on average three times more than the IPCC default figure for temperate forests and much more than would be calculated by NCAS (the National Carbon Accounting System).⁶ The older the forest, the greater the underestimation because most carbon is stored in large old trees and in the soil (in south-east Australian eucalypt forests, about half the carbon is stored in the soil and half in the biomass -- trees and other vegetation). Soil carbon losses following logging are not included in Australia's accounts.⁷
10. Uptake by regrowing native forests is reported to be -57.3 Mt CO₂-e per annum. This figure has no scientific basis – it was calculated from data collected for the Regional Forest Agreement process in the 1990s and is reported unchanged in every greenhouse account and projection from 1990 to 2020. It may be considerably higher or lower – we do not know. In any case it excludes uptake by forests reserved for conservation or not used for logging.
11. Australia's standard accounts net out CO₂ uptake by regrowing forests against emissions from logging – only the resulting net figure is reported. In effect, this allocates all the uptake by forests regrowing after disturbance up to 200 years ago to offset emissions from current logging.⁸
12. Kyoto-compliant post-1990 native forest revegetation, is not reported in the accounts.⁹
13. Non-forest native vegetation. 'Forest' in Australia's accounts is defined such that most woodlands are included.¹⁰ CO₂ emissions and uptake on land supporting non-forest native vegetation – savanna, grassland, heathland, wetlands etc – are assumed to be in balance and are not reported in Australia's accounts (the relevant IPCC categories are 'grasslands remaining grasslands', 'wetlands remaining wetlands' and 'other' land). Non-CO₂ emissions, such as from savanna burning, are reported under Agriculture.

14. Emissions reported for 'Agriculture' include only gases other than carbon dioxide, primarily methane from livestock and non-CO₂ emissions from activities such as savanna burning, stubble burning (compare table 1(a) which shows CO₂-e emissions with 1(b) which shows CO₂ emissions only). The IPCC intends CO₂ fluxes attributable to land use to be reported under 'croplands'. In Australia's case, no CO₂ emissions or uptake attributable to 'agriculture' as an industry sector are reported (see note 17).¹¹

15. Pre-1990 plantations, primarily softwoods planted in the 1960s to 1980s, are currently being logged. The 2 Mt CO₂-e reported emissions nets out logging emissions against growth and replanting. In 1990, these plantations were net sinks, sequestering -9 Mt CO₂-e (Table 2a).

16. Uptake by post 1990 'Kyoto' plantations (23 Mt CO₂-e) largely results from massive hardwood plantation expansion since the 1990s, driven by Managed Investment Schemes (MIS). The standard rotation length (10-15 years) means that most of these plantations are not yet being logged. When logging starts, emissions will eventually cancel out sequestration unless the area of plantations continues to expand. New tax breaks for 'carbon sink' plantations and proposed inclusion in the Carbon Pollution Reduction Scheme (CPRS) are likely to promote continued expansion. Note that references to 'forestry' in the CPRS usually mean Kyoto-compliant tree planting, not native forest logging or pre-1990 plantations.

17. Croplands (other than tree plantations) are assumed to be in equilibrium and not reported. This ignores CO₂ emissions from land degradation and the large potential for enhanced CO₂ storage in agricultural soils.

18. 'Other' emissions are from agricultural lime and soil disturbance (2 Mt CO₂-e) and additions to carbon storage in wood products (-4 Mt CO₂-e). Forestry interests have placed much emphasis on carbon storage in wood products. In the overall accounts, and for native forest logging, this is a minor factor, especially compared with carbon storage in the forests where the logs originated.¹²

19. Overall, using the figures as reported, fossil fuel emissions of 429 Mt CO₂-e compare with biocarbon emissions of 205 Mt CO₂-e. That is, at least one-third of Australia's emissions (**not** net emissions) are from sources other than fossil fuels and this proportion is likely to be higher when more comprehensive and reliable greenhouse accounting is introduced.

20. The primary goal of climate policy is to reduce emissions (not net emissions). While the main focus should remain on eliminating fossil carbon emissions, efforts to reduce biocarbon emissions should be proportionate to their significance. Policy attention and funding should be vastly higher.

21. Emissions totalling at least 100 Mt CO₂-e per annum (18% of Australia's net 2006 emissions; see note 7) could be avoided immediately if native forests were protected from clearing and logging. Protected forests would continue to contribute additionally by sequestering carbon as they regrow to maturity.

Table 1b. Australia's 2006 UNFCCC greenhouse accounts by industry

22. Much commentary confuses industry sectors with greenhouse gas accounting sectors. This table assigns activities usually reported in the 'land use, land-use change and forestry' category to their proper industry classification. 'Agriculture', as an industry sector, includes land-clearing, CO₂ fluxes in croplands and non-native grasslands (not currently reported at all), and agricultural lime. 'Forestry' as an industry sector includes native forest logging, fuelwood, plantations and wood products.

Table 1c. Australia's 2006 UNFCCC greenhouse accounts. Mt CO₂

23. Table 1b presents CO₂ emissions only. The main difference from table 1a, which shows Mt CO₂-e, is that the Agriculture and Waste sectors report carbon dioxide emissions as 'not occurring'. The lack of data on carbon dioxide emissions and uptake on agricultural land (Croplands) is a major gap.

Table 2. Australia's 1990 UNFCCC greenhouse accounts. Mt CO₂-e

24. 1990 is the base year for Kyoto accounting and targets. Comparing 1990 and 2006, the main trends are the massive increase in fossil fuel emissions (up by 38% since 1990) counter-balanced by the decrease in land clearing rates (down by 54%). It is notable that Agriculture and Waste emissions are little changed over the period.

Table 3. (a) Australia's 2006 Kyoto greenhouse account; (b) sectors in the CPRS; and (c) sectors targeted by the Coalition

25. The Kyoto account includes fossil fuel emissions, agriculture (excluding land use), deforestation (land-clearing) and reforestation (post-1990 plantations). Significantly native forest logging and regrowth, and carbon dioxide emissions and uptake on agricultural land are excluded.

26. The government's proposed CPRS is based on Kyoto accounting but, in addition, excludes agriculture and land-clearing. This leaves only fossil fuel emissions, waste and reforestation (post-1990) as 'covered' sectors participating in emissions trading (incorporating 73% of emissions in 2006). Waste emissions are relatively small and more or less static. Inclusion of tree planting gives fossil fuel polluters another option to 'offset' their emissions (in addition to purchasing overseas credits). Native forest logging and clearing are excluded from the CPRS creating the risk that wood, biomass and biochar will be sourced from native forests with higher overall pollution.

27. The Coalition is flagging the potential for carbon dioxide sequestration in agricultural soils, although this is not a Kyoto sector. There is no corresponding proposal to penalise CO₂ emissions from land degradation. The Coalition, like the government, also promotes more tree-planting but not penalties for clearing. Tree planting is an inefficient, expensive counter-productive strategy unless underpinned by demand for wood or limited to permanent biodiverse revegetation.

28. Both the government and the Coalition are ignoring green carbon. They are missing the opportunity to reduce emissions dramatically and promote permanent sequestration in native forests and other natural ecosystems while also protecting biodiversity and water.¹³

¹ For convenience, chemical/mineral sources and sinks such as cement are included in the fossil fuel account.

² These accounts deal only with terrestrial greenhouse gas sources and sinks – carbon dioxide absorption in the ocean is not included for example.

³ See Australian Greenhouse Emissions Information System, accessed March 2009, www.climatechange.gov.au/inventory/index

⁴ The Land Use, Land-Use Change and Forestry accounts aim to report all greenhouse gas emissions and sequestration caused by human activity, whether for commercial, conservation or cultural purposes. The IPCC divides land into 6 categories: forest, grassland, cropland, wetland, settlement, other. These are further subdivided into land that has changed from one use to another (e.g. grassland to forest), and land remaining under the same use (e.g. forest remaining forest).

For 'forests remaining forests' Australia includes only harvested native forests (15 million ha) and pre-1990 plantations (1 million ha); the other 90 million ha of forest is assumed to be in equilibrium. Similarly 440 million hectares of 'grassland remaining grassland' is assumed to be in equilibrium and 25 million hectares of 'cropland remaining cropland'. Wetlands (14 million hectares) and 'other lands' (176 million hectares) are not reported.

⁵ Forest 'degradation' includes any activity that degrades forest carbon storage, in Australia's case mainly logging. The 31 Mt CO₂-e comprises logging (21 Mt CO₂-e), fuelwood consumption (7 Mt CO₂-e), and biomass burning (3 Mt CO₂-e).

⁶ Mackey B.G., Keith H., Berry S. and Lindenmayer D.B. (2008), *Green Carbon: The Role of Natural Forests in Carbon Storage*, The Australian National University, E PRESS <http://epress.anu.edu.au/green_carbon_citation.html>

⁷ Another source of under-estimation is that emissions are calculated relative to the harvested log volume; in native forests this may be much less than the actual on-site log volume.

⁸ The AGEIS (Australian Greenhouse Emissions Information System www.climatechange.gov.au/inventory/index) tables show net emissions for 'managed native forests' in 2006 of -36.5 Mt CO₂-e. This nets off logging emissions of 20.8 Mt CO₂-e against assumed sequestration of -57.3 Mt CO₂-e.

⁹ It is not entirely clear from the methodology, but it appears that the reported uptake for Kyoto reforestation (post-1990) only includes plantations, not revegetation for environmental purposes. The effect is to give the government an additional buffer of unknown size in meeting its Kyoto target.

¹⁰ 'Forests' are defined as vegetation (trees) with a height of at least 2 m and a minimum crown canopy cover of 20%; the minimum area is 0.2 ha.

¹¹ There is a general problem of confusion where the names of IPCC land uses or CPRS sectors are the same as those of industry sectors, especially in forestry and agriculture.

¹² For plantations, wood product storage may be a significant factor if it is allowed to offset logging emissions in an emissions trading scheme.

¹³ There is increasing recognition that maintaining natural ecosystems, including forests, is essential to prevent dangerous climate change because of their role in the global carbon cycle. See for example the findings of the Ad Hoc Technical Expert Group on Biodiversity and Climate Change www.cbd.int/doc/meetings/cc/ahteg-bdcc-01/other/ahteg-bdcc-01-findings-en.pdf

Table 1a. Australia's 2006 UNFCCC greenhouse accounts re-arranged. Emissions highlighted (pink). Mt CO₂-e

Activity (UNFCCC sector)	Fossil carbon
	Emission
1, 2 Energy/industrial processes	429
4 Agriculture (includes non CO ₂ emissions only)	
5 Land use, land-use change and forestry	
<i>Native forest clearing</i>	
<i>Native forest degradation and regrowth</i>	
<i>Pre-1990 plantations</i>	
<i>Post-1990 plantations and reforestation</i>	
<i>Croplands</i>	
<i>Non-forest native vegetation, grazing land</i>	
<i>Other</i>	
6 Waste	
TOTAL 2006 (550 net)	429
TOTAL 1990 (516 net)	310

Biocarbon			
Green carbon		Production carbon	
Emission	Uptake	Emission	Uptake
		90	
63			
31	-57		
		2	
	n.r.		-23
		n.r.	n.r.
n.r.	n.r.	n.r.	n.r.
		2	-4
		17	
94	-57	111	-27
172	-57	107	-15

n.r. = not reported

Table 1b. Australia's 2006 UNFCCC greenhouse accounts by industry sector. Mt CO₂-e. Sectors in italics are normally reported in the 'land use, land-use change and forestry' UNFCCC sector

Activity (industry sector)	Fossil carbon	Biocarbon			
		Green carbon		Production carbon	
	Emission	Emission	Uptake	Emission	Uptake
Energy/industrial processes	429				
Agriculture (non CO ₂)				90	
<i>Native forest clearing</i>		63			
<i>Croplands and non-native grasslands (CO₂)</i>				n.r.	n.r.
<i>Other (agricultural lime)</i>				2	
Forestry					
<i>Native forests available for logging</i>					
<i>Pre-1990 plantations</i>				2	
<i>Post-1990 plantations</i>					-23
<i>Other (wood products)</i>					-4
<i>Native forests not available for logging</i>		n.r.	n.r.		
<i>Non-forest native vegetation, grazing land</i>		n.r.	n.r.	n.r.	n.r.
Waste				17	
TOTAL 2006 (550 net)	429	94	-57	111	-27

n.r. = not reported

Table 1b. Australia's 2006 UNFCCC greenhouse accounts. Mt CO₂

Activity	Fossil carbon
	Emission
Energy/industrial processes	390
Agriculture	
Land use, land-use change and forestry	
<i>Native forest clearing</i>	
<i>Native forest degradation and growth</i>	
<i>Pre 1990 plantations</i>	
<i>Post 1990 plantations and reforestation</i>	
<i>Croplands</i>	
<i>Non-forest native vegetation, grazing land</i>	
<i>Other</i>	
Waste	
TOTAL 2006 (398 net)	390
TOTAL 1990 (370 net)	278

n.r. = not reported, n.o = not occurring

Biocarbon			
Green carbon		Production carbon	
Emission	Uptake	Emission	Uptake
		n.o.	
60			
28	-57		
		2	
	n.r.		-23
		n.r.	n.r.
n.r.	n.r.	n.r.	n.r.
		2	-4
		n.o.	
88	-57	4	-27
166	-57	n.r	-15

Table 2. Australia's 1990 UNFCCC greenhouse accounts. Mt CO₂-e

Activity	Fossil carbon
	Emission
Energy/industrial processes	310
Agriculture (includes non CO ₂ emissions only)	
Land use, land-use change and forestry	
<i>Native forest clearing</i>	
<i>Native forest degradation and growth</i>	
<i>Pre 1990 plantations</i>	
<i>Post 1990 plantations and reforestation</i>	
<i>Croplands</i>	
<i>Non-forest native vegetation, grazing land</i>	
<i>Other</i>	
Waste	
TOTAL 1990 (516 net)	310

Biocarbon			
Green carbon		Production carbon	
Emission	Uptake	Emission	Uptake
		87	
137			
35	-57		
			-9
	n.r.		-2
		n.r.	n.r.
n.r.	n.r.	n.r.	n.r.
		1	-4
		19	
172	-57	107	-15

n.r. = not reported

Table 3a. Australia's 2006 Kyoto (green highlight) and UNFCCC greenhouse accounts. Mt CO₂-e

Activity	Fossil carbon	Biocarbon			
		Green carbon		Production carbon	
	Emission	Emission	Uptake	Emission	Uptake
Energy/industrial processes	429				
Agriculture (includes non CO ₂ emissions only)				90	
Land use, land-use change and forestry					
<i>Native forest clearing</i>		63			
<i>Native forest degradation and growth</i>		31	-57		
<i>Pre 1990 plantations</i>				2	
<i>Post 1990 plantations and reforestation</i>			n.r.		-23
<i>Croplands</i>				n.r.	n.r.
<i>Non-forest native vegetation, grazing land</i>				n.r.	n.r.
<i>Other</i>				2	-4
Waste				17	
TOTAL 2006 Kyoto account (576 net)	429	63		107	-23
TOTAL 2006 UNFCCC account (550 net)	429	94	-57	111	-27

n.r. = not reported

Table 3b. Sectors (yellow) proposed for inclusion in Australia's CPRS scheme; Kyoto sectors not in the CPRS (green). Mt CO₂-e

Activity	Fossil carbon	Biocarbon			
		Green carbon		Production carbon	
	Emission	Emission	Uptake	Emission	Uptake
Energy/industrial processes	429				
Agriculture (includes non CO ₂ emissions only)				90	
Land use, land-use change and forestry					
<i>Native forest clearing</i>		63			
<i>Native forest degradation and growth</i>		31	-57		
<i>Pre 1990 plantations</i>				2	
<i>Post 1990 plantations and reforestation</i>			n.r.		-23
<i>Croplands</i>				n.r.	n.r.
<i>Non-forest native vegetation, grazing land</i>		n.r.	n.r.	n.r.	n.r.
<i>Other</i>				2	-4
Waste				17	

n.r. = not reported

Table 3c. Sectors targeted by the Coalition to reduce net greenhouse gas emissions (blue); other Kyoto sectors (green). Mt CO₂-e

Activity	Fossil carbon	Biocarbon			
	Emission	Green carbon		Production carbon	
		Emission	Uptake	Emission	Uptake
Energy/industrial processes	429			90	
Agriculture (includes non CO ₂ emissions only)					
Land use, land-use change and forestry					
<i>Native forest clearing</i>		63			
<i>Native forest degradation and growth</i>		31	-57		
<i>Pre 1990 plantations</i>				2	
<i>Post 1990 plantations and reforestation</i>			n.r.		-23
<i>Croplands</i>				n.r.	n.r.
<i>Non-forest native vegetation, grazing land</i>		n.r.	n.r.	n.r.	n.r.
<i>Other</i>				2	-4
Waste				17	

n.r. = not reported