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# Greenhouse Gas Emissions Per Capita of Annex B Parties to the Kyoto Protocol

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## Executive Summary

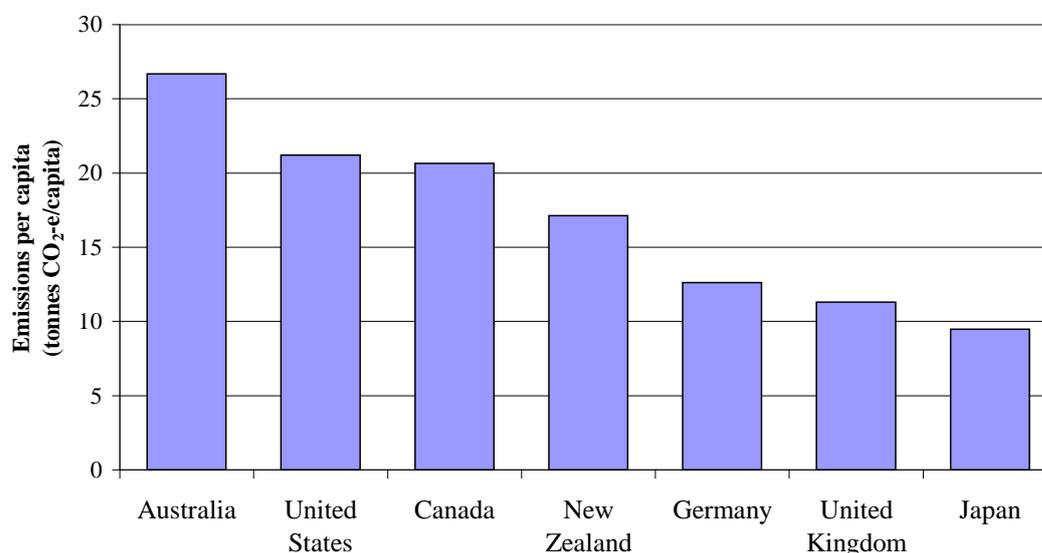
The international debate on climate change is heavily influenced by notions of fairness and justice. One of the most important principles referred to internationally is that of polluter pays. The most common interpretation of polluter pays is that national targets for the reduction of greenhouse gas emissions should be based on the level of emissions per person.

This paper reports new calculations of total greenhouse gas emissions per person for all 35 Annex B parties to the Kyoto Protocol, i.e. the industrialised nations that have signed up to emissions reduction targets.<sup>1</sup> The calculations are based on the official communications submitted by the various nations to the UN. They apply to emissions of the three main greenhouse gases (carbon dioxide, methane and nitrous oxide) in 1995 from all sources and all sinks measured in carbon dioxide equivalents (CO<sub>2</sub>-e).

The results show that Australia has the world's highest greenhouse gas emissions per person at 26.7 tonnes; this is twice the average level for all other wealthy countries (13.4 tonnes) and 25% higher than emissions per person in the USA (21.2 tonnes).

While the USA has higher emissions per capita from energy (20.6 tonnes compared to Australia's 17.6 tonnes), Australia has much higher levels of emissions from agriculture and land-use change.

**Net greenhouse gas emissions per capita for selected countries, 1995**



<sup>1</sup> This report is part of a larger study of the contribution of population growth to the past and future growth of Australia's greenhouse gas emissions being conducted in conjunction with the Centre for Population and Urban Research at Monash University. The full study will be published in the December issue of *People and Place*.

## 1. The polluter pays principle

Notions of fairness and justice underpin international negotiations to reduce greenhouse gas emissions. The concepts of burden sharing and 'common but differentiated responsibilities' enshrined in the UN Framework Convention on Climate Change (UNFCCC) are based on the widespread belief that nations that have contributed most to the problem of climate change should do most to solve it.

One of the most important principles referred to internationally is that of polluter pays. The most common interpretation of polluter pays is that national targets for the reduction of greenhouse gas emissions should be based on the historical contribution of each nation to global emissions. The most important factor in determining this contribution is the level of emissions per capita. A number of studies of burden sharing or differentiation have identified emissions per capita as the foremost criterion on which emission reduction targets should be based (for example, Elzen *et al.* 1999; Torvanger and Godal 1999; Walz *et al.* 1997). Other criteria include: the ability to pay (usually measured by GNP per capita), emissions intensity of output and dependence on fossil fuels.

Due to measurement difficulties, perception of emissions per capita have to date been based on energy emissions only, and on this basis it is widely believed that the USA has the world's highest emissions per capita. However, the provisions of the UNFCCC require Parties to compile and submit to the UN systematic and comprehensive inventories of emissions from all sources and sinks. The availability of these data on a consistent basis for Annex B (industrialised) countries now makes it possible to make a more thorough comparison of national emissions.

## 2. The data

Table 1 presents total emissions by sector for each Annex B country in 1995. It also presents 1995 population and per capita emissions. Figure 2 presents graphically the size and breakdown of per capita emissions for all Annex B countries. For those countries where the Land-Use Change and Forestry (LUC&F) sector is a net sink, the block of sequestered emissions below the zero line must be subtracted from the emissions above the line to obtain net emissions per capita. Figure 1 presents the same information as Figure 2 for selected Annex B countries.

The information presented in Table 1 and Figures 1 and 2 has been obtained from an Addendum to the Second compilation and synthesis of national communications presented under the Review of the Implementation of Commitments and of Other Provisions of the Convention (referred to from now on as UNFCCC 1998).<sup>2</sup>

The emissions information presented in Table 1 and Figures 1 and 2 represents carbon dioxide-equivalent (CO<sub>2</sub>-e) emissions of the three main greenhouse gases – carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). Emissions of these gases are reported consistently and are available for almost all countries (UNFCCC 1998, Tables A.1., A.2., A.6., A.7., A.8. and A.9.). Emissions of other greenhouse gases (HFCs, PFCs and SF<sub>6</sub>) are not included because a number of Annex B countries have not reported these emissions (UNFCCC, Table A.10.). Although potent greenhouse

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<sup>2</sup> FCCC/CP/1998/11/Add.2, <http://www.unfccc.org/resource/docs/cop4/11a02.pdf>

gases, the contribution made by these gases to total CO<sub>2</sub>-equivalent emissions is relatively small. For example, in Australia these gases contributed 0.3% to 1996 CO<sub>2</sub>-equivalent emissions (NGGIC 1998, p. xviii). Emissions of the three main greenhouse gases were converted to carbon dioxide equivalents using the global warming potentials reported by the Intergovernmental Panel on Climate Change (NGGIC 1999, p. vi, xiv) and aggregated according to source (see Table 1).

Emissions of CO<sub>2</sub> from the land-use change and forestry sector (LUC&F) are also incorporated into Tables 1 and Figures 1 and 2 (UNFCCC 1998, Table A.5.). The UNFCCC did not report the emissions of other gases (CH<sub>4</sub>, N<sub>2</sub>O etc.) from this sector.

A number of sources of greenhouse gas emissions have been excluded from this analysis. Emissions from international bunkers (fuel used in international shipping and aviation) are excluded because they are not included in national inventories. Greenhouse gas precursor gases and SO<sub>x</sub> are also excluded from these calculations. Precursor gases comprise carbon monoxide (CO), oxides of nitrogen (NO<sub>x</sub>) and non-methane volatile organic compounds (NMVOC).

There are several Annex B countries that did not report 1995 emissions information to the UNFCCC, requiring the use of emissions data for these countries from earlier years. In the case of the Ukraine, Slovenia and Lithuania the most recent emissions data were from 1990. For Belgium, Poland, Portugal, the Russian Federation and Spain 1994 data were used. For Germany and Japan a combination of 1995 and 1994 data were used. Monaco reported 1996 data instead of 1995.

An important point to note is that a number of countries did not report emissions and removals for some sectors, particularly LUC&F. The UNFCCC noted an inconsistency in methods of reporting LUC&F emissions (UNFCCC 1998, Table A.2.). Canada, Greece, Iceland and Monaco did not report emissions or removals from the LUC&F sector at all (at least in a form that satisfied IPCC guidelines). Estimates of Sweden's 1995 LUC&F emissions were not available so 1992 estimates were used. Finland reported a range of emissions estimates to account for 'cultivated peatlands and non-viable drainage areas' (UNFCCC 1998, Table A.5.) so an average was used. Australia was the only country to report the Forest and Grassland Conversion (F&GC) subsector of LUC&F separately. This subsector was responsible for 'an additional 80,972 Gg of CO<sub>2</sub> in 1995' (UNFCCC 1998, Table A.5.).

Omissions existed for other sectors as well. Spain reported an estimate of '2,657 Gg of emissions [of CO<sub>2</sub>] from waste' that was 'not included in the Party's national total'. Instead, Spain included an estimate of 863 Gg CO<sub>2</sub> in its national total, which 'included emissions resulting from both non-renewable waste and torches in the chemical industry and refineries.' (UNFCCC 1998, Table A.2.). Spain also reported 17,554 Gg CO<sub>2</sub> of emissions from agriculture for information purposes only (meaning it is not included in their inventory). Sweden, Finland, Iceland and Estonia did not report estimates for fugitive emissions of CH<sub>4</sub>. Similarly, Monaco did not provide estimates of CH<sub>4</sub> or N<sub>2</sub>O emissions from any sector, but indicated such emissions were negligible (UNFCCC 1998, Table A.7., Table A.9.).

### 3. Results

The results show that Australia has the world's highest greenhouse gas emissions per person at 26.7 tonnes; this is twice the average level for all other industrialised countries (13.4 tonnes) and 25% higher than emissions per person in the USA (21.2 tonnes).

While the USA has higher emissions per capita from energy (20.6 tonnes compared to Australia's 17.6 tonnes), Australia has much higher levels of emissions from agriculture and land-use change. Australia's emissions from land clearing fell sharply between 1990 and 1995, and it is likely that the difference between Australia and the USA in the earlier year would have been greater than in 1995. The year 1990 is especially important because it is the base year for calculating mandatory emission targets in the commitment period 2008-2012 under the Kyoto Protocol.

In descending order, the six nations with the highest per capita emissions are: Australia (26.7), Luxembourg (24.2), USA (21.2), Canada (20.6), New Zealand (17.3) and Ukraine (16.7). The next five countries have emissions per capita of 14 to 15 tonnes. Luxembourg's very high emissions are due to the presence of a large steel plant. New Zealand has low energy emissions (due to the predominance of hydro-electricity) but very high emissions from agriculture (due to the large number of sheep). These are offset to some extent by the net sink provided by forests in that country.

Among larger countries at the other end of the scale, France (7.8), Germany (12.6), Spain (7.1), Italy (9.0) and Japan (9.5) are notable. Their low emissions are due to a combination of energy efficiency, industrial structure and the use of nuclear power.

## References

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**Table 1 Total emissions, breakdown by source and per capita emissions for Annex B countries , 1995 (Mt CO<sub>2</sub>-equivalents)<sup>a</sup>**

	Energy		Industry	Agriculture	Waste	LUC&F	Other	Total	Population 1995 (millions)	Per capita emissions (t CO <sub>2</sub> -e/capita)
	Fuel combustion	Fugitive								
Australia	291.77	25.58	7.45	87.36	16.36	51.87	1.55	481.94	18.07	26.67
Austria	50.05	2.46	11.49	5.41	4.63	-13.58	4.13	64.59	8.06	8.01
Belgium <sup>c</sup>	112.83	0.95	14.27	11.52	4.99	-2.06	0.06	142.56	10.14	14.06
Bulgaria	59.34	5.57	8.18	3.40	10.96	-7.52	0.06	79.98	8.41	9.51
Canada	478.96	48.20	36.34	25.04	19.47	0.00	3.31	611.32	29.62	20.64
Czech Republic	130.37	8.51	5.22	3.45	3.02	-5.45	0.30	145.42	10.33	14.08
Denmark	58.91	0.71	1.31	16.17	1.55	-0.96	0.46	78.14	5.23	14.94
Estonia	20.93	0.00	0.22	0.84	0.67	-13.27	0.00	9.39	1.49	6.30
Finland	57.33	0.08	1.77	4.64	2.79	-10.50	0.08	56.19	5.11	11.00
France	365.79	14.33	40.79	48.88	19.15	-46.80	9.93	452.06	58.14	7.78
Germany <sup>e</sup>	885.13	24.57	50.31	61.52	39.90	-30.00	0.00	1031.43	81.66	12.63
Greece	84.79	1.03	8.33	8.37	2.77	0.00	0.00	105.29	10.45	10.08
Hungary	58.97	6.62	2.28	3.06	6.11	-4.80	0.00	72.23	10.23	7.06
Iceland	1.77	0.08	0.46	0.29	0.04	0.00	0.01	2.65	0.27	9.81
Ireland	33.27	0.23	2.58	19.28	2.95	-6.23	0.75	52.83	3.6	14.68
Italy	425.20	10.07	29.31	41.84	21.65	-24.51	12.39	515.95	57.3	9.00
Japan <sup>c</sup>	1162.10	3.55	68.65	20.65	28.54	-94.62	1.51	1190.38	125.57	9.48
Latvia	12.16	0.46	0.13	5.81	0.64	-10.48	0.04	8.76	2.52	3.48
Lithuania <sup>b</sup>	37.75	0.55	2.64	7.15	3.49	-8.85	4.09	46.81	3.72	12.58
Luxembourg	9.16	0.04	0.41	0.51	0.08	-0.30	0.01	9.92	0.41	24.19
Monaco <sup>d</sup>	0.08	0.00	0.00	0.00	0.05	0.00	0.00	0.13	0.03	4.30
Netherlands	183.66	3.57	7.61	18.31	9.13	-1.70	1.48	222.06	15.46	14.36
New Zealand	24.95	1.19	2.74	44.33	2.77	-13.49	0.20	62.69	3.66	17.13
Norway	29.89	2.35	8.52	3.88	6.78	-13.64	0.34	38.12	4.36	8.74
Poland <sup>c</sup>	365.18	18.90	13.76	22.87	17.96	-41.95	0.23	396.94	38.59	10.29
Portugal <sup>c</sup>	47.92	0.26	4.01	6.33	13.77	-1.15	0.27	71.41	9.92	7.20
Russian Fed <sup>c</sup>	1607.27	297.20	24.37	114.53	41.04	-568.00	9.95	1526.37	148.2	10.30
Slovakia	45.99	2.25	3.43	4.24	1.45	-5.12	0.19	52.42	5.37	9.76
Slovenia <sup>b</sup>	13.60	1.07	0.64	2.35	1.60	-2.29	1.79	18.75	1.99	9.42
Spain <sup>c</sup>	221.62	13.41	18.85	37.64	15.30	-28.97	0.04	277.88	39.21	7.09
Sweden	56.29	0.02	5.17	4.20	1.28	-30.00	0.25	37.21	8.83	4.21
Switzerland	40.95	0.34	2.71	5.84	2.85	-5.10	0.12	47.72	7.08	6.74
Ukraine <sup>b</sup>	671.17	130.81	33.70	50.50	19.68	-51.98	7.25	861.12	51.55	16.70
United Kingdom	533.77	23.94	28.93	26.19	38.44	9.95	1.53	662.75	58.61	11.31
United States	5206.40	202.49	96.43	268.23	236.44	-428.00	0.00	5581.99	263.17	21.21
<b>Total</b>	<b>13385.31</b>	<b>851.36</b>	<b>542.98</b>	<b>984.59</b>	<b>598.30</b>	<b>-1409.50</b>	<b>62.33</b>	<b>15015.37</b>	<b>1106.36</b>	<b>13.57</b>

a: Main gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O), excluding bunkers and non-CO<sub>2</sub> emissions from LUC&F. Year is 1995 unless stated otherwise.

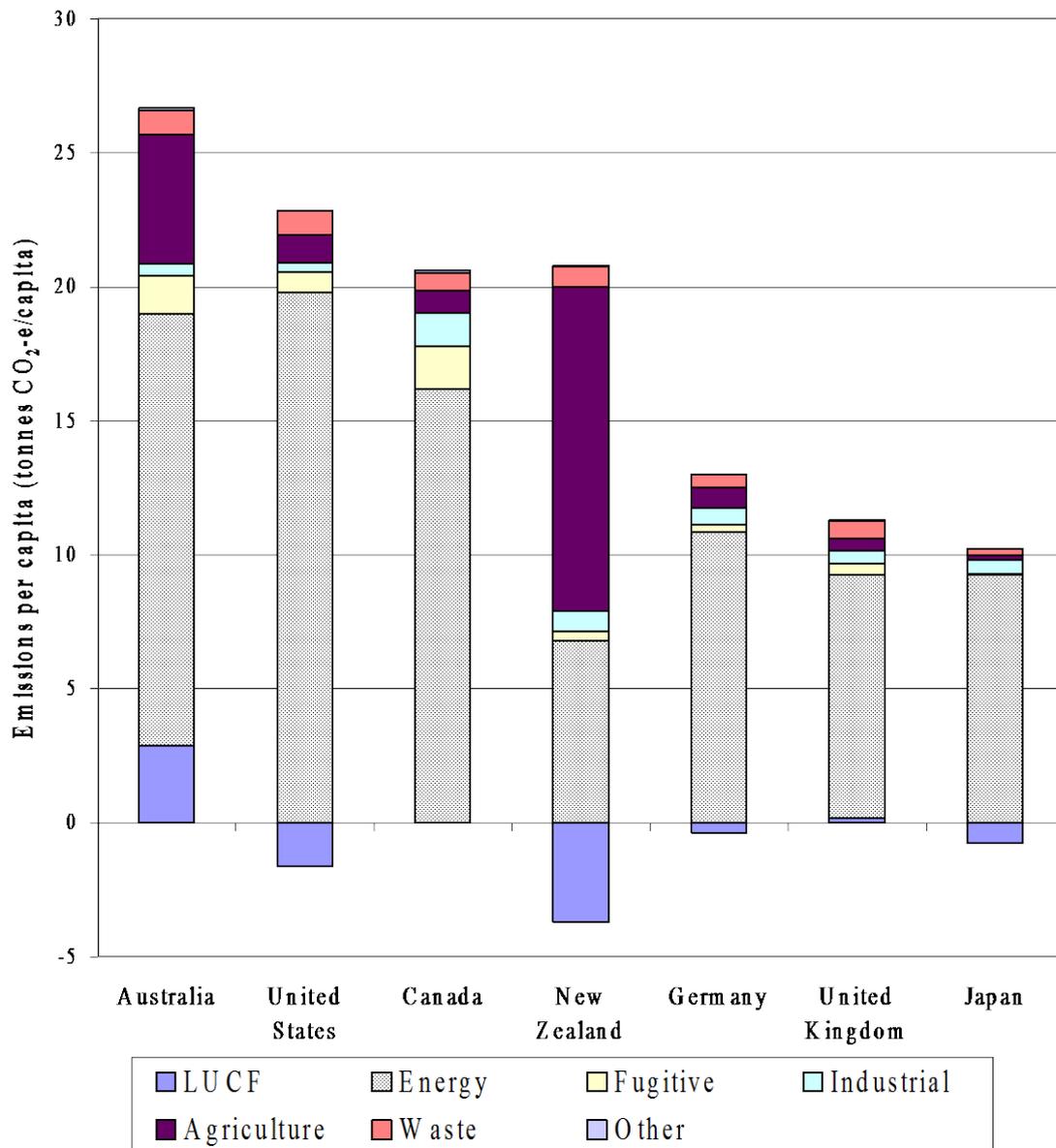
b: 1990 data c: 1994 data d: 1996 data

e: Combination of 1994 and 1995 data

Note: there are a number of instances where countries did not report emissions and emissions have been counted as zero.

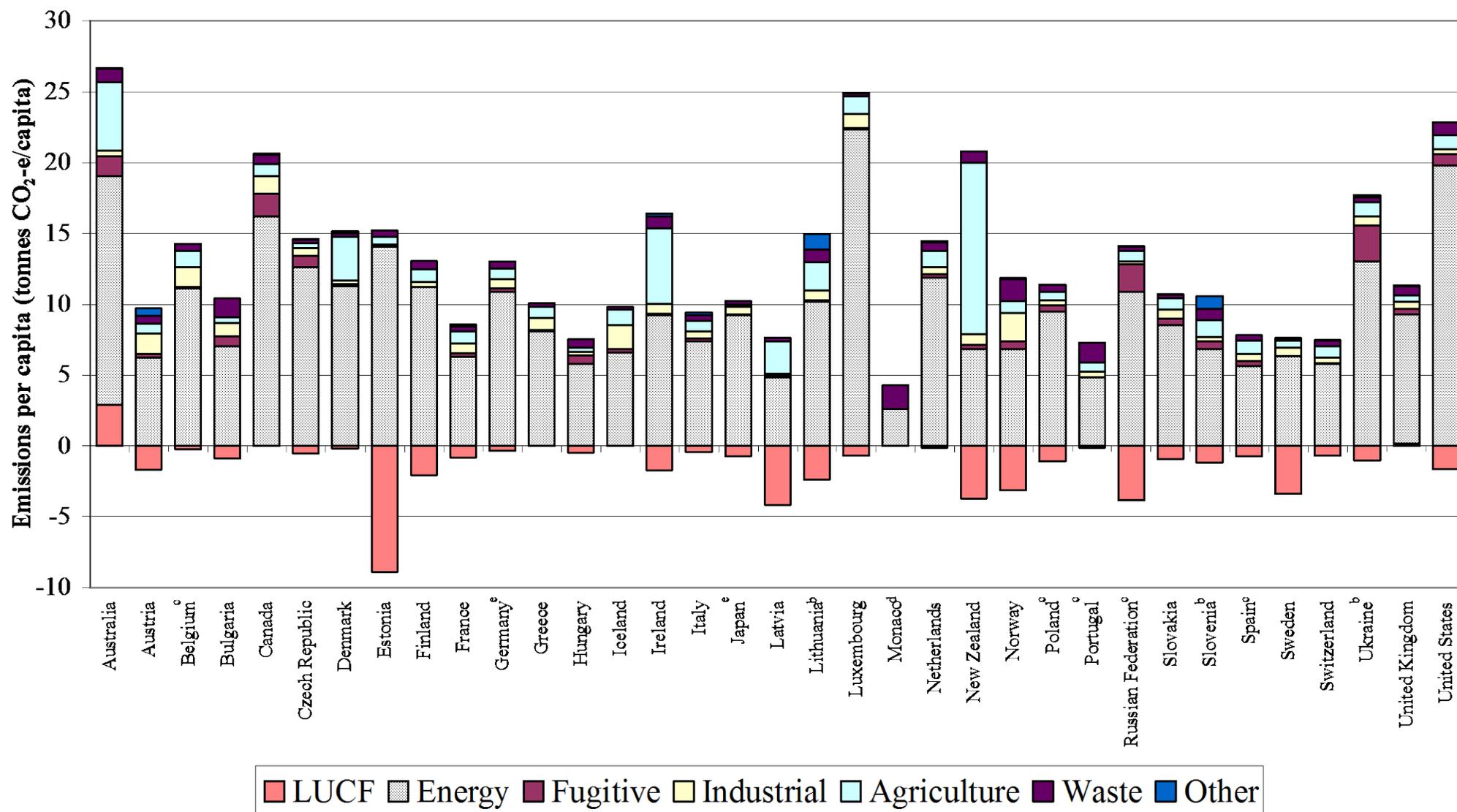
Source: UNFCCC 1998. Population data obtained from IEA 1997, p. 48–57. Monaco's population was obtained from <http://www.monaco.monte-carlo.mc/us/presentation/index.html>.

**Figure 1 Greenhouse gas emissions per capita by source for selected countries, 1995**



Note: For those countries where the LUC&F sector is a net sink, the block of sequestered emissions below the zero line in the figure must be subtracted from the emissions above the line to obtain net emissions per capita.

**Figure 2 Emissions per capita by source for Annex B countries, 1995**



Note: For description of footnotes, refer to Table 1.