THE AUSTRALIA INSTITUTE

Greenhouse gas emissions in industrialised countries

Where does Australia stand?

Hal Turton

Discussion Paper Number 66

June 2004

ISSN 1322-5421

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Acknowledgements

Thanks are due to Hugh Saddler and Clive Hamilton for commenting on the draft of this paper.

Hal Turton is a researcher in Environmentally Compatible Energy Strategies at the International Institute for Applied Systems Analysis, Schlossplatz 1, A-2361, Laxenburg, Austria.

Summary

The international climate change community is increasingly turning its attention to proposals to base future greenhouse gas emission reduction obligations at least in part on a per capita principle. In the case of industrialised countries, expectations about the responsibility to take action have been, and will increasingly be, influenced by recognition of each country's overall contribution to the climate problem as well as by perceptions of the contribution to climate change of individual citizens in each country.

Serious consideration of these issues can proceed only on the basis of good information on per capita emissions, yet to date only data on energy-related emissions per capita have been available. When measured on this partial basis Australia's per capita emissions are high, but are exceeded by some other industrialised countries, including the USA.

This paper reports calculations showing per capita greenhouse gas emissions on a comprehensive basis for all industrialised (Annex I) countries. The data are drawn from national communications and greenhouse gas inventory submissions to the UNFCCC secretariat. The paper presents the most recent and consistent estimates of per capita emissions, covering the years up to and including the year 2001. It also presents historical data on the per capita emissions of all Annex I countries for the years 1990-2001 inclusive.

The results are summarised in Figure S1 which shows greenhouse gas emissions per capita in 2001 for a selection of industrialised countries. Australians have the highest emissions per person of all industrial countries. At 27.2 tonnes of carbon dioxide equivalent (t CO_2-e) per person, emissions by Australians are 27 per cent higher than those of US citizens (21.4 tonnes) and more than double the average for industrialised countries.

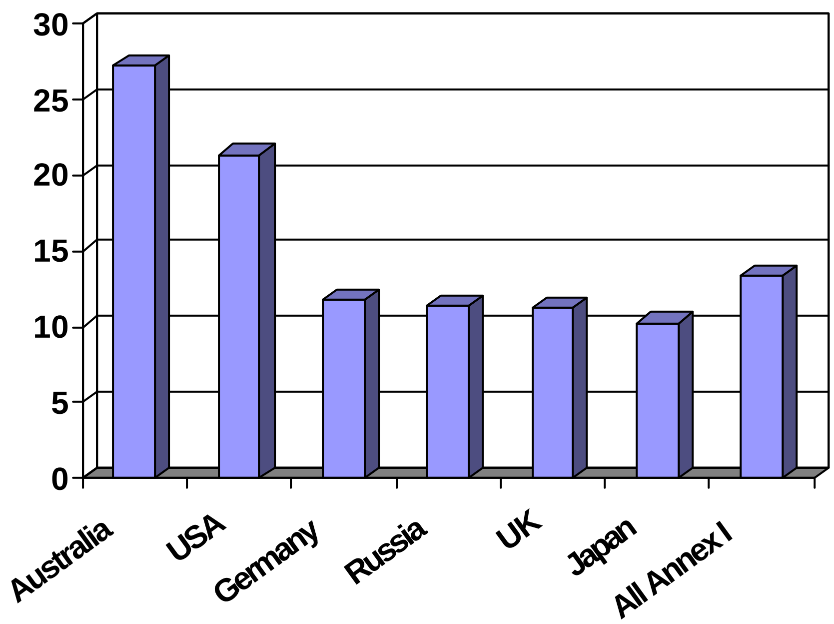
It has often been argued that although Australia has high per capita emissions, the country's small population means that, in absolute terms, it is not a major greenhouse polluter. However, this is not the case. While Australia accounts for 3.4 per cent of total Annex I emissions, Australia's total emissions exceed those of major European economies such as France and Italy (each with around three times Australia's population), and are only 20 per cent lower than those of the UK. Thus if Australia's contribution to the climate change problem is trivial, then so are those of these countries.

Average per capita emissions in industrialised countries as a whole declined by over 12 per cent between 1990 and 2001, although most of this decline occurred before 1995. This decrease can be attributed mostly to the changes affecting Eastern Europe and the former Soviet Union. However, average per capita emissions in the European Union also declined, by around six per cent.

In Australia, per capita emissions declined by just over 7.5 per cent between 1990 and 2001. This decline is accounted for by a large reduction in emissions from land-clearing. The fall in emissions from land clearing has masked the rapid and sustained increase in emissions from other sources, especially energy. This has allowed the

Australian Government to claim that it is ‘on track’ to meet its target under the Kyoto Protocol. However, as land clearing emissions stabilise at a low level in the next few years, the underlying, and rapid, increase in energy-related emissions will see Australia’s total emissions rise.

Figure S1 Greenhouse gas emissions per capita for selected Annex I countries, 2001 (t CO_2-e)



In an attempt to explain why Australia’s per capita emissions are so high, and to indicate what might be done to reduce them, this report presents a breakdown of the activities and sectors responsible for the difference in per capita CO_2 emissions from fuel combustion between Australia and the European Union as a whole. Three activities account for a large share of the difference: the electricity generation mix; road transportation; and the production of non-ferrous metals (mainly aluminium). These sectors also account for most of the growth in Australia’s emissions, so this result is of particular interest.

1. In electricity generation, the higher per capita emissions in Australia are due about equally to the greater willingness or capacity of European nations to accept hydro and nuclear power and to a less greenhouse-intensive mix of fossil fuels (more natural gas and less coal). The latter provides good opportunities for policy intervention.

2. Contrary to the popular myth that Australia’s transportation emissions are high because of the large distances separating major urban centres, most of Australia’s passenger transportation occurs within, rather than between, urban centres (around 72 per cent of total car travel occurs in urban centres, and only 5.5 per cent is for interstate travel). This suggests that fuel efficiency, public transport and urban design policies could shift Australia’s vehicle emissions’

profile closer to Europe's.

Road freight transportation activity also contributes to the difference in per capita emissions. However, road freight transport distances are not longer in Australia. In fact, although per capita road freight tonne-kilometres in Australia are around twice those in the EU, the average road freight distance is actually longer in the EU than in Australia. Thus additional trips and heavier loads, rather than longer distances, account for Australia's higher road freight emissions. Again, this provides an opportunity for emission reductions since these factors can be influenced more readily by policy-makers.

3. The aluminium smelting sector in Australia is a significant source of Australia's GHG emissions. The Australian smelting industry is the most polluting (in terms of GHG emissions) of any world region with greenhouse gas emissions around double the world average for each tonne of aluminium produced. Moreover, the industry is heavily subsidized to the tune of $210-250 million per year through contracts for cheap electricity. Considering the limited economic benefit associated with the smelting industry in Australia, and its much higher emissions intensity compared to the rest of the world, reducing the size of the sector by eliminating the large subsidies it receives may well be a cost-effective means of reducing Australia's emissions.

In sum, the three activities that account for much of Australia's relatively high per capita emissions also present significant abatement opportunities. The high levels of emissions from these sectors are not caused by underlying intractable physical or social constraints, nor are they based on economic imperatives. However, influencing these activities and bringing about a significant reduction in emissions will take time, highlighting the need for early, consistent and sustained policy action.

1. Introduction

The principle of polluter pays has been prominent in the international climate change debate for some years, but it is only in recent times that attention has become more focussed on the per capita emissions. For instance, the agreement on flexibility mechanisms reached at negotiations in Bonn in July 2001 included the following statement:

> …the Parties included in Annex I shall implement domestic action in accordance with national circumstances and with a view to reducing emissions in a manner conducive to narrowing per capita differences between developed and developing country Parties while working towards achievement of the ultimate objective of the Convention.

This reflects a growing level of support for some broader principle of equity that would, in time, permit developing countries to take on fair and reasonable targets. The idea of 'contraction and convergence' proposes equal per capita entitlements to the use of the global atmospheric commons. It is an idea that is gaining widespread acceptance. (www.gci.org.uk).

Differences in per capita emissions have had a substantial subterranean effect on climate change negotiations to date. The exclusion of developing countries from targets is due not only to their low incomes but their low emissions per capita. In the case of industrialised countries, expectations about the responsibility to take action have been influenced by recognition of each country's overall contribution to the climate problem as well as by perceptions of the profligacy of individual citizens in each country.

However, serious consideration of these issues can proceed only on the basis of good information on emissions. While any number of papers have reported on energy emissions per capita, there has been no study of comprehensive per capita emissions, taking account of all sources and sinks.[1] Yet the data required to calculate per capita emissions for industrialised countries are readily available from the official communications of the United Nations Framework Convention on Climate Change (UNFCCC) secretariat.

The Australia Institute has previously compiled data from the United Nations Framework Convention on Climate Change (UNFCCC) secretariat to estimate comprehensive emissions per capita for Annex I (industrialised) countries (see Turton and Hamilton 2002, 2001, 1999). While many other groups have developed estimates of energy emissions per capita, this paper calculates comprehensive emissions – that is, including all sources and sinks as reported in national communications and greenhouse gas inventory submissions to the UNFCCC secretariat. It presents the most recent and consistent estimates of per capita emissions, covering the years up to and including the year 2001. The paper also presents historical data on the per capita emissions of all Annex I countries for the years 1990-2001 inclusive. While data are reported for all Annex I countries, the analysis focuses on Australia's emissions, and includes a detailed

[1] With the exception of Hamilton and Turton (2001) and Turton and Hamilton (1999).

comparison of some of the key differences in the per capita emissions between Australia and the EU.[2]

[2] Unless specified otherwise, this refers to the EU15.

2. Data for comprehensive emissions

Under Articles 4 and 12 of the UNFCCC, Parties to the Convention submit national greenhouse gas inventories to the UNFCCC secretariat (UNFCCC 1992). The information presented in Table 1 is based on recently submitted inventory data for Annex I (industrialised) countries, and has been reproduced as reported by the UNFCCC (2003a; 2002). The UNFCCC reviews and assesses Parties' inventory submissions, and undertakes further in-depth reviews of selected countries. In most cases, the UNFCCC has completed reviews of and reports data from greenhouse gas inventory submissions for 2003, which cover the year 2001. Exceptions (with the most recent year indicated in brackets) include Australia (2000), Belarus[3] (2000), Croatia (1995), Liechtenstein (1999), Lithuania (1998), the Russian Federation[4] (1999), Slovenia[5] (1996) and the Ukraine (1998). The UNFCCC also makes available 2001 national inventory submissions from Australia, Belarus and Croatia, although they were received after the secretariat's deadline and are not included in the UNFCCC's assessment report (UNFCCC 2003a,b,c,d). Emissions from these submissions are also reported in Table 1 for comparative purposes.

The numbers presented in Table 1 are, in most cases, based on emissions of the six main greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). However, a number of small and transition economies did not report emissions of HFCs, PFCs and SF_6.[6] Emissions are reported in terms of carbon dioxide equivalents (CO_2-e) (UNFCCC 2003a, p. 6).

The source categories (fuel combustion, agriculture, etc.) are defined according to IPCC guidelines (see IPCC 1997). Emissions resulting from the combustion of fuel used in international shipping and aviation are not included in country totals, in accordance with IPCC methodology. Emissions and removals from the land-use change and forestry (LUCF) sector are included in the totals, and CO_2 emissions from LUCF are also reported separately.

Table 1 reports population data from the World Bank (2003), for each country (for the appropriate year). This is used to calculate comprehensive per capita emissions.

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[3] Unlike in earlier papers (Turton and Hamilton, 2002, 2001, 1999) we now report data for Belarus and Croatia, so the analysis covers all countries listed in Annex I to the Convention except for Turkey (UNFCCC 1992).

[4] The UNFCCC reports total, but not fully disaggregated emissions for the Russian Federation for this year. See Turton and Hamilton (2002) for a disaggregation of Russia's emissions in 1998.

[5] The UNFCCC reports total, but not fully disaggregated emissions for Slovenia for this year.

[6] These being Belarus, Estonia, Liechtenstein, Lithuania, Monaco and the Ukraine.

3. Results of analysis of per capita emissions

3.1 Per capita emissions in 2001

Table 1 shows that Annex I countries (excluding Turkey, hereafter referred to simply as Annex I or industrialised) produced total net emissions of over 15.6 billion tonnes CO_2-e in 2001.[7] This is around 1 billion tonnes more than reported for 1999 in our previous paper (Turton and Hamilton 2002), although almost all of this difference is accounted for by revisions and updates to the UNFCCC data (UNFCCC 2003a).[8] Using a consistent set of countries and data, Annex I emissions have increased by 0.1 Gt CO_2-e between 1999 and 2001, although this slight increase had an insignificant impact on average Annex I per capita emissions. The average per capita emissions of Annex I countries in 2001 was 13.3 tonnes of CO_2-e. This average is heavily influenced by the per capita emissions of the EU15 (which accounts for 25 per cent of the total emissions and 32 per cent of total Annex I population)[9] and the USA (accounting for 39 per cent of emissions and 24 per cent of Annex I population).

Australia continues to have the highest per capita greenhouse gas emissions in the industrialised world, with emissions of 27.2 tonnes of CO_2-e per person in 2001 based on the Australian Government's 2003 submission (and 27.9 tonnes of CO_2-e in 2000, based on latest figures reviewed by the UNFCCC). The figure for 2001 is over twice the industrialised country average of 13.3 tonnes CO_2-e, 24 per cent higher than the next highest per capita emitter, Canada, and 27 per cent higher than the world's largest polluter, the USA.[10] In comparison, per capita emissions in major industrialised European countries, such as France (8.5 tonnes per capita), Germany (11.8), Italy (9.1) and the UK (11.2), are substantially lower.

It has been argued that although Australia has high per capita emissions, the country's small population means that, in absolute terms, it is not a major greenhouse polluter. However, this is not the case. While Australia accounts for 3.4 per cent of total Annex I emissions, Australia's total emissions exceed those of major European economies such as France and Italy (each with around three times Australia's population), and are only 20 per cent lower than those of the UK.[11] Among the industrialised countries presented in Table 1, Australia has the thirteenth largest population, but is the seventh largest emitter, exceeded by only the USA, Japan, Russia, Germany, the United Kingdom and Canada.[12]

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[7] For those countries for which 2001 data are unavailable, the most recent year's data have been used to calculate the Annex I total.

[8] For example, including 1999 data for Russia (rather than 1996 as in Turton and Hamilton 2002), increases the 1999 estimate by roughly 0.6 Gt CO_2-e, and a revision of the USA data for 1999 increases emissions by around 0.3 Gt CO_2-e.

[9] The Annex I members of the EU25 (i.e. excluding Malta and Cyprus) account for around 29 per cent of emissions and almost 39 per cent of the population of Annex I.

[10] The five countries with the highest per capita emissions are Australia (27.2), Canada (22.0), the USA (21.4), Ireland (18.1) and Belgium (14.5). The ranking of these five is identical to the previous paper (Turton and Hamilton 2002), although Ireland's per capita emissions are reported to have increased by 16 per cent. Revisions to Ireland's reported emissions for 1999 eliminate this apparent increase.

[11] As shown in Table 1, Australia's total emissions are 528.1 Mt CO_2-e, compared to 501.8 Mt CO_2-e from France and 526.7 Mt CO_2-e from Italy.

[12] Moreover, Australia's total emissions are roughly the same as the sum of emissions from Austria, Denmark, Finland, Ireland, New Zealand, Norway, Portugal, Sweden and Switzerland.

Table 1 Greenhouse gas emissions from Annex I countries (Mt CO_2-e), 2001[a]

		Energy		Industrial processes	Agri-culture	Other[b]	LUCF (CO_2)[c]	Total	Population	Per capita emissions
	Year	**Fuel combustion**	**Fugitive fuel**						(millions)	(t CO_2-e)
Australia	**2000**	340.3	31.5	10.3	98.4	21.9	32.8	535.3	19.18	*27.90*
Australia[d]	*2001*	*336.8*	*32.2*	*24.9*	*105.8*	*21.1*	*7.3*	*528.1*	*19.39*	*27.24*
Austria	2001	57.3	0.3	15.4	7.6	5.3	-7.6	78.2	8.13	9.62
Belarus[e]	**2000**						-19.0	52.4	10.01	5.23
Belarus[d]	*2001*	*51.3*	*2.6*	*1.6*	*12.0*	*3.5*	*-16.9*	*54.0*	*9.97*	*5.42*
Belgium	2001	117.8	0.9	15.2	12.1	4.5	-1.8	148.7	10.29	14.46
Bulgaria	2001	47.6	2.8	5.5	5.0	4.8	-9.5	56.3	7.91	7.12
Canada	2001	529.0	54.8	49.0	60.0	27.3	-36.4	683.8	31.08	22.00
Croatia	**1995**	14.5	1.8	2.0	2.9	1.0	0.0	22.3	4.67	4.77
Croatia[d]	*2001*	*17.9*	*1.9*	*2.8*	*3.0*	*1.2*	*-8.1*	*18.8*	*4.38*	*4.29*
Czech	2001	124.1	6.2	7.0	7.6	4.5	-4.4	143.7	10.22	14.05
Denmark	2001	53.6	0.8	2.2	11.6	1.3	-3.5	65.9	5.36	12.29
Estonia	2001	16.9	0.7	0.4	0.8	0.7	-0.7	18.7	1.36	13.69
Finland	2001	62.9	3.6	3.0	7.5	3.9	-16.9	64.0	5.19	12.34
France	2001	396.6	7.8	41.5	98.4	23.9	-66.4	501.8	59.19	8.48
Germany	2001	859.3	15.1	43.2	65.2	12.5	-23.7	971.6	82.33	11.80
Greece	2001	102.0	1.6	13.1	10.0	5.6	-1.3	130.9	10.59	12.36
Hungary	2001	59.1	2.2	4.1	7.6	5.6	-4.5	74.0	10.19	7.26
Iceland	2001	1.8	0.0	0.6	0.3	0.1	-0.1	2.6	0.28	9.14
Ireland	2001	45.1	0.2	4.0	19.2	1.5	-0.6	69.4	3.84	18.07
Italy	2001	447.9	6.4	34.1	42.5	14.4	-18.7	526.7	57.95	9.09
Japan	2001	1148.4	1.1	82.1	33.8	33.9	0.0	1299.4	127.03	10.23
Latvia	2001	7.9	0.2	0.3	1.6	1.6	-9.3	2.2	2.36	0.95
Liechtenstein	**1999**	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.03	6.81
Lithuania	**1998**	14.2	0.4	5.4	2.3	1.6	-9.6	12.9	3.56	3.64
Luxembourg	2001	4.9	0.0	0.0	0.0	0.0	-0.3	4.7	0.44	10.67
Monaco	2001	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.03	4.67
Netherlands	2001	178.3	4.5	11.1	15.8	10.1	-1.4	218.3	16.04	13.61
New Zealand	2001	29.5	1.5	3.2	35.8	2.4	-23.9	48.5	3.85	12.61
Norway	2001	33.1	3.2	10.6	5.0	4.3	-19.0	37.3	4.51	8.25
Poland	2001	310.5	16.7	17.3	25.8	12.4	-53.6	329.2	38.64	8.52
Portugal	2001	60.4	0.5	5.6	11.8	5.5	-2.2	81.7	10.02	8.15
Romania	2001	105.8	11.3	7.8	13.7	9.7	-9.0	139.2	22.41	6.21
Russia[e]	**1999**						-211.7	1665.4	146.31	11.38
Slovakia	2001	39.0	1.3	3.3	4.2	1.9	-5.3	44.9	5.40	8.30
Slovenia[e]	**1996**						-5.6	14.1	1.99	7.11
Spain	2001	288.9	6.3	27.9	43.0	16.8	-29.3	353.5	41.12	8.60
Sweden	2001	53.1	0.3	5.8	8.9	2.4	-33.1	37.4	8.89	4.21
Switzerland	2001	41.3	0.3	2.7	5.4	3.6	-1.5	51.9	7.23	7.18
Ukraine	**1998**	298.9	92.1	18.6	27.1	18.2	-68.7	386.2	50.30	7.68
UK	2001	547.5	21.5	28.4	46.4	13.4	3.2	660.5	58.80	11.23
USA	2001	5722.6	204.5	287.6	474.9	246.6	-838.1	6098.1	285.32	21.37
EU15	2001	3275.6	68.1	251.1	400.2	121.0	-203.5	3912.6	378.18	10.35
Annex I[f]		12211.7	505.9	785.2	1231.6	525.9	-1532.0	15623.1	1171.9	13.33

a Aggregate emissions of CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, using 1995 IPCC global warming potentials.
b Includes solvent use, waste, other and CH_4 and N_2O from land-use change and forestry.
c Land-use change and forestry (LUCF) CO_2 estimates as reported in accordance with the present IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1997).
d Note, recent data for these countries is derived from their latest greenhouse gas inventory submissions, which have yet to be reviewed and synthesised by the UNFCCC (UNFCCC 2003b,c,d).
e Sectoral disaggregation not available, except for LUCF. See Turton and Hamilton (2002) for a breakdown of an earlier year for Russia and Slovenia.
f Excluding Turkey. Sectoral emissions do not sum to total, because of missing sectoral breakdown for some Annex I countries. Note, this is the total emissions for the most recently available years (not always 2001).

Source: UNFCCC 2004; UNFCCC 2003a,b,c,d; UNFCCC 2002: IBRD 2001; World Bank 2003.

3.2 Sources of emissions

Figure 1 depicts, for selected countries, the contribution of different emitting activities to net per capita emissions. This shows that, for most countries, the land-use change and forestry (LUCF) sector acts as a net sink, except in Australia where continued land-clearing results in net emissions, although these are declining.

However, the role of land clearing gives cause for caution as there is significant uncertainty in measuring emissions from this source. The situation is further complicated by the way in which the Australian Government underestimates the actual emissions from LUCF in its submissions to the UNFCCC. For example, the Australian Government's latest 'Fact Sheet' on LUCF states that:

> The results for land use change for 2000 and 2001 will increase when areas of deforestation are confirmed following the next update of estimates using the [Australian Government's National Carbon Accounting System] (AGO 2004a).

Accordingly, data for both 2000[13] and 2001 are presented for Australia in Figure 1.[14]

For fuel combustion, Figure 1 shows that Germany, Japan, New Zealand and the United Kingdom all generate a similar amount of emissions per capita (7-11 tonnes per person), whilst Australia, Canada and the USA emit twice as much per capita (17-20 tonnes). It is also interesting to note that although the USA generates the most emissions from fuel combustion in per capita terms, Australia's emissions from agriculture and LUCF are of a sufficient size to push Australia well ahead of the USA. New Zealand is also an interesting case, where more than half of all emissions arise from agriculture (mainly methane from cattle and sheep).

A more detailed analysis of the factors giving rise to Australia's relatively high per capita emissions from fuel combustion are examined in Section 4 of this report.

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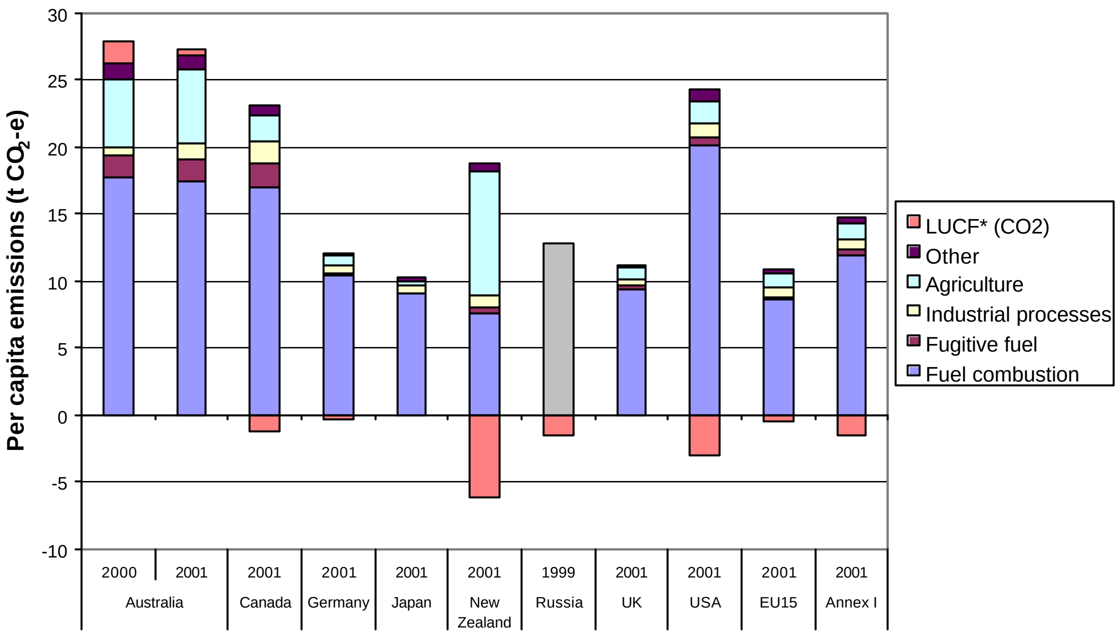
[13] Subsequent to the UNFCCC review of 2000 data, the Australian Government revised down its estimate of emissions from LUCF for 2000 by 16.3 Mt CO_2, eliminating a large part of the apparent decline reported in Table 1 (UNFCCC 2003a). The original figures are still reported for 2000 because: i) the 2000 and 2001 figures are acknowledged to be underestimates (AGO 2004a); and ii) the revision is yet to be assessed and fully reviewed by the UNFCCC.

[14] Note, the apparent increase in emissions from industrial processes is explained by a change in the accounting of the emissions from the oxidation of some of the coke and natural gas used in the iron and steel production (where it is not combusted but instead used as a reductant) (AGO 2003, p. A-18).

Figure 1 Per capita emissions for selected countries



Note: Annex I average is based on the most recently available data for each party (not always 2001).
* Land-use change and forestry appears below the horizontal axis because it represents a sink, and should be subtracted from the emissions above the axis to realise total net emissions.

Source: Table 1

3.3 Trends in per capita emissions

Trends in per capita emissions for Annex I industrialised countries between 1990 and 2001 are presented in Table 2 and, for selected countries, in Figure 2. A number of countries report infrequently, or have not provided emissions estimates for all years in the period, making analysis of trends difficult. However, the data show clear and reliable trends for many countries. For example, the severe economic depression that befell Eastern Europe and, in particular, the former Soviet Union post-communism, is clearly evident in the data on emissions; per capita emissions in Belarus, Bulgaria, Russia and the Ukraine collapsed more than 45 per cent after 1990, whilst those for the Czech Republic, Germany, Hungary, Poland, Romania and Slovakia also exhibited a substantial decline.

Average per capita emissions in industrialised countries as a whole declined by over 12 per cent between 1990 and 2001, although most of this decline occurred before 1995. This decrease in per capita emissions can be attributed to the changes affecting Eastern Europe and the former Soviet Union, as discussed above. However, average per capita emissions in the European Union also declined, by around six per cent. In contrast, per capita emissions increased by more than five per cent in the USA, 22 per cent in Canada and 6.5 per cent in Japan. For Australia, per capita emissions declined by just over 7.5 per cent between 1990 and 2001. This decline is accounted for by a reduction in per capita emissions from land-clearing of over 3.6 tonnes CO_2-e (or close to 12.5 per cent of total emissions) between 1990 and 2001 (if the 2001 estimate of emissions from LUCF is accurate). At the same time, emissions from other sources grew in line with the population plus five per cent over the period.

Closer inspection of the period 1990-2001 reveals that although Australia's per capita emissions fell significantly in the early 1990s, as emissions from land clearing declined, this was soon offset by rapid growth in emissions from the energy sectors as the country emerged from the recession of the early 1990s. Rapid and sustained growth in emissions in the late 1990s was driven by reforms to the electricity market that saw the expansion of brown-coal fired generation at the expense of black coal and natural gas (Hamilton and Denniss 2001). To illustrate, emissions from energy industries (comprising mostly electricity) grew by 21 per cent between 1995 and 1999. As predicted in Turton and Hamilton (2002), the effect on emissions of market liberalisation slowed in 2000. However, emissions from the energy industries sector continue to grow, and rose by five per cent between 1999 and 2002 according to the latest greenhouse gas inventory submission (AGO 2004b).

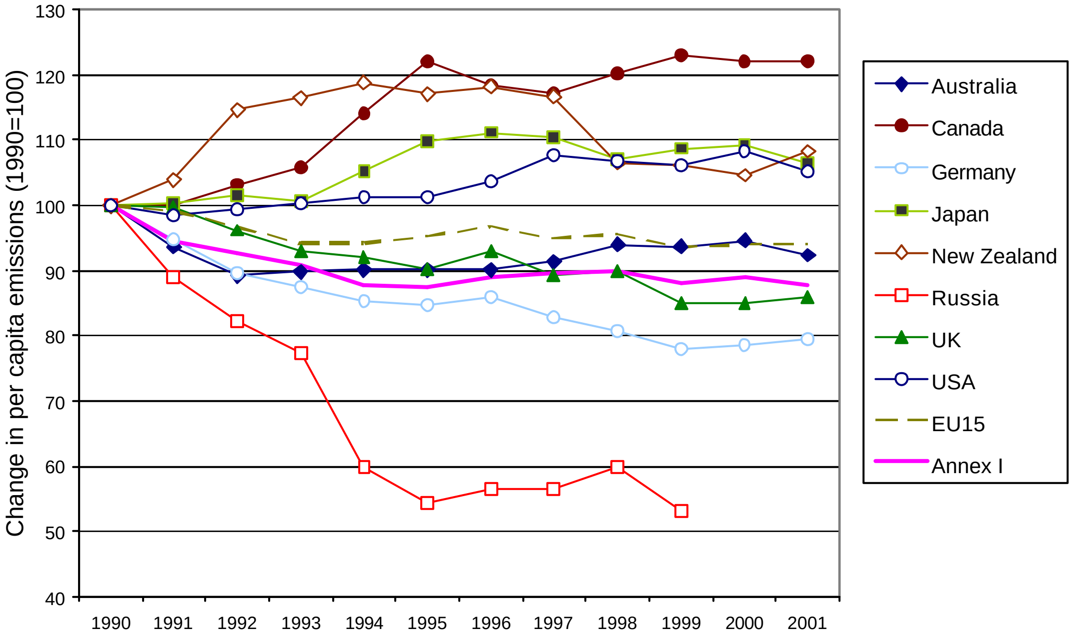
Table 2 Trends in per capita emissions (tonnes CO_2-e per capita), 1990-2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Australia	29.49	27.64	26.30	26.49	26.59	26.57	26.60	26.94	27.71	27.63	27.90	27.24
Austria	8.91	8.78	8.42	8.46	8.71	9.14	9.83	9.48	9.43	9.21	9.16	9.62
Belarus	11.85	11.46	10.76	8.83	7.05	6.35	6.44	6.57	6.43	6.08	5.23	5.42
Belgium	14.00	14.50	14.31	14.09	14.39	14.82	15.03	14.51	14.89	14.56	14.48	14.46
Bulgaria	16.03	11.09	9.99	9.98	8.96	9.48	9.22	8.87	7.84	7.13	6.83	7.12
Canada	18.01	18.02	18.60	19.06	20.54	21.97	21.31	21.10	21.65	22.18	21.98	22.00
Croatia	5.32	3.85	3.47	3.41	3.30	3.37	*3.37*	*3.37*	*3.37*	*3.37*	*3.37*	4.29
Czech Republic	18.32	16.52	15.04	14.43	14.24	13.84	14.58	14.97	14.07	13.32	13.98	14.05
Denmark	12.86	14.90	13.61	14.08	14.78	14.19	16.66	14.72	13.70	13.08	12.11	12.29
Estonia	23.66	21.34	14.33	9.09	11.26	9.77	9.43	9.98	9.36	8.40	8.31	13.69
Finland	10.72	7.39	7.99	8.63	12.17	12.13	11.92	13.31	13.35	12.97	12.27	12.34
France	9.03	9.47	9.17	8.67	8.53	8.70	8.90	8.69	8.94	8.57	8.53	8.48
Germany	14.85	14.08	13.31	13.00	12.68	12.58	12.77	12.29	12.00	11.59	11.67	11.80
Greece	10.47	10.29	10.52	10.45	10.63	10.53	10.90	11.35	12.10	11.75	12.68	12.36
Hungary	9.51	8.18	7.29	7.22	7.05	7.15	7.38	7.15	7.84	8.15	7.81	7.26
Iceland	11.12	10.40	10.07	10.13	9.84	9.95	10.10	10.49	10.47	10.70	9.74	9.14
Ireland	15.17	15.38	15.52	15.36	15.80	15.97	16.31	16.89	17.23	17.63	17.98	18.07
Italy	8.55	8.58	8.54	8.37	8.28	8.75	8.62	8.76	8.95	9.04	9.15	9.09
Japan[a]	8.93	8.97	9.08	8.95	9.37	9.78						
Japan[a]	9.61	9.65	9.77	9.67	10.12	10.55	10.69	10.62	10.30	10.45	10.51	10.23
Latvia	3.83	2.55	0.27	-0.51	-0.13	-0.34	-0.74	0.48	1.05	0.99	0.69	0.95
Liechtenstein[b]	6.82	*6.82*	*6.82*	*6.82*	*6.82*	*6.82*	*6.82*	*6.82*	*6.82*	6.83	*6.83*	*6.83*
Lithuania	11.31	*11.31*	*11.31*	*11.31*	*11.31*	*11.31*	*11.31*	*11.31*	3.64	*3.64*	*3.64*	*3.64*
Luxembourg	34.44	*34.44*	*34.44*	*34.44*	30.66	24.24	*24.24*	*24.24*	*24.24*	13.22	12.96	10.67
Monaco[b]	3.12	3.63	3.84	3.89	3.96	3.86	4.04	4.05	3.91	4.16	4.23	4.67
Netherlands	13.95	14.35	14.18	14.25	14.23	14.36	14.92	14.04	14.26	13.62	13.53	13.61
New Zealand	11.64	12.09	13.34	13.55	13.83	13.64	13.76	13.58	12.40	12.36	12.18	12.61
Norway	9.96	8.85	8.07	8.47	8.33	8.27	8.51	8.77	8.56	8.62	8.22	8.25
Poland	13.90	10.32	10.38	10.13	10.30	9.70	10.22	10.01	9.66	9.26	8.88	8.52
Portugal	6.21	6.37	6.74	6.52	6.53	6.85	6.59	6.79	7.26	8.06	8.00	8.15
Romania	11.26	7.49	8.74	8.27	7.97	9.01	8.81	8.57	7.51	6.51	6.58	6.21
Russia	21.45	19.10	17.67	16.59	12.85	11.68	12.11	12.11	12.84	11.38	*11.38*	*11.38*
Slovakia	13.20	11.38	10.25	9.45	9.06	9.51	9.51	9.63	9.22	9.02	8.42	8.30
Slovenia	8.49	6.42	6.19	6.55	6.45	6.64	7.11	*7.11*	*7.11*	*7.11*	*7.11*	*7.11*
Spain	6.65	6.81	7.02	6.71	7.07	7.40	7.18	7.71	7.87	8.50	8.84	8.60
Sweden	6.13	5.05	5.62	4.88	5.74	6.09	6.38	5.25	5.71	5.07	4.70	4.21
Switzerland	7.43	7.58	7.45	6.88	6.71	6.78	6.82	6.67	6.83	6.87	7.05	7.18
Ukraine	16.71	14.06	13.66	11.99	10.00	9.43	8.48	7.84	7.68	*7.68*	*7.68*	*7.68*
UK	13.08	13.04	12.58	12.17	12.04	11.81	12.14	11.69	11.76	11.11	11.11	11.23
USA	20.31	19.99	20.17	20.37	20.58	20.58	21.05	21.88	21.70	21.56	22.01	21.37
EU15	10.99	10.90	10.63	10.35	10.36	10.47	10.64	10.44	10.51	10.29	10.34	10.35
Annex I	15.20	14.35	14.09	13.78	13.34	13.30	13.52	13.64	13.66	13.37	13.51	13.33

Note: some countries did not provide data to the UNFCCC for every year. Where this is the case, the previous year's per capita figure has been reported in italics (with the exception of Japan).
[a] Japan did not provide estimates of emissions from LUCF for 1996-2001. Accordingly, per capita emissions excluding LUCF are reported for Japan.
[b] Lichtenstein and Monaco did not provide estimates of emissions from LUCF for 1990-2001. Accordingly, per capita emissions estimates exclude LUCF.

Source: UNFCCC 2003a,b,c,d; UNFCCC 2002; IBRD 2001; World Bank 2003.

Figure 2 Trends in per capita net greenhouse gas emissions for selected countries, 1990-2001



Source: Table 2.

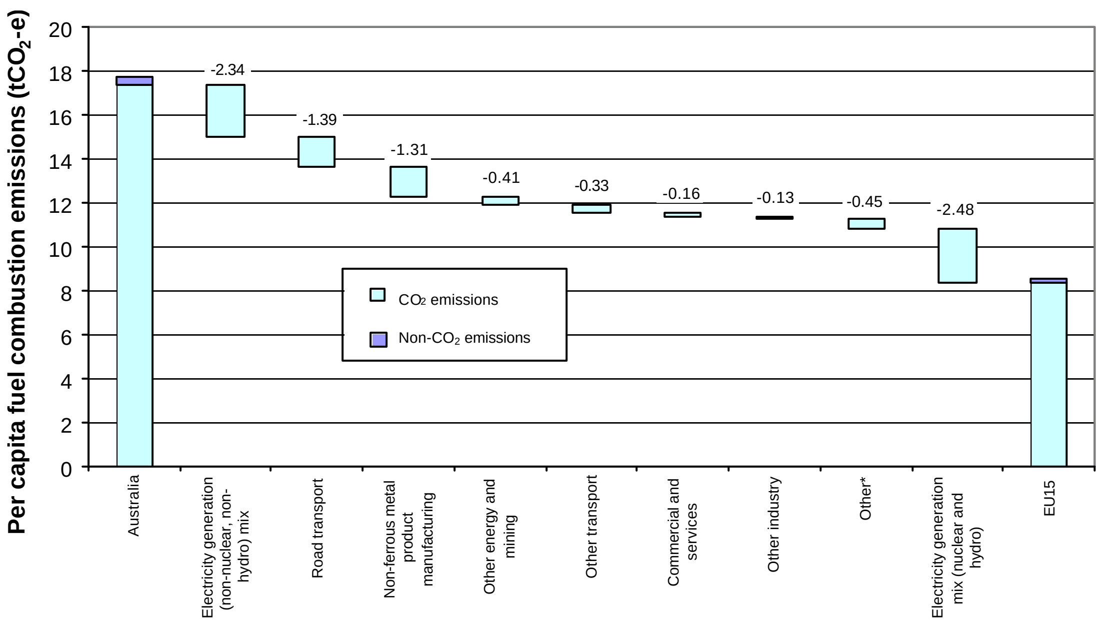
4. Comparison of fuel combustion emissions in Australia and the EU

4.1 Identifying the differences

This section examines some of the key factors that account for the difference in per capita emissions from fuel combustion between Australia and the European Union (EU). This is designed to illustrate some of the main influences on Australia's high per capita energy emissions and provide some insights into possible areas on which policy-makers should focus. Further, this section assesses the extent to which underlying constraints, either physical (for example, geography or climate) or social (such as the Australian community's rejection of nuclear energy) account for the differences in emissions. The analysis compares sectoral and activity-based per capita emissions for Australia and the EU - see Figure 3. These emissions were calculated by combining sectoral energy use data from the IEA with GHG emission factors and population data (IEA 2003; IPCC 1997, Table 1-2 and Table 1-5; World Bank 2003). Differences in the emissions intensity of electricity generation were analysed separately in order to compare the other sectors on a more consistent basis. These calculations are presented in Appendix 1.

Figure 3 presents a breakdown of the activities and sectors responsible for the difference in per capita CO_2 emissions from fuel combustion between Australia and the EU. This figure shows the amount by which per capita emissions from certain activities or sectors are higher in Australia than the EU, and how this contributes to Australia's overall higher emissions. Three activities account for a large share of the difference: the electricity generation mix; production of non-ferrous metals (mainly aluminium); and road transportation. These sectors also account for most of the growth in Australia's emissions, so this result is of particular concern.

Figure 3 Per capita emissions from fuel combustion, differences between Australia and the EU, 2000



* Other includes residential, agriculture, non-specified sectors, discrepancies between IEA (2003) and UNFCCC (2002) and discrepancies arising from the application of consistent emission factors (IPCC 1997).

Interestingly, agriculture, households, the commercial and services sector, and manufacturing other than non-ferrous metals account for relatively little of the difference (if the impact of Australia's more GHG-intensive electricity generation mix is considered separately). This implies that Australia's relative high per capita emissions from energy are primarily a result of fuel choice in electricity generation and structural GHG intensity (i.e. the share of GHG-intensive sectors such as aluminium smelting is larger in Australia), rather than relatively higher GHG intensity within sectors (with the exception of transport). Each of the three sectors is discussed below.

4.2 Electricity generation supply mix

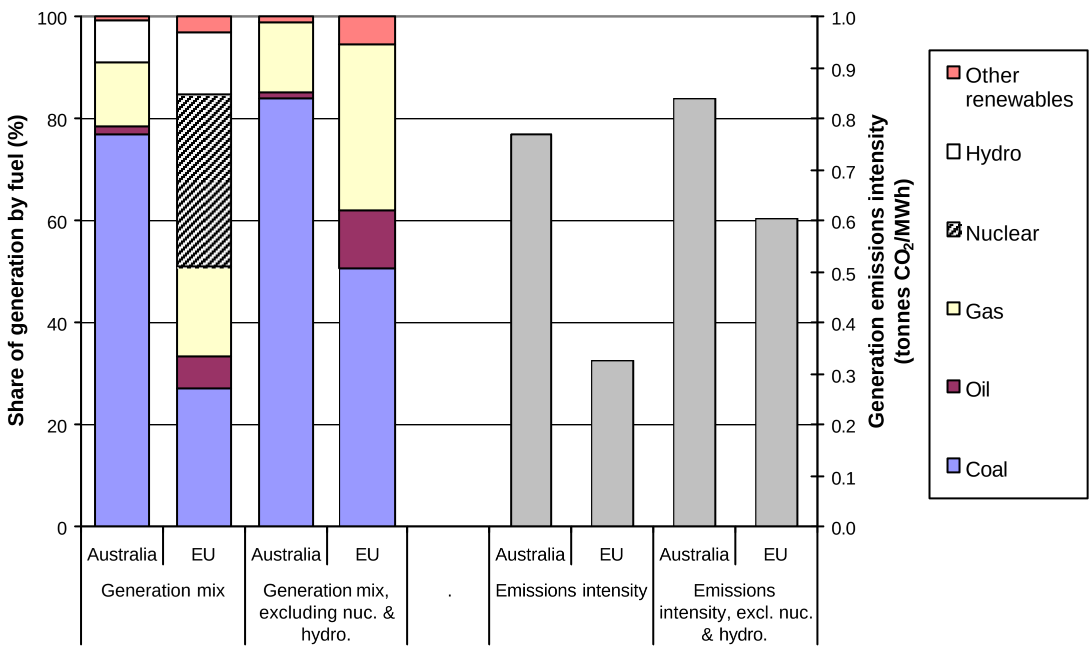
Emissions of CO_2 from electricity generation account for a large share of Australia's emissions (55 per cent of CO_2 emissions from fuel combustion, UNFCCC 2003b) and grew by over 40 per cent between 1990 and 2001. Almost 90 per cent of this electricity is generated from black and brown coal, among the most GHG-intensive sources of energy. This is despite Australia having access to large reserves of natural gas and renewable energy resources.

Figure 4 shows the share of generation according to fuel type and emissions intensity in Australia and the EU, including and excluding nuclear and hydroelectric generation. To examine the extent to which Australia's coal-intensive electricity generation sector raises per capita emissions, we measure the likely impact of shifting to the generation mix used in the EU. However, it was decided that it is unrealistic for this exercise to include the impact of the higher availability of hydroelectric generation resources in Europe or the willingness of some parts of the European electorate to tolerate large-scale nuclear generation. Accordingly, we separate the impact of substituting the EU non-nuclear and non-hydro mix for Australia's current non-hydro generation[15] from the impact of substituting additional hydro and nuclear generation.

Figure 3 shows the amount by which Australia's energy-related CO_2 emissions are above those in the EU as a result of a different non-nuclear and non-hydro generation mix. This generation mix is by no means 'green' and still comprises around 95 per cent fossil fuel (as shown in Figure 4). However, the different mix of predominantly fossil fuels is around 28 per cent less GHG intensive per unit of electricity, and this accounts for per capita emissions of roughly 2.35 tonnes CO_2-e (compared to Australia's total of 17.7 tonnes CO_2-e from fuel combustion).

[15] Since there is no nuclear electricity generation in Australia.

Figure 4 Electricity generation mix and emissions intensity for Australia and the EU, 2000



Source: IEA 2003; IPCC 1997.

Figure 3 also shows the amount by which Australia's energy-related CO_2 emissions are above those in the EU as a result of the EU's greater availability of hydroelectric resources and tolerance of nuclear energy (which together accounted for 46 per cent of the EU's generation in 2000).[16] The greater use of hydro and nuclear has roughly the same impact on per capita emissions as a change in the fossil fuel mix. Accordingly, Australia's lack of access to hydroelectric generation resources and the community's rejection of nuclear generation account for only half of the difference in emissions from electricity generation between Australia and the EU, indicating that there is significant scope available to policy-makers to reduce emissions. Furthermore, since most sources of renewable energy are largely excluded in this comparison, even more abatement opportunities exist.

4.3 Road transportation

Figure 3 shows that emissions from road transportation account for the third-largest share of the difference in per capita emissions between Australia and the EU. Some of this difference can be attributed to slightly higher levels of car ownership and utilization in Australia.[17] However, contrary to the popular myth that Australia's transportation

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[16] In comparison, eight per cent of Australia's electricity generation comes from hydro, and none from nuclear.

[17] In Australia, there are 514 cars per 1000 inhabitants *versus* 469 per 1000 in the EU15 (BTRE 2003, Table 8, EUROSTAT 2003, p. 37). On average, each car in Australia travels 14.6 thousand km per year compared to 13 thousand km (in Germany), 14 (France), 16 (UK), 11 (Italy) and 10 (Spain) (IRF 2000, BTRE 2003, Table 8).

emissions are high because of the large distances separating major urban centres, most of Australia's passenger transportation occurs within, rather than between, urban centres (around 72 per cent of total car travel occurs in urban centres, and only 5.5 per cent is for interstate travel) (ABS 2003a). The urban share of passenger car transportation for the whole EU15 is not readily available; however in the UK almost equal shares of travel occur on urban (41.3 per cent) and non-urban (40.9 per cent) roads, and around 18 per cent on unclassified motorways (DfT 2003, Table 4.9).[18] Definitional differences aside, it does not appear that there are particularly high levels of non-urban motoring in Australia – instead, it may be the case that levels of urban car travel are particularly high in Australia. Accordingly, this implies that Australia's higher levels of vehicle ownership and use cannot be attributed to geographic features alone, and indicates that there is a greater scope to reduce emissions through policy. Inefficient pricing, lower fuel efficiency (not examined here), poor urban design and a lack of alternatives are among the factors that may result in high emissions from transport.

Road freight transportation activity also contributes to the difference in per capita emissions in Figure 3. However, again it is not the case that road freight transport distances are longer in Australia. In fact, although per capita road freight tonne-kilometres in Australia are around twice those in the EU, the average road freight distance is actually longer in the EU than in Australia (EUROSTAT 2003, Table 5.1, 5.5; BTRE 2003, Table 3). That is, some combination of additional trips and heavier loads in road freight transport account for Australia's greater demand for road freight, rather than longer travel distances. The greater demand for road freight may be in large part because Australia has a relatively material-intensive economy relying on bulk and semi-processed goods rather than high value-added products. To illustrate, the total volume of goods exported by Australia in 2001-02 was roughly nine times the total volume imported, although the total value of imports was slightly higher (BTRE 2003, Table 4. This means that it is not geographical features that result in Australia's high emissions from road freight transport, but rather the material intensity of the Australian economy. Again, this provides an opportunity for emission reductions since this intensity can be influenced more readily by policy-makers.

4.4 Non-ferrous metal product manufacturing

The non-ferrous metal product manufacturing industry is comprised almost entirely of aluminium smelting and alumina refining. Detailed analysis of the aluminium smelting sector in Australia and elsewhere has shown that this industry is a significant source of Australia's GHG emissions, and the Australian smelting industry is the most polluting (in terms of GHG emissions) of any world region, as shown in Figure 5 (Turton 2002). Moreover, the industry is heavily subsidized to the tune of $210-250 million per year and contributes relatively little to the Australian economy (Turton 2002).

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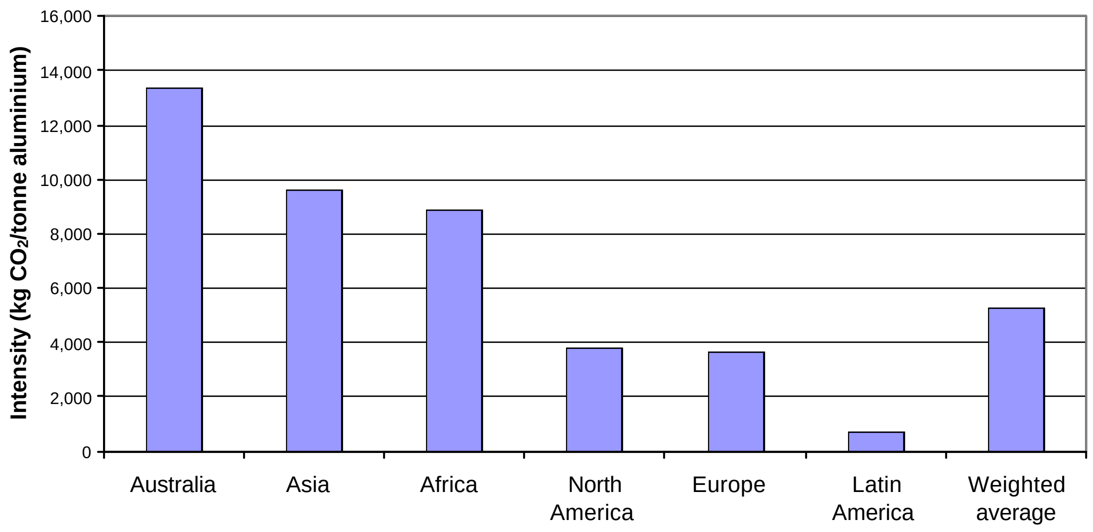
[18] Urban roads are those within an urban settlement of 10,000 people or more (DfT 2003, Table 4.9). In comparison, urban roads in Australia are defined by the ABS as those being in either Statistical Districts with a population greater than 40,000 or clusters of collection districts and other urban areas with a population greater than 40,000 (ABS 2003b).

Figure 5 Electricity-related greenhouse gas intensities of aluminium smelting, 1998



Source: Turton 2002

After removing the impact of Australia's more emissions-intensive electricity generation mix, per capita emissions from the non-ferrous metal product manufacturing industry in Australia are roughly 14 times those in the EU. This is mostly because of the scale of the industry: per capita aluminium smelting capacity in Australia is estimated to be 90 kg, compared to only 6.6 kg in the EU (and 13.6 kg in the USA) (based on Turton 2002). If the size of Australia's non-ferrous metals industry were more in line with that in the EU or USA, per capita emissions from fuel combustion would be around 1.3 tonnes CO_2-e lower.[19] Considering the limited economic benefit associated with the smelting industry in Australia, and its much higher emissions intensity compared to the rest of the world, reducing the size of the sector by eliminating the more than $200 million in subsidies it receives may well be a cost-effective means of reducing emissions (Turton 2002).

In sum, the three activities that account for much of Australia's relatively high per capita emissions also present significant abatement opportunities. The high levels of emissions from these sectors are not caused by underlying intractable physical or social constraints, nor are they based on economic imperatives. Moreover, experience in the EU demonstrates that it is possible to maintain lower GHG emission levels at the same or higher income levels than in Australia. However, influencing these activities and bringing about a significant reduction in emissions will take time, highlighting the need for early, consistent and sustained policy action.

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[19] Taking into account the higher emissions intensity of the electricity generation mix (because of no nuclear and much lower hydroelectric generation in Australia), this figure is 1.8 tonnes CO_2-e. Not correcting for any of the differences in the generation mix raises this figure to 2.3 tonnes CO_2-e. However, it should be remembered that this figure is for the whole non-ferrous metals sector, and therefore also includes alumina refining, which is not as emissions intensive as smelting. It should also be noted that significant non-combustion emissions arise for the smelting industry, accounting for per capita emissions of another 0.2 tonnes CO_2-e (based on Turton 2002).

5. Underlying trends in Australia's emissions

The Australian Government has declared that Australia is on track to meet its Kyoto target of limiting emissions to 108 per cent of 1990 levels in the first commitment period of 2008-2012. However, emissions from the most important sectors - transport and stationary energy - continue to grow rapidly. It is possible for the Government to claim that Australia is on track only because the continued rapid growth in fossil emissions has been masked by the decline in emissions from land clearing since 1990.

Table 3 shows Australia's emissions between 1990 and 2001, the latest year for which official data are available. Over the 11 year period, emissions from energy have increased by 83 million tonnes of CO_2-e. In the same period, emissions from land use change have *fallen* by the same amount (in fact, by slightly more), thus completely offsetting the growth in energy emissions. At current trends, in the next 3-4 years emissions from land use change will stabilise at a low level and the continued rapid growth in energy-related emissions will begin to dominate the total.

Although the Australian Government claims that it has a suite of policies to reduce emissions they appear to have had no appreciable effect on the growth of energy emissions.

Table 3 Changes to Australia's greenhouse gas emissions, 1990-2001 (Mt CO_2-e)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Growth
Total	515.8	493.5	479.0	482.7	488.4	487.4	493.1	501.3	529.5	527.6	528.7	528.1	2.4%
Energy	286.2	288.1	294.1	297.0	300.9	313.4	323.1	331.6	349.7	356.8	364.0	369.0	28.9%
Land use change and forestry 5A+5B	95.8	71.2	54.5	56.1	58.4	45.6	41.5	38.4	46.2	33.3	24.0	14.3	-85.1%
Forests 5A	-24.6	-24.1	-24.5	-24.2	-23.2	-22.4	-22.4	-22.5	-22.7	-23.3	-23.3	-22.7	-7.7%
Land use change 5B	120.4	95.3	79.0	80.3	81.6	68.0	63.9	60.9	68.9	56.6	47.3	37.0	-69.3%
All other	133.8	134.2	130.4	129.6	129.1	128.4	128.5	131.3	133.6	137.5	140.7	144.8	8.2%

Source: National Greenhouse Gas Inventory (2001) CRF Table 10, sheet 6 (p. B-79).

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Appendix 1 Accounting for differences in per capita emissions from energy use, Australia and the EU

The following tables show how the differences in per capita emissions between Australia and the European Union for electricity production, non-ferrous metal production and road transportation were calculated. These results are discussed in detail in Section 4.

A1.1 Electricity generation

Table A1 presents data from the IEA for fuel used in electricity generation in Australia and the EU, and the total amount of electricity generated according to fuel type.[20] Generation from sources other than nuclear and hydroelectric is also shown; thet accounts for around 92 per cent of Australia's generation, but only 54 per cent of electricity generated in the EU.

Table A1 Fuel used in electricity generation and electricity output, Australia and the EU, 2000

	Coal	Oil	Gas	Nuclear	Hydro	Other renew-ables	Total	Total minus nuclear and hydro
Fuel used in generation (Mtoe)								
Australia	39.64	0.50	4.52	0.00	1.44	1.02	47.12	45.7
EU	155.37	33.74	74.16	225.14	27.40	15.28	531.08	278.5
Electricity generated (TWh)								
Australia	160.6	2.7	26.2	0.0	16.8	1.8	208.1	191.3
EU	704.4	161.0	449.4	863.9	318.6	75.0	2572.3	1389.9

Source: IEA 2003.

Table A2 presents the average amount of fuel input needed to produce one unit of electricity output – that is, the table shows the quantity of each fuel used in generation divided by the total generation (from all sources) – for both total generation and generation excluding nuclear and hydro. Table A2 also presents average CO_2 emissions per unit of generation, based on IPCC (1997) emission factors.

Table A3 shows the impact on Australia's emissions of switching to the different fuel mixes implied by the emission factors calculated in Table A2. For example, the impact on Australia's emissions of switching to the average EU generation fuel mix is to reduce electricity emissions by 92.5 Mt CO_2. This alone reduces Australia's per capita emissions by 4.82 t CO_2. However, much of this reduction occurs because of a large

[20] Note, fuel used in combined heat and power plants is allocated between electricity generation and heat production on the basis of electricity and heat output and assuming high efficiency in heat production (since it is essentially a waste product of electricity generation).

shift to nuclear and hydroelectric generation. The impact of switching only Australia's non-nuclear and non-hydro generation to the average non-nuclear and non-hydro generation fuel mix used in the EU is only 44.85 Mt CO_2. However, this still equates to 2.34 t CO_2 per capita.

Table A2 Average fuel use and emissions from electricity generation in Australia and the EU, 2000

	Coal	Oil	Gas	Nuclear	Hydro	Other renew-ables	Total
Average fuel used per unit of electricity generated (MJ/MJ$_e$)							
Australia	2.216	0.028	0.252	0.000	0.081	0.057	2.634
EU	0.702	0.153	0.335	1.018	0.124	0.069	2.401
Average fuel used per unit of electricity generated, excluding nuclear and hydro (MJ/MJe)							
Australia	2.410	0.030	0.275	0.000	0.000	0.062	2.777
EU	1.300	0.282	0.621	0.000	0.000	0.128	2.331
Average emissions per unit of electricity generated (t CO_2/MWh)							
Australia	0.718	0.007	0.046	0.000	0.000	0.000	0.771
EU	0.228	0.037	0.062	0.000	0.000	0.000	0.326
Average emissions per unit of electricity generated, excluding nuclear and hydro (t CO_2/MWh)							
Australia	0.781	0.007	0.050	0.000	0.000	0.000	0.839
EU	0.421	0.069	0.114	0.000	0.000	0.000	0.604

Note: The following emission factors were applied: Coal (90 t CO2/TJ), Oil and petroleum (68 t CO2/TJ), Gas (51 t CO2/TJ), Other fuels (0 t CO2/TJ), based on IPCC (1997).

Table A3 Comparison of emissions from electricity generation in Australia using different fuel mixes, 2000

	Total	Total, excluding nuclear and hydro
Generation (TWh)	208.1	191.3
Emission factors (t CO_2/MWh)		
Australian fuel mix	0.771	0.839
EU fuel mix	0.326	0.604
Emissions (Mt CO_2)		
Australian fuel mix	160.43	160.43
EU fuel mix	67.93	115.59
Difference (Aust fuel mix - EU fuel mix)	92.50	44.85
Population (millions)	19.182	19.182
Per capita difference (t CO_2)	4.82	2.34

A1.2 Non-ferrous metal product manufacturing and road transportation

Table A4 presents IEA (2003) data for energy use in the non-ferrous metals and road transportation sectors for Australia and the EU in the year 2000. To determine differences in sectoral per capita emissions energy use is converted to CO_2 emissions using emission factors (based on IPCC 1997), and emission factors for electricity and heat. It is important to note that differences in emissions from electricity generation between Australia and the EU are accounted for already (see Table A3), and this analysis seeks to illustrate the extent to which factors other than Australia's more emissions-intensive electricity generation account for differences in sectoral emissions. Therefore, for delivered electricity we use the emission factors calculated in Table A5.

Table A4 Fuel use in the non-ferrous metals and road transportation sectors, Australia and the EU, 2000 (PJ)

	Coal and Coal Products	Petroleum Products	Natural Gas	Biomass	Electricity	Heat	Total
Non-ferrous metal product manufact.							
Australia	56.56	32.45	112.75	0.84	128.74	0.00	331.34
EU	28.51	55.43	104.04	0.21	240.15	0.33	428.69
Road transportation							
Australia	0.00	939.14	2.26	0.00	0.00	0.00	941.40
EU	0.00	10784.65	14.24	11.26	0.00	0.00	10810.15

Source: IEA 2003.

Table A5 Delivered electricity and emissions, Australia and the EU, 2000

	Electricity delivered (TWh)	Total emissions with EU electricity fuel mix (Mt CO_2)	Average emissions per delivered electricity (t CO_2/MWh)	(t CO_2/TJ)
Australia	172.8	67.93	0.393	109.2
EU	2200.3	839.86	0.382	106.0

Source: IEA 2003; Tables A3 above.

Table A6 presents sectoral emissions for non-ferrous metal product manufacturing and road transportation calculated as described above (that is, excluding the impact of Australia's more emissions-intensive electricity). Table A6 also presents per capita emissions for each of these sectors, and the difference between Australia and the EU. These results are discussed in more detail in Section 4.

Table A6 Emissions from the non-ferrous metals and road transportation sectors, Australia and the EU, 2000 (Mt CO_2)

	Coal and Coal Products	Petroleum Products	Natural Gas	Electricity	Heat	Total	Population	Per capita emissions
Non-ferrous metal product manufact.							(millions)	(tonnes CO_2)
Australia	5.09	2.21	5.75	14.06	0.00	27.11	19.182	1.41
EU	2.57	3.77	5.31	25.46	0.02	37.12	376.475	0.10
							Difference	1.31
Road transportation								
Australia	0.00	63.86	0.12	0.00	0.00	63.98	19.182	3.34
EU	0.00	733.36	0.73	0.00	0.00	734.08	376.475	1.95
							Difference	1.39

Note: see footnote to Table A2 for emission factors. See Table A4 for emission factors for electricity (note, the calculation for the emission factor for heat (55.5 tCO2/TJ) is not shown).

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