ADVANCING THE INTERNATIONAL EFFORT AGAINST CLIMATE CHANGE

CLIMATE DATA:

A SECTORAL PERSPECTIVE

by

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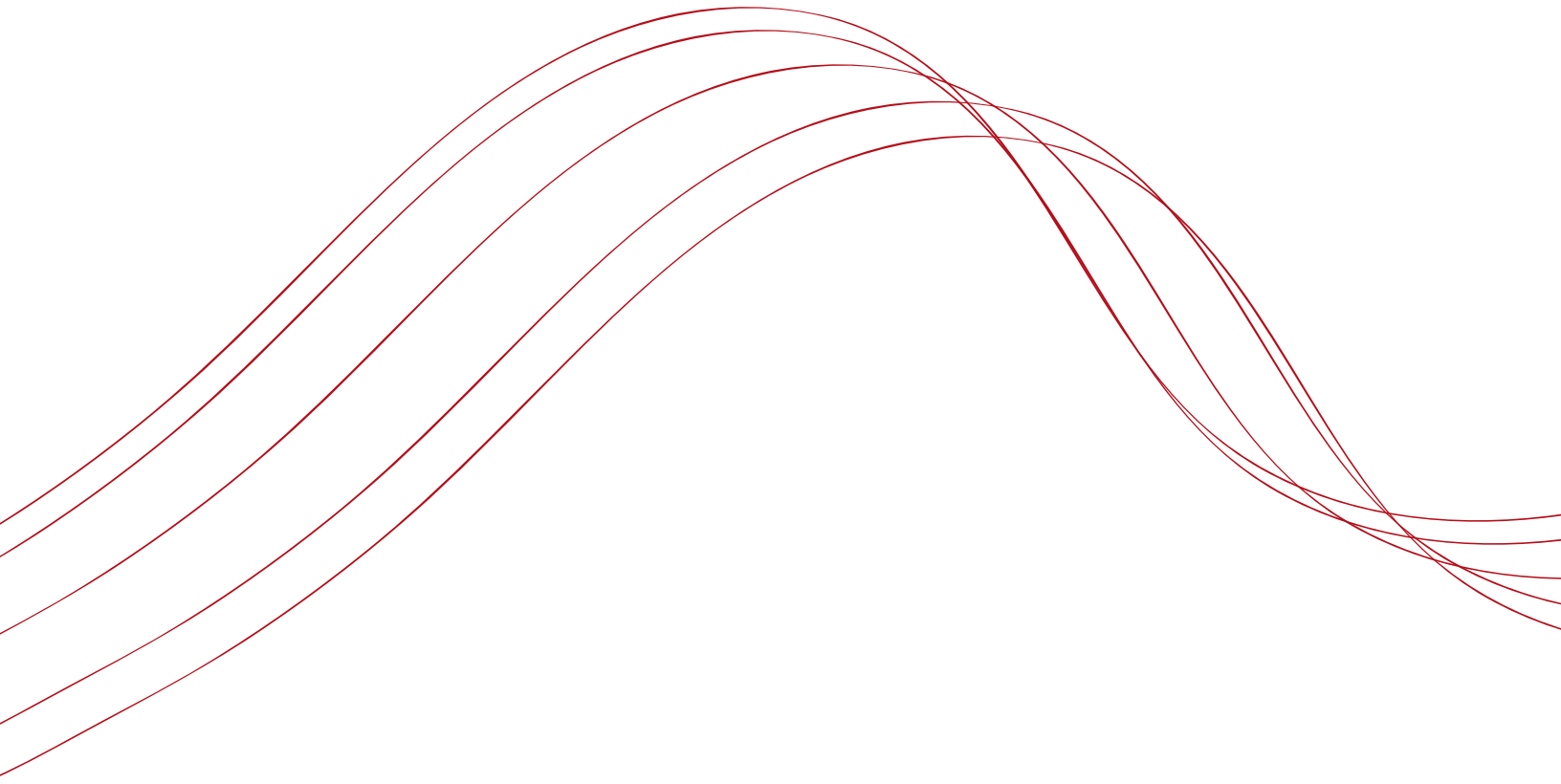
WORLD RESOURCES INSTITUTE

PEW CENTER ON Global CLIMATE CHANGE



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Contents

Explanatory Notes

The following conventions and caveats apply to the data and analysis presented in this paper:

- **Definition of Sectors.** When examining GHG emissions, the authors have followed the sectors and sub-sector definitions adopted by the Intergovernmental Panel on Climate Change (IPCC, 1996). However, there are several exceptions which have been noted in the text and supporting documentation to the World Resources Institute's Climate Analysis Indicators Tool (CAIT).[1] In some cases, the authors have deviated from IPCC guidelines because the underlying GHG data sources do not match IPCC definitions. In other cases, the authors have altered sector definitions to enable a more comprehensive accounting of a particular *end-use* activity (e.g., under the IPCC guidelines, fossil fuel-related emissions from agriculture are included in the Energy rather than Agriculture sector).

- **Data Sources.** Most information presented in this paper is drawn from CAIT (see Appendix). Where noted, data are drawn from other sources or studies. CAIT's GHG data is drawn from a wide variety of sources, including the Carbon Dioxide Information Analysis Center (CDIAC); Richard Houghton; the Intergovernmental Panel on Climate Change (IPCC); the International Energy Agency (IEA); U.S. Environmental Protection Agency (EPA); and the U.S. Energy Information Administration (EIA). A comprehensive discussion of GHG data and sources used in CAIT can be downloaded from the CAIT website.[2] The sources of any data presented here not derived from CAIT are identified in the relevant figures and tables.

- **Treatment of different gases.** When examining GHG emissions by sector, the default approach taken is to include six greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs). However, several of the sectors, particularly those related to energy use, include only CO_2 emissions (e.g., Electricity and Heat).

- **Uncertainty.** In some cases, there is significant uncertainty with respect to emission figures. This is especially the case for non-CO_2 data and for CO_2 estimates from the land-use change and forestry sector. More information about uncertainty can be found in CAIT's supporting documentation[3] and from the underlying data sources referenced therein.

- **The European Union.** In addition to individual member states, the European Union (EU) is in most cases treated as a "country." This is because the European Community has acceded to the UN Framework Convention on Climate Change (UNFCCC) as a regional economic integration organization, with "Party" status. Furthermore, the EU is typically considered as a 25-member state body (reflecting EU membership as of 2004), rather than the 15-member state body that existed when the EU ratified the Kyoto Protocol. To avoid double counting when national data are summed, data are included for the EU but not for individual member states.

Introduction

An earlier paper, *Climate Data: Insights and Observations*, presented a range of climate-related data relevant to the consideration of future international efforts to address global climate change. It provided data primarily at the global and national levels, with particular focus on the 25 countries with the largest total greenhouse gas (GHG) emissions.[4]

This note supplements that paper, taking a closer look at data by sector, again with a focus on major emitters. It presents sector-specific data by country and, for some sectors, identifies leading producers and manufacturers.

As with the previous paper, a number of caveats apply:

- This paper represents a preliminary effort to compile climate-relevant sectoral data. Some of the methodologies employed are being refined. Improved data and further analysis will be available in forthcoming work by the authors.[5]
- Much of the data are dated and the years are inconsistent, with both national and industry information often coming from different sources and years (ranging from 1995 to 2003).
- The data are incomplete. Data on the OECD countries are generally more comprehensive (and likely more accurate) than data on developing countries. Industry data are primarily from industry association sources, and have not been independently verified.
- Data may not be comparable. Generally, this paper uses the sector definitions established in the IPCC Guidelines. In some cases, however, data is presented using different definitions. This is due to inconsistencies in the underlying data sources used.

I. Overview

Figure 1 provides a global overview of GHG emissions by sector. It includes all greenhouse gases and sources—carbon dioxide (CO_2) from fossil fuel use, CO_2 from land use change, and non-CO_2 gases. From top to bottom, the figure shows total GHG emissions by gas, each sector's share of total global emissions, and the principal sources within each sector. While the major sectors are discussed in greater detail in subsequent sections of this note, a number of general conclusions emerge here:

- The sectors responsible for the largest shares of global GHG emissions are electricity and heat (22 percent), land use change and forestry (18 percent), agriculture (14 percent), transportation (13 percent), and manufacturing and construction (10 percent).

- The bulk of global GHG emissions are CO_2. Its principal sources are electricity generation, land use change and forestry, transportation, and manufacturing.

- Of the non-CO_2 gases, the most significant are methane and nitrous oxide. Their principal sources are agricultural activity.

Figure 2 presents total GHG emissions of the major emitting countries, and the relative contribution of different sectors' direct emissions to a country's national total. A number of general conclusions can be drawn from the data in Figure 2:

- *Electricity and Heat* represents the largest source of emissions for 15 of the 25 countries. Its contribution to national emissions ranges from 2 percent in Brazil to 48 percent in South Africa.

- *Transportation* emissions range from 4 percent of the national total (Ukraine) to a quarter of total emissions (France, Spain, USA). In general, the share in developing countries ranges from 2 to 10 percent, and in industrialized countries, from 15 to 25 percent. Transportation is the fastest growing share of emissions in most countries.

- *Agriculture and Waste*[6] constitutes the largest share of emissions from three countries, including Argentina, Pakistan, and India. In other countries, such as Japan, South Korea, and Saudi Arabia, this sector produces almost no emissions.

- *Manufacturing and Industry* emissions range from a very small share of the national total in Argentina and Brazil to 27 percent in China, with developing, transition, and industrialized economies spread across that range. For instance, the share of national emissions is small for the United States and Pakistan (12 and 10 percent, respectively) and large for Japan and China (26 and 27 percent).

- *Other* represents the largest share of emissions in four countries, including Russia and Ukraine. This category includes mostly "on-site" energy-related emissions, including from residential, commercial (i.e., mostly buildings), and fugitive sources (i.e., from mining of coal, oil, and gas). Emissions from these activities range from very small shares of the national total in Brazil and Indonesia to 41 percent in Ukraine.

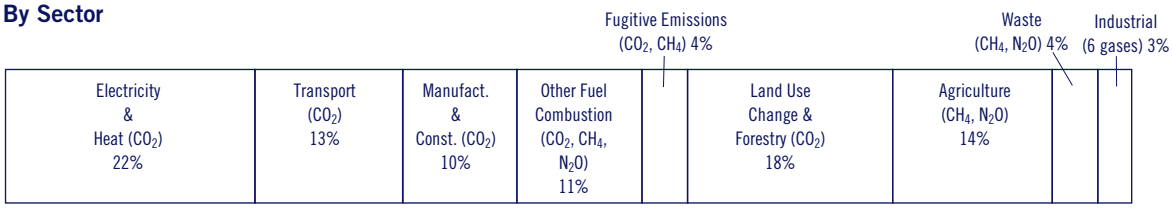
- *Land-Use Change and Forestry* (LUCF) emissions are the largest share of emissions in two countries, Brazil and Indonesia (see Land-Use Change and Forestry section, below). It should be noted, however, that the LUCF estimates shown in Figure 2 are highly uncertain. Errors here could have significant effect on the other sectoral shares in Brazil and Indonesia (which, if LUCF is overstated, would be larger).

Figure 1

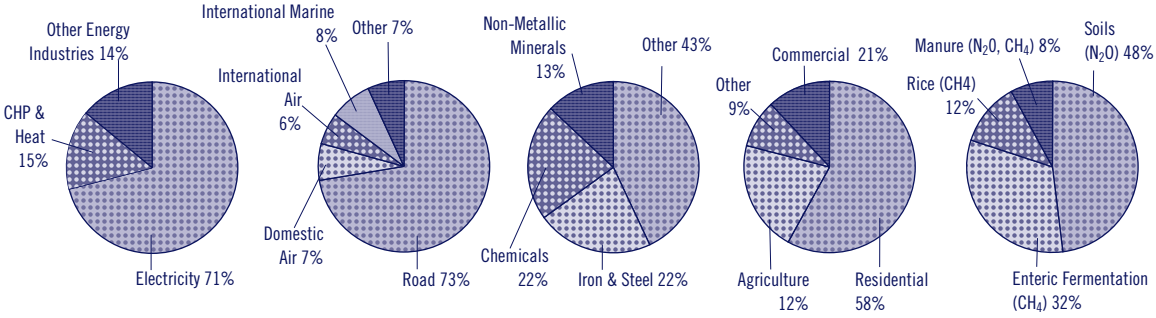
Global Emissions of Greenhouse Gases, 2000

By Gas

By Sector



By Sub-Sector

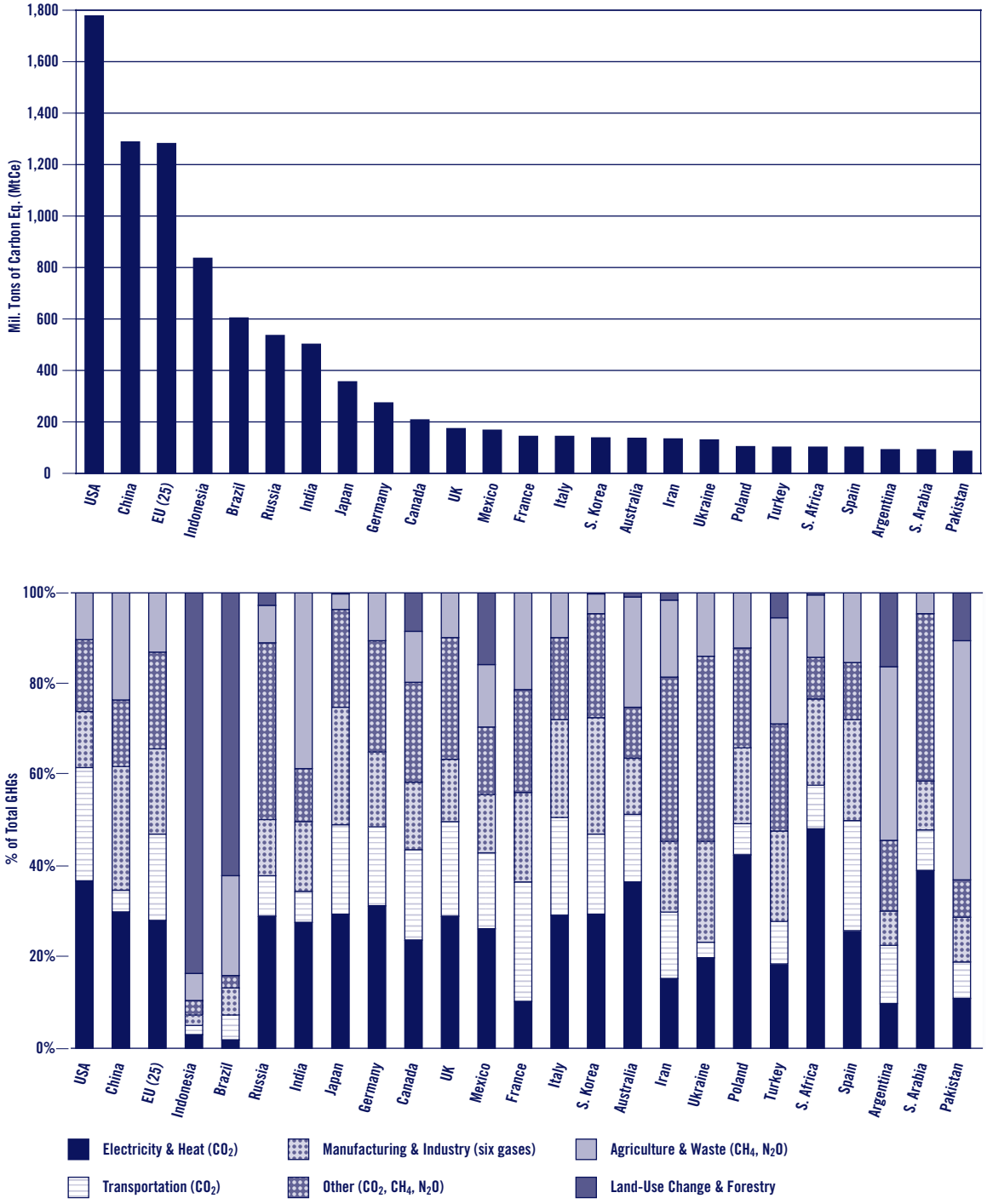


Sources: World Resources Institute, Climate Analysis Indicators Tool (CAIT v. 2.0). Underlying data: International Energy Agency, U.S. Environmental Protection Agency, U.S. Energy Information Administration, Carbon Dioxide Information Analysis Center.

Notes:
Figures may add up to more than 100% due to rounding.
Sectors and sub-sectors correspond to those specified by the IPCC Guidelines, with the exception of International Bunker, which has been included in the Transport sector (because the above are global, not national figures). Due to incompatibilities between IPCC Guidelines and some greenhouse gas data sources, small amounts of emissions (particularly in the Transport, Energy Industries, and Manufacturing & Construction may be imprecisely allocated at the sector or sub-sector level. For display purposes, they are presented as individual sectors here.
Transport, Electricity & Heat, Manufacturing & Construction, and Other Fuel Combustion collectively constitute "Energy" emissions under the IPCC Guidelines. "Electricity & Heat" pertains to IPCC Source Category A1A (Energy Industries) and includes emissions related to petroleum refining and fossil fuel extraction.
Sub-sector emissions from transport include CO_2 only. CH_4 and N_2O from mobile sources are included in "Other Fuel Combustion."
High-GWP gases include HFCs, PFCs, and SF_6. Emissions of these gases are found only in the Industrial Processes sector.
For more details, see *CAIT: GHG Sources and Methods*, at: http://cait.wri.org.

Figure 2

Total GHG Emissions and Relative Sectoral Shares (2000, all GHGs; including LUCF)



Notes: For simplicity, CAIT and IPCC sector categories have been altered for this figure. "Manufacturing & Industry" includes IPCC Category 1A2 (Manufacturing and Construction) and 2 (Industrial Processes). "Other" includes emissions from IPCC Categories IA4 (e.g., residential, commercial), IA5 (e.g., unallocated emissions), and 1B (fugitive emissions from coal, oil, and gas). Emissions from Land-Use Change & Forestry (LUCF) sector are subject to very large uncertainties. For countries where the LUCF sector is a net sink, the sector shares shown above represent shares of total emissions excluding LUCF. For more information on sector definitions and uncertainty, see *CAIT: GHG Sources & Methods,* at: http://cait.wri.org.

II. Energy and Fuels

As shown in **Figure 1**, CO_2 accounts for the large majority of global GHG emissions, and its largest source is fossil fuel combustion. Later sections look at emissions from the major fossil fuel-consuming sectors—electricity and heat, transportation, and manufacturing. This section focuses on the fuels, in terms of production, consumption, and reserves in the top GHG emitting countries.

Because fossil fuels are carbon-intense resources, it is not surprising that fossil fuel consumption is highly correlated with total GHG emissions. This is particularly true for coal and oil consumption; the top five coal consuming countries are also the top five GHG emitters, while the top six oil consumers comprise the top six GHG emitters. However, coal consumption does not always correlate with total GHG emissions. Consumption in South Africa and Poland (6th and 8th respectively) rank much higher than those countries' emissions (18th and 19th), while Brazil's emissions (7th) rank higher than its coal consumption (22nd). The correlation between natural gas consumption and GHG emissions is not as strong, reflecting the relatively low carbon intensity of natural gas. Only two of the top five gas-consuming countries are among the top five GHG emitters.

Coal

Table 1 shows coal consumption, production, and reserves in the top GHG emitting countries. Together, these countries account for 91 percent of global coal consumption, 93 percent of production, and 91 percent of known reserves. Coal mining and use is highly concentrated; the top five coal-consuming countries alone account for 69 percent of coal consumption and 67 percent of production. Six countries—the United States, the Russian Federation, China, India, Australia, and South Africa—contain 76 percent of global coal reserves and account for 80 percent of coal production. A comparison of coal production and consumption gives a rough estimate of coal exports and imports.[7] Unlike oil and to some extent natural gas, most coal is consumed domestically. The major exceptions are Japan (a significant coal importer) and Australia (a significant exporter).

Electricity and heat account for 69 percent of coal consumption, with the industry and residential sectors representing smaller shares.

Oil

Table 2 shows oil consumption, production, and reserves in the top GHG emitting countries (plus top oil producing countries that are not top GHG emitters). Together, the top GHG emitting countries account for 78 percent of oil consumption, 62 percent of production, and 51 percent of known oil reserves. Oil reserves

Table 1

World Coal Consumption, Production, and Reserves, 2003

	Consumption			Production			Reserves
	Mtoe	Rank	% World	Mtoe	Rank	% World	Mtoe
China	800	(1)	31.0%	843	(1)	33.5%	58,900
United States	574	(2)	22.3%	551	(2)	21.9%	121,962
India	185	(3)	7.2%	172	(4)	6.8%	55,597
Japan	112	(4)	4.4%	1	(32)	0.0%	515
Russian Federation	111	(5)	4.3%	125	(6)	5.0%	68,699
South Africa	89	(6)	3.4%	135	(5)	5.3%	33,013
Germany	87	(7)	3.4%	54	(9)	2.1%	29,667
Poland	59	(8)	2.3%	71	(7)	2.8%	14,153
Korea	51	(9)	2.0%	2	(29)	0.1%	52
Australia	50	(10)	1.9%	189	(3)	7.5%	41,547
United Kingdom	39	(11)	1.5%	17	(15)	0.7%	833
Ukraine	39	(12)	1.5%	42	(11)	1.7%	16,809
Canada	31	(14)	1.2%	33	(12)	1.3%	3,350
Spain	21	(16)	0.8%	7	(20)	0.3%	287
Indonesia	19	(18)	0.7%	71	(8)	2.8%	2,053
Turkey	16	(19)	0.6%	11	(17)	0.4%	1,322
Italy	15	(20)	0.6%	—	—	0.0%	—
France	12	(21)	0.5%	1	(31)	0.1%	19
Brazil	11	(22)	0.4%	2	(27)	0.1%	3,976
Mexico	8	(28)	0.3%	5	(22)	0.2%	690
Pakistan	3	(39)	0.1%	1	(30)	0.1%	755
Iran	1	(46)	0.0%	—	—	0.0%	—
Argentina	1	(48)	0.0%	—	—	0.0%	—
Saudi Arabia	—	—	0.0%	—	—	0.0%	—
Rest of World	**245**		**9.5%**	**188**		**7.4%**	**46,971**
World	**2,578**			**2,519**			**501,172**

Source: BP (2004).

Notes:
"—" Signifies no data.
The countries shown account for 91% of coal consumption and 93% of coal production.
Coal production and reserves are highly correlated, so country rankings for reserves are not shown. However, the Reserve/Production (R/P) ratio is significantly higher for Brazil, and to a lesser extent, Japan, Russia, Germany, and Pakistan.
Coal production and consumption are extremely highly correlated, reflecting the fact that almost all coal is consumed domestically.

are highly concentrated; 74 percent of known reserves reside in just seven countries—Saudi Arabia, Iran, Iraq, the United Arab Emirates, Kuwait, Venezuela, and the Russian Federation. However, oil production and consumption are less concentrated than for coal. Furthermore, unlike coal, oil is heavily traded internationally; among major GHG emitters, most countries are either significant net importers or exporters of oil.

Transportation consumes the largest share of oil, nearly 50 percent, with electricity and heat, industry, and residential use accounting for the rest.

Table 3 lists major oil companies, ranked by production levels. Collectively, these companies account for approximately 60 percent of global production. They have headquarters in 19 countries (although production occurs in many more).

Table 2

World Oil Consumption, Production, and Reserves, 2003

	Consumption			Production			Reserves
	Mil. Tonnes	Rank	% World	Mil. Tonnes	Rank	% World	Mil. Tonnes
United States	914.3	(1)	25.1%	341.1	(3)	9.2%	4183.5
China	275.2	(2)	7.6%	169.3	(6)	4.6%	3232.7
Japan	248.7	(3)	6.8%	0.0	—	0.0%	—
Germany	125.1	(4)	3.4%	0.0	—	0.0%	—
Russian Federation	124.7	(5)	3.4%	421.4	(2)	11.4%	9425.2
India	113.3	(6)	3.1%	36.7	(26)	1.0%	761.1
Korea	106.0	(7)	2.9%	0.0	—	0.0%	—
Canada	96.0	(8)	2.7%	142.0	(9)	3.8%	2,302.0
France	94.0	(9)	2.6%	0.0	—	0.0%	—
Italy	92.0	(10)	2.5%	6.0	(45)	0.2%	102.0
Brazil	84.0	(11)	2.3%	77.0	(15)	2.1%	1,446.0
Mexico	83.0	(12)	2.3%	189.0	(5)	5.1%	2,188
United Kingdom	77.0	(13)	2.1%	106.0	(13)	2.9%	609.0
Spain	76.0	(14)	2.1%	0.0	—	0.0%	—
Saudi Arabia	67.0	(15)	1.8%	475.0	(1)	12.8%	35,836.0
Iran	54.0	(16)	1.5%	190.0	(4)	5.1%	17,826.0
Indonesia	54.0	(17)	1.5%	58.0	(18)	1.6%	605.0
Australia	38.0	(21)	1.1%	27.0	(29)	0.7%	601.0
Turkey	32.0	(24)	0.9%	0.0	—	0.0%	—
South Africa	24.0	(26)	0.7%	0.0	—	0.0%	—
Venezuela	24.0	(27)	0.7%	153.0	(7)	4.2%	10,639.0
Poland	21.0	(30)	0.6%	0.0	—	0.0%	—
Argentina	18.0	(31)	0.5%	39.0	(23)	1.1%	436.0
Pakistan	17.0	(32)	0.5%	0.0	—	0.0%	—
United Arab Emirates	15.0	(36)	0.4%	118.0	(10)	3.2%	13,340.0
Kuwait	14.0	(38)	0.4%	110.0	(11)	3.0%	13,163.0
Ukraine	13.0	(40)	0.4%	0.0	—	0.0%	—
Algeria	10.0	(45)	0.3%	79.0	(14)	2.1%	1,543.0
Norway	10.0	(47)	0.3%	153.0	(8)	4.1%	1,378.0
Nigeria	—	—	0.0%	107.0	(12)	2.9%	4,685.0
Rest of World	**719.0**		**19.8%**	**701.0**		**19.0%**	**32,248.0**
World	**3,637**			**3,697**			**156,547**

Source: BP (2004).

Notes:

Italicized countries are those not among the top 25 emitters, but whose oil production accounts for at least 2% of the world total.

"—" Signifies no data.

The countries shown account for 91% of coal consumption and 93% of coal production.

Oil production and reserves are highly correlated, so country rankings for reserves are not shown. However, the Reserve/Production (R/P) ratio is significantly higher for OPEC countries.

Oil production and consumption are only loosely correlated compared to gas and coal, reflecting the fact that most countries are next exporters or importers.

Table 3

Major Oil Companies 2002

Company	Country	Production (Kilotonnes per Day)	Reported Reserves (Mil. Tonnes)	Refining Capacity (Kilotonnes per Day)
Saudi Aramco	Saudi Arabia	1,133	35,716	284
NIOC	Iran	515	12,237	201
Pemex	Mexico	486	5,896	231
PDV	Venezuela	409	10,612	421
ExxonMobil	United States	347	1,680	854
INOC	Iraq	329	15,348	88
Royal Dutch Shell	United Kingdom & Netherlands	303	1,292	437
PetroChina	China	285	1,495	262
ChevronTexaco	United States	267	1,188	320
BP	United Kingdom	263	1,143	445
KPC	Kuwait	240	13,165	136
Yukos (2003)†	Former Soviet Union	224	2,007	104
Lukoil (2003)†	Former Soviet Union	223	2,180	116
TotalFinaElf	France	198	950	352
NNPC	Nigeria	194	1,965	60
Petrobras	Brazil	188	1,057	276
Sonatrach	Algeria	181	1,192	63
Adnoc	United Arab Emirates	174	7,338	69
ConocoPhillips	United States	139	702	357
Surgutneftegas†	Former Soviet Union	135	1,334	42
Pertamina	Indonesia	122	546	136
ENI	Italy	117	539	111
Repsol YPF	Spain	88	313	160
Tatneft†	Former Soviet Union	67	838	23

Source: Intertanko (2003), except †: Company annual report. Lukoil (2004); Surgutneftegas (2003); Tatneft (2003); and Yukos (2005).

Natural Gas

Table 4 shows natural gas consumption, production, and reserves in top GHG emitting countries (plus countries that are not top GHG emitters but that account for significant gas production or reserves). Together, the top GHG emitters account for 78 percent of global consumption, 72 percent of production, and 57 percent of gas reserves. As with oil, natural gas reserves are highly concentrated; 70 percent of known gas reserves are in just seven countries—the Russian Federation, Iran, Qatar, Saudi Arabia, the United Arab Emirates, the United States, and Nigeria. Unlike oil, however, most gas is consumed domestically, although exports and imports are significant.

Electricity and heat accounts for 36 percent of natural gas consumption, while the industrial and "other" (primarily residential and commercial) sectors account for about 25 percent each.

Table 4

World Natural Gas Consumption, Production, and Reserves, 2003

	Consumption			Production			Reserves
	Mtoe	Rank	% World	Mtoe	Rank	% World	Mtoe
United States	567	(1)	24.3%	495	(2)	21.0%	4,711
Russian Federation	365	(2)	15.7%	521	(1)	22.1%	42,300
United Kingdom	86	(3)	3.7%	93	(4)	3.9%	567
Canada	79	(4)	3.4%	163	(3)	6.9%	1,498
Germany	77	(5)	3.3%	16	(28)	0.7%	186
Iran	72	(6)	3.1%	71	(6)	3.0%	24,021
Japan	69	(7)	3.0%	—	—	0.0%	—
Italy	65	(8)	2.8%	12	(30)	0.5%	198
Ukraine	61	(9)	2.6%	16	(27)	0.7%	999
Saudi Arabia	55	(10)	2.4%	55	(9)	2.3%	6,010
Uzbekistan	43	(11)	1.8%	48	(12)	2.1%	1,665
Mexico	41	(12)	1.8%	33	(16)	1.4%	374
France	39	(13)	1.7%	—	—	0.0%	—
Netherlands	35	(14)	1.5%	53	(10)	2.2%	1,500
United Arab Emirates	34	(15)	1.4%	40	(14)	1.7%	5,454
Indonesia	32	(16)	1.4%	65	(8)	2.8%	2,301
Argentina	31	(17)	1.3%	37	(15)	1.6%	598
China	30	(18)	1.3%	31	(17)	1.3%	1,641
India	27	(19)	1.2%	27	(20)	1.2%	769
Venezuela	26	(20)	1.1%	26	(21)	1.1%	3,735
Malaysia	26	(21)	1.1%	48	(13)	2.0%	2,165
Korea	24	(22)	1.0%	—	—	0.0%	—
Australia	24	(24)	1.0%	30	(18)	1.3%	2,294
Spain	22	(26)	0.9%	—	—	0.0%	—
Algeria	19	(27)	0.8%	75	(5)	3.2%	4,071
Pakistan	19	(28)	0.8%	19	(24)	0.8%	675
Turkey	19	(29)	0.8%	—	—	0.0%	—
Brazil	14	(33)	0.6%	9	(35)	0.4%	221
Turkmenistan	13	(34)	0.6%	50	(11)	2.1%	2,610
Poland	11	(37)	0.5%	4	(46)	0.2%	104
Qatar	10	(39)	0.4%	28	—	1.2%	23,919
Norway	4	(52)	0.2%	66	(7)	2.8%	2,215
Nigeria	—	—	—	17	(26)	0.7%	4,497
South Africa	—	—	—	—	—	—	—
Rest of World	**294**		**12.6%**	**211**		**9.0%**	**16,902**
World	**2,332**			**2,357**			**158,198**

Source: BP (2004).

Notes:

Italicized countries are those not among the top 25 GHG emitters, but whose gas production and/or reserves account for at least 2% of the world total.

"—" Signifies no data.

The countries shown account for 84% of gas consumption and 86% of gas production.

Gas production and reserves are highly correlated, so country rankings for reserves are not shown. However, the Reserve/Production (R/P) ratio is significantly higher for Saudi Arabia and Iran.

Gas production and consumption are only highly correlated (but not as high as coal), reflecting the fact that most gas is consumed domestically.

III. Electricity and Heat

Electricity and heat account for about 22 percent of global GHG emissions, the largest single sectoral source. Electricity accounts for 16 percent of global emissions; heat (including combined heat and power) and other energy industries[8] account for roughly 3 percent each.

Table 5 shows trends in the electricity and heat-related CO_2 emissions of the top emitting countries. (**Figure 4** shows total emissions and emissions per capita.) Together, these countries account for 88 percent of global emissions from this sector. The 10 largest emitters account for 81 percent of the global total.[9] The United States, China, and the EU-25 are by far the largest emitters (27, 15, and 14 percent, respectively, of the global total for this sector).

Table 5

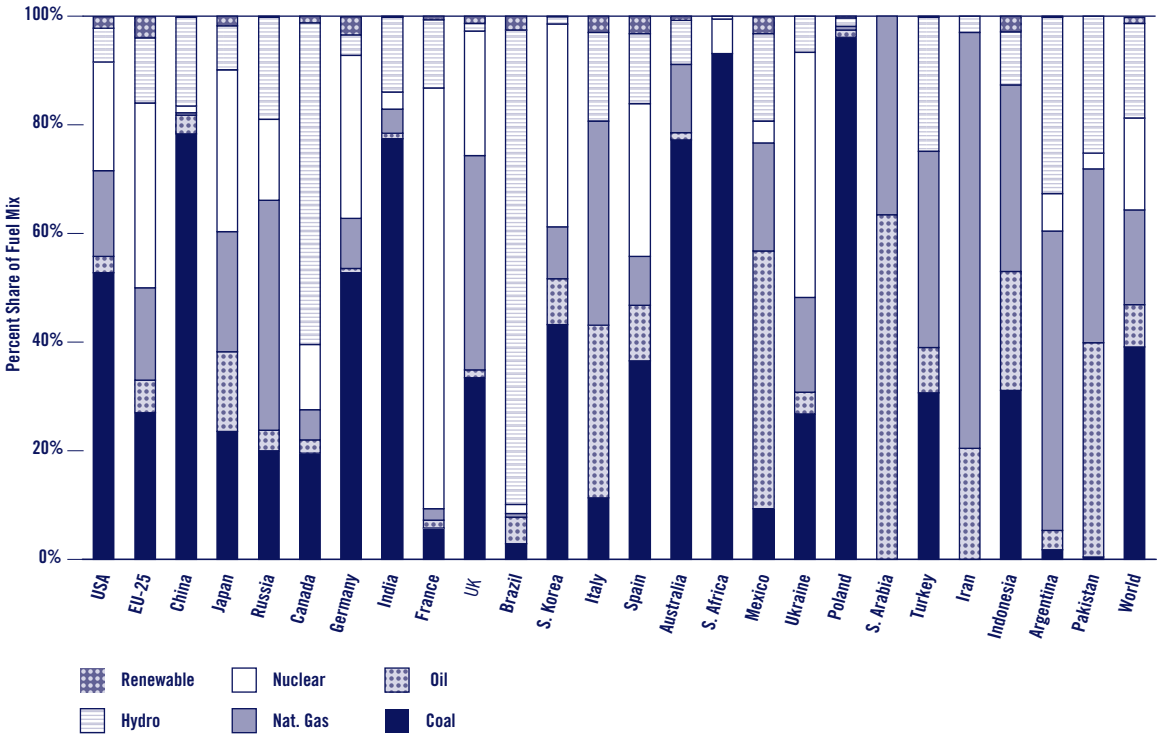
CO_2 from **Electricity and Heat** 2000

Country	Millions of Tons of Carbon	% of World	Tons per Capita	% Change 1990 to 2000	Projected 2001-2020*
United States	693	27.4%	2.4	25%	23%
China	390	15.4%	0.3	112%	104%
EU-25	363	14.4%	0.8	4%	26%
Russia	155	6.1%	1.1	-30%	19%
India	142	5.6%	0.1	107%	84%
Japan	105	4.1%	0.8	11%	—
Germany	86	3.4%	1.0	-8%	—
United Kingdom	51	2.0%	0.9	-20%	—
Australia	49	2.0%	2.5	34%	19%
Canada	49	2.0%	1.6	33%	—
South Africa	49	1.9%	1.1	33%	—
Mexico	44	1.7%	0.4	56%	65%
Poland	44	1.7%	1.1	-3%	—
Italy	42	1.7%	0.7	22%	—
Korea (South)	41	1.6%	0.9	232%	—
Saudi Arabia	36	1.4%	1.7	70%	—
Spain	27	1.1%	0.7	31%	—
Ukraine	26	1.0%	0.5	-43%	—
Indonesia	25	1.0%	0.1	97%	149%
Iran	21	0.8%	0.3	97%	—
Turkey	19	0.7%	0.3	105%	—
France	15	0.6%	0.3	32%	—
Brazil	10	0.4%	0.1	75%	133%
Pakistan	9	0.4%	0.1	117%	—
Argentina	9	0.4%	0.2	25%	—
Rest of World	**295**	**11.7%**		**76%**	**—**
World	**2,529**			**54%**	**51%**

Notes: Growth rates for Russia and Ukraine are from 1992 (not 1990). *Projections are drawn from IEA (2004). The figure for US includes Canada; Australia includes New Zealand.

Figure 3

Fuel Mix in the Electricity Sector, 2001

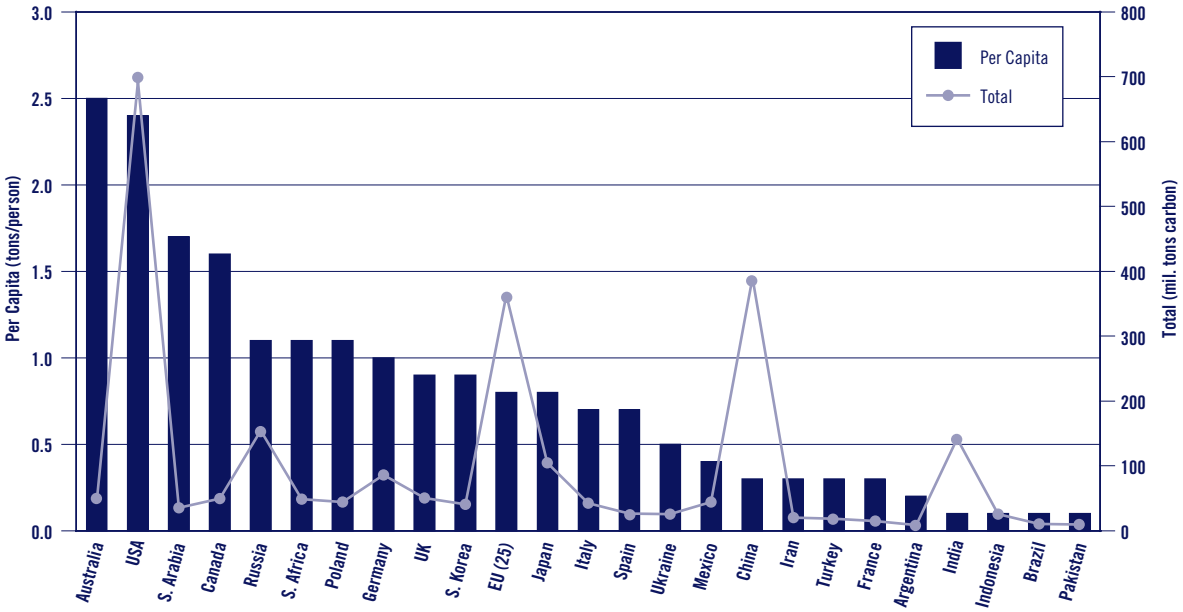


Source: IEA (2003).

Note: Shares are based on gigawatt hours of generation.

Figure 4

Total & Per Capita CO_2 from Electricity & Heat, 2000



Emissions are largely determined by the mix of fuels and technologies used to generate electric power, which itself depends heavily on a country's own resource endowment. **Figure 3** shows the current fuel mixes in each of the top 25 emitting countries. Coal plays a particularly dominant role in the power sectors of China, India, Australia, South Africa, and Poland. For Saudi Arabia, Iran, Italy, and Pakistan, oil and gas are key fuels. Hydroelectric and nuclear power are especially important in Brazil, France, Canada, and the Ukraine. Spain and Germany have the largest shares of non-hydro renewable energy (e.g., wind), at 3.4 percent each.

From 1990 to 2000, emissions from electricity and heat rose fastest in the developing Asian economies, growing more than 100 percent in South Korea, China, India, and Pakistan. Emissions remained almost flat in Europe, grew modestly in other industrialized countries, and declined in Russia and the Ukraine.

Emission projections are available for a limited set of countries (IEA, 2004). Continued rapid growth is projected in India, China, Indonesia, and other developing countries. Collectively, developing country emissions are expected to grow nearly 100 percent by 2020. Increases of about 25 percent are projected in the United States and the European Union (without taking into account the impact of the EU's emissions trading scheme, which began in January 2005).

IV. Transportation

Transportation accounts for about 13 percent of global GHG emissions. **Table 6** shows trends in country-level CO_2 emissions from transportation (**Figure 5** shows total emissions and emissions per capita). Together, the major emitters account for roughly 88 percent of global emissions from this sector. The 10 largest emitters account for 80 percent of the global total.[10] The United States far outranks all other countries, with 36 percent of global emissions, about twice the EU's emissions and more than six times the emissions of the next highest country, Japan.

In most countries, transportation is the fastest growing source of GHG emissions. From 1990 to 2000, transportation-related emissions grew about 20 percent in most industrialized countries, but much faster in

Table 6

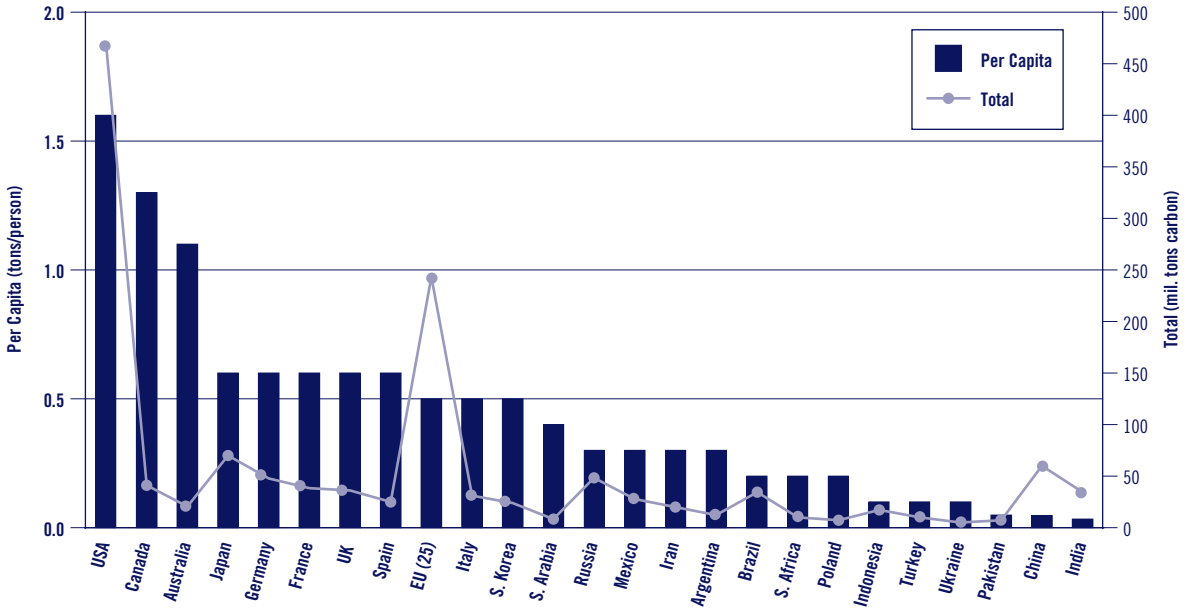
CO_2 from Transport 2000

Country	Millions of Tons of Carbon	% of World	Tons per Capita	% Change 1990 to 2000	Projected 2001-2020*
United States	469	35.7%	1.6	21%	30%
EU-25	243	18.5%	0.5	21%	31%
Japan	70	5.3%	0.6	28%	—
China	60	4.5%	0.0	86%	143%
Russia	48	3.7%	0.3	-32%	49%
Germany	48	3.6%	0.6	9%	—
Canada	41	3.1%	1.3	21%	—
France	38	2.9%	0.6	20%	—
United Kingdom	36	2.7%	0.6	8%	—
India	34	2.6%	0.0	53%	92%
Brazil	34	2.6%	0.2	56%	77%
Italy	31	2.3%	0.5	17%	—
Mexico	28	2.1%	0.3	17%	71%
Spain	25	1.9%	0.6	43%	—
Korea (South)	24	1.8%	0.5	102%	—
Australia	20	1.6%	1.1	21%	29%
Iran	20	1.5%	0.3	85%	—
Indonesia	17	1.3%	0.1	100%	122%
Argentina	12	0.9%	0.3	55%	—
South Africa	10	0.7%	0.2	22%	—
Turkey	10	0.7%	0.1	25%	—
Saudi Arabia	8	0.6%	0.4	47%	—
Poland	7	0.5%	0.2	23%	—
Pakistan	7	0.5%	0.0	83%	—
Ukraine	5	0.4%	0.1	-40%	—
Rest of World	**157**	**11.9%**		**57%**	**—**
World	**1316**			**37%**	**50%**

Notes: Includes emissions from road travel (86% of world total), domestic air transport (6%), rail (2%), and other (5%). Growth rates for Russia and Ukraine are from 1992 (not 1990). *Projections are drawn from IEA, 2004. The figure for US includes Canada; Australia includes New Zealand.

Figure 5

Total & Per Capita CO_2 from Transportation, 2000



many developing countries. The fastest growth was in South Korea and Indonesia, where emissions doubled. Emissions declined only in Russia and Ukraine.

By 2020, global transport emissions are expected to increase 50 percent. Increases of about 30 percent are projected in developed countries. Much higher increases are projected in developing countries: China (143 percent), India (67 percent), Indonesia (122 percent), Mexico (71 percent), and the Middle East (68 percent).

Transport

More than 86 percent of all transport emissions are from road travel, with domestic air and rail accounting for much smaller shares. **Table 7** shows national emissions from road travel only, as well as figures for vehicle ownership (number of vehicles per 1,000 people) and vehicle production. Vehicle ownership is highest in the United States, Canada, Japan, and the European countries. A second tier includes South Korea, Argentina, Russia, and Mexico. Overall, the United States and Japan are by far the largest vehicle producers, followed by Germany, China, France, South Korea, and Spain. Although vehicle use remains very low in China and India, production rates are growing rapidly—35 percent and 30 percent, respectively, in 2003.

Vehicle manufacturing is highly concentrated. **Table 8** lists the world's 20 largest vehicle manufacturers. Together, they account for 92 percent of global production in 2003. The companies are headquartered principally in the United States, Japan, Europe, and South Korea, but virtually all are multinational operations, with manufacturing facilities in multiple countries. Joint ventures are also common among major manufacturers, particularly in developing countries.

Table 7

Vehicle Emissions, Ownership, and Production

Country	CO_2 from Vehicle (Road) Travel (MtC, 2001)	Vehicles per 1000 people	Annual Vehicle Production
United States	394	779	12,077,726
Japan	64	572	10,286,318
Germany	45	—	5,506,629
China	39	12	4,443,686
France	36	575	3,620,056
India	32	10	1,160,525
United Kingdom	32	391	1,846,429
Canada	31	580	2,546,124
Brazil	31	—	827,038
Italy	31	606	1,321,631
Russia	30	176	1,279,663
Mexico	27	159	1,585,914
Spain	23	467	3,029,690
Iran	21	—	567,019
Korea (South)	19	255	3,177,870
Australia	17	—	413,261
Indonesia	17	—	322,044
South Africa	9	—	421,335
Argentina	9	181	169,622
Saudi Arabia	9	—	—
Turkey	8	85	533,672
Poland	7	307	322,061
Pakistan	6	9	51,692
Ukraine	4	—	107,890
World	**1,148**	**137**	**—**

Sources: IEA (2003), OICA (2004), World Bank (2001-2004).

Notes: Production data is from 2003; vehicle use data ranges from 1997-2000. "—" Signifies no data.

Aviation

Aviation represents approximately 13 percent of CO_2 emissions from transportation when international flights are included.[11] **Table 9** lists emissions from the aviation sector, including both domestic and international flights. Emissions from aviation increased almost 22 percent between 1990 and 2000. Globally, emissions from the aviation sector are split almost evenly between domestic and international travel. However, the vast majority of domestic aviation emissions—over 65 percent—occur in the United States.

Aircraft manufacturing is very highly concentrated, and nearly all jet aircraft are manufactured by five companies. Nearly all large (100+ seat) commercial jet aircraft are manufactured by Boeing Corporation, headquartered in the United States, or Airbus S.A.S, headquartered in France. Most smaller jet aircraft, including regional corporate jets, are manufactured by Bombardier (Canada), Embraer (Brazil), or Gulfstream, a division of General Dynamics (United States). According to industry sources, these manufacturers accounted for nearly all of the approximately 16,000 jet aircraft in service worldwide in 2003.[12] Industry forecasts project demand for almost 24,000 new jet aircraft through 2023 (Airbus 2004; Embraer 2004).

Table 8

Top 20 Vehicle Manufacturers 2003

Company (& other brands)	Total Vehicles	Primary Countries
General Motors (Opel, Vauxhall)	8,185,997	United States, Germany
Ford (Volvo, Jaguar)	6,566,089	United States, Germany
Toyota	6,240,526	Japan, United States
Volkswagen Group (VW, Audi)	5,024,032	Germany, Spain, China
DaimlerChrysler (Mercedes, Evobus)	4,231,603	United States, Germany
PSA Peugeot Citroën	3,310,368	France, Spain
Nissan	2,942,306	Japan, United States
Honda	2,922,526	Japan, United States
Hyundai (Kia)	2,697,435	Korea (South)
Renault (Dacia, Samsung)	2,386,098	France, Spain
Fiat (Iveco, Alfa Romeo)	2,077,828	Italy, Brazil
Suzuki (Maruti)	1,811,214	Japan, India
Mitsubishi	1,582,205	Japan, Taiwan, Malaysia
Mazda	1,152,578	Japan, China, Thailand
BMW	1,118,940	Germany, UK, United States
Daihatsu	897,116	Japan, Malaysia, China
AvtovAZ (seAZ)	699,888	Russia
FAW Group (without VW)	556,391	China
Fuji (Subaru)	544,868	Japan, United States
GM-Daewoo	520,556	Korea (South)

Source: OICA (2004).

Note: Companies shown account for 92% of all vehicles manufactured in 2003.

Table 9

CO_2 from Aviation 2000

	Domestic			International (Bunkers)		
	MtC (2000)	% of World (2000)	% Change 1990-2000	MtC (2000)	% of World (2000)	% Change 1990-2000
United States	55.1	65.1%	8%	15.6	16.2%	47%
European Union	7.5	8.9%	24%	30.7	31.9%	68%
China	3.9	4.6%	595%	0.6	0.6%	326%
Canada	3.6	4.2%	28%	0.8	0.9%	14%
Japan	3.1	3.7%	26%	5.4	5.6%	47%
United Kingdom	2.9	3.4%	33%	6.5	6.8%	84%
Brazil	2.6	3.1%	64%	0.6	0.6%	44%
Korea (South)	1.7	2.0%	10%	0.5	0.5%	102%
Australia	1.5	1.8%	77%	2.0	2.0%	67%
Spain	1.5	1.8%	33%	2.3	2.4%	142%
Argentina	1.5	1.8%	169%	—	—	—
France	1.3	1.6%	118%	4.3	4.5%	63%
Turkey	0.6	0.7%	148%	0.4	0.5%	191%
South Africa	0.5	0.6%	76%	0.7	0.8%	137%
Germany	0.2	0.3%	-70%	5.9	6.2%	53%
Italy	0.1	0.2%	8%	2.9	3.1%	64%
Russia	0.0	—	—	7.5	7.8%	—
Mexico	0.0	—	—	2.2	2.3%	47%
Ukraine	0.0	—	—	0.2	0.2%	—
India	0.0	—	—	1.9	2.0%	34%
Indonesia	0.0	—	—	0.5	0.5%	-34%
Pakistan	0.0	—	—	0.6	0.6%	64%
Poland	0.0	—	—	0.3	0.3%	81%
Saudi Arabia	0.0	—	—	2.0	2.1%	-9%
Iran	—	—	—	—	—	—
Rest of World	**3.0**	**3.5%**	**110.4%**	**23.9**	**24.9%**	**36.4%**
World	**84.6**		**21.6%**	**96.0**		**61.5%**

Source: IEA (2003).

"—" Signifies no data.

V. Manufacturing, Construction, and Industrial Processes

GHG emissions associated with manufacturing, construction, and industrial processes (including iron and steel, cement, and chemicals) represent approximately 14 percent of direct global GHG emissions.[13] This figure would be considerably higher if *indirect* CO_2 emissions from electricity-related emissions were factored in. Because of limitations in the underlying GHG emissions data, however, it is not possible on a country-by-country (or global) basis to allocate electricity emissions to end-use sectors and subsectors. Accordingly, some figures in this section exclude indirect CO_2 emissions related to electricity and heat production.

Table 10

Direct GHG Emissions from **Industry/Manufacturing** 2000

Country	Millions of Tons of Carbon Eq.	% of World	% Change 1990 to 2000	Projected 2001–2020*
China	353	22.7%	18%	22%
United States	234	15.0%	11%	13%
EU-25	240	15.4%	-15%	4%
Japan	91	5.9%	1%	—
India	79	5.1%	48%	65%
Russia	66	4.2%	-24%	44%
Germany	45	2.9%	-28%	—
Ukraine	28	1.8%	-56%	—
Brazil	35	2.3%	54%	65%
Canada	31	2.0%	-1%	—
Korea (South)	35	2.3%	80%	—
Italy	31	2.0%	-3%	—
France	29	1.9%	-17%	—
United Kingdom	24	1.5%	-31%	—
Iran	21	1.3%	51%	—
South Africa	19	1.2%	-5%	—
Indonesia	20	1.3%	88%	54%
Mexico	21	1.4%	-12%	49%
Turkey	20	1.3%	61%	—
Spain	23	1.5%	21%	—
Australia	17	1.1%	12%	21%
Poland	17	1.1%	4%	—
Saudi Arabia	10	0.6%	51%	—
Pakistan	9	0.6%	32%	—
Argentina	7	0.4%	30%	—
Rest of World	**219**	**14.1%**	**25%**	**—**
World	**1556**		**18%**	**26%**

Notes: This table combines IPCC Source/Sink Categories 1A2 (manufacturing & construction) and 2 (industrial processes). Growth rates for Russia and Ukraine are from 1992 (not 1990). *Projections are drawn from IEA (2004) and include only CO_2 from fossil fuel combustion. The figure for US includes Canada; Australia includes New Zealand.
"—" Signifies no data.

Within this sector, the most dominant sources are: (1) iron and steel (2) cement, and (3) chemicals and petrochemicals.

Table 10 shows total manufacturing and industrial emissions for each major emitter. Together, these countries account for roughly 75 percent of global manufacturing and industrial emissions. China, the United States, and the EU-25 are by far the largest sources, followed by Japan, India, and Russia. This sector has declined as a relative share of many countries' national totals since 1990, as evidenced by the relatively modest growth rates, many of which are negative.

Iron and Steel

The iron and steel industry is the largest energy-consuming manufacturing sector in the world (OECD/IEA, 2001b). CO_2 is emitted at a variety of points in iron and steel production processes, including: (1) direct process-related (i.e., non-energy) emissions, (2) the direct, on-site burning of fossil fuels, and (3) indirect emissions from electricity consumed during the production process. Taking all of these emissions

Table 11

Steel, Iron, and Aluminum Production and Steel Consumption

	Consumption (% of world)	Production (% of world)		
Country	Crude Steel (2003)	Crude Steel (2003)	Pig Iron (2003)	Aluminum (2002)
China	26.0%	20.1%	27.8%	16.6%
EU-25	18.1%	20.0%	17.2%	11.0%
Japan	7.8%	11.9%	13.3%	0.0%
United States	12.6%	10.1%	6.6%	10.5%
Russia	3.0%	6.6%	7.6%	12.9%
Korea (South)	4.8%	5.0%	4.4%	—
Germany	4.0%	5.0%	4.8%	2.5%
Ukraine	0.1%	3.8%	4.5%	0.4%
Brazil	1.8%	3.3%	4.9%	5.1%
India	3.6%	3.2%	4.0%	2.5%
Italy	3.4%	2.9%	1.6%	0.7%
France	1.9%	2.2%	2.2%	1.7%
Turkey	1.4%	1.8%	0.8%	0.2%
Spain	2.2%	1.8%	0.7%	1.5%
Canada	1.9%	1.8%	1.4%	10.5%
Mexico	2.1%	1.6%	0.7%	0.2%
United Kingdom	1.5%	1.3%	1.4%	1.3%
South Africa	0.6%	1.0%	1.0%	2.6%
Poland	0.8%	0.9%	0.9%	0.2%
Australia	0.8%	0.8%	1.0%	7.1%
Iran	1.3%	0.8%	0.4%	0.5%
Argentina	0.2%	0.5%	0.4%	1.0%
Saudi Arabia	0.6%	0.4%	—	—
Indonesia	0.6%	0.3%	—	0.6%
Pakistan	0.2%	0.1%	—	—
Rest of World	**12.4%**	**6.9%**	**4.1%**	**18.2%**

Sources: IISI (2004); USGS (2003).
"—" Signifies no data.

into account, iron and steel accounts for an estimated 7 percent of total world CO_2 emissions (OECD/IEA, 2001b), and about 5 percent of all GHGs.

Table 11 presents data for steel production and consumption for the major emitting countries. Together, they represent approximately 93 percent of the global production.[14] China, Japan, and the United States are the three largest steel producers (42 percent of the global total) and consumers (46 percent).

Table 12 lists the world's 25 largest steel companies, ranked by production. Collectively, these companies account for roughly 42 percent of global production in 2002. While in some countries the sector is dominated by a small number of large producers, in other countries such as China it is characterized by a large number of small producers.

Table 12

Top 25 Steel Companies 2002

Company	Production (million tons of crude steel)	Country of Origin
Arcelor	44	Luxembourg
LNM Group	35	Netherlands
Nippon Steel	30	Japan
Posco	28	Korea (South)
Shanghai Baosteel	20	China
Corus	17	United Kingdom
Thyssen Krupp	16	Italy
NKK	15	Japan
Riva	15	Italy
US Steel	14	United States
Kawasaki	14	Japan
Nucor	12	United States
Sumitomo	12	Japan
Gerdau	12	Brazil
SAIL	11	India
Magnitogorsk	11	Russia
China Steel	11	China
Anshan	10	China
Severstal	10	Russia, United States
Novolipetsk	9	Russia
Shougang	8	China
Bethlehem	8	United States
Wuhan	8	China
Nisco	7	Iran
INI	7	Korea (South)

Source: IISI (2003).
Note: Producers above represent 42% of the world total steel production in 2002.
"—" Signifies no data.

Aluminum

GHGs from aluminum production account for about 0.8 percent of global emissions (including indirect emissions from electricity use).[15] GHGs are emitted at a variety of points in the production process, including: (1) CO_2 and perflourocarbons (PFCs) from the process of making aluminum, (2) direct, on-site burning of fossil fuels and (3) indirect emissions from electricity consumed during the aluminum production process. PFCs—potent, long-lived greenhouse gases—constitute about 48 percent of the direct emissions from primary aluminum production (IAI, 2002). The global aluminum industry collectively constitutes the largest source of PFCs, about 65 percent of the total world.

Table 11 presents data on aluminum production for the major emitting countries. Collectively, these countries account for about 79 percent of world production. The largest producers are China, Russia, Canada, the United States, and Australia.

Cement

Total CO_2 from cement manufacturing accounts for about 5 percent of global CO_2 (OECD/IEA, 2001a; and Holcim, 2004), and about 4 percent of all global GHGs. CO_2 is emitted at a variety of points in the cement production process, including: (1) the chemical process of making clinker (a key component of cement), (2) the direct, on-site burning of fossil fuels and (3) indirect emissions from electricity consumed during the cement production process. Although the energy-related emissions depend on the fuels used (both for direct energy use and electricity purchases), Swiss cement giant Holcim Ltd. estimates that about 50 percent of cement emission come from the chemical process and 40 percent come from direct fossil fuel combustion, with the remaining coming from electricity purchases and on-site transportation (Holcim, 2004).

Table 13

CO_2 from Cement Production 2000

Country	Millions of Tons of Carbon	% of World	% Change, 1990-2000
China	81.2	35.9%	184%
EU-25	30.2	13.4%	-1%
India	12.9	5.7%	93%
United States	11.9	5.3%	25%
Japan	11.0	4.9%	-4%
Korea (South)	7.0	3.1%	52%
Brazil	5.3	2.3%	51%
Italy	5.3	2.3%	-2%
Spain	5.2	2.3%	37%
Turkey	4.9	2.2%	49%
Germany	4.7	2.1%	-8%
Russian Federation	4.4	1.9%	-62%
Mexico	4.3	1.9%	34%
Indonesia	3.8	1.7%	100%
Iran	3.2	1.4%	78%
France	2.7	1.2%	-25%
Saudi Arabia	2.5	1.1%	56%
Poland	2.0	0.9%	18%
Canada	1.7	0.8%	6%
United Kingdom	1.7	0.8%	-15%
Pakistan	1.3	0.6%	30%
South Africa	1.2	0.5%	9%
Argentina	1.0	0.4%	100%
Australia	1.0	0.4%	0%
Ukraine	0.7	0.3%	-78%
Rest of World	**14.9**	**6.6%**	**71%**
World	**226.0**		**44%**

Table 13 presents data on emissions from cement production in the major emitting countries (*process-related CO_2 only*). Collectively, these countries account for about 93 percent of process-related cement emissions. China is by far the largest source, accounting for 36 percent of the world total. In Europe, Japan, Australia, and transition economies, emissions from cement production are stagnant or declining. The fastest growth is in East and South Asia. Cement emissions in the U.S. and Middle East are also rising.

VII. Agriculture

Methane, nitrous oxide, and carbon dioxide emissions from agricultural activities account for about 14 percent of global GHG emissions. The principal sources of methane emissions are domestic ruminants (livestock) and wetland rice cultivation. The main nitrous oxides sources are conventional tillage and fertilizer use. Carbon dioxide emissions from on-site fossil fuel combustion make a relatively small contribution to agricultural emissions.

In addition, agriculture contributes to CO_2 emissions indirectly through electricity consumption as well as from land clearing and the burning of biomass. Due to data limitations and classifications, however, these latter contributions are not readily quantifiable.

Table 14 shows methane, nitrous oxide, and direct fossil fuel-related CO_2 emissions from agriculture for the major GHG-emitting countries. Together, these countries account for 72 percent of global emissions from agriculture. China and India, the two largest emitters, together account for 29 percent of the global total. The United States, EU (25), and Brazil together account for another 25 percent. All other countries individually constitute less than 2 percent of the world total.

Table 14

GHG Emissions from Agriculture 2000

	Total Agriculture Emissions		Mt Carbon Equivalent		
Country	MtC Eq.	% World	CO_2	CH_4	N_2O
China	299	18%	24.1	119.2	156.1
India	175	11%	0.1	75.0	99.5
EU-25	150	9%	19.5	61.3	68.9
United States	141	9%	12.8	44.2	84.0
Brazil	126	8%	4.3	68.2	53.5
Pakistan	41	3%	0.2	18.3	22.3
Indonesia	35	2%	1.6	24.5	9.1
Argentina	34	2%	1.9	15.4	16.5
Russia	32	2%	5.5	14.3	12.3
France	30	2%	2.3	11.9	15.4
Australia	29	2%	1.2	20.7	7.4
Germany	26	2%	1.7	14.5	9.9
Turkey	21	1%	2.3	8.4	10.5
Iran	19	1%	2.8	5.1	11.5
Canada	19	1%	2.4	6.2	10.4
Mexico	15	1%	1.7	12.6	1.0
Japan	15	1%	5.4	3.8	5.5
United Kingdom	14	1%	0.6	5.6	7.9
Spain	14	1%	1.6	6.3	5.6
Italy	13	1%	2.3	4.7	6.4
South Africa	12	1%	1.0	4.5	6.4
Ukraine	12	1%	2.1	5.4	4.4
Poland	11	1%	3.8	2.8	4.5
Korea (South)	7	0%	2.8	3.3	0.5
Saudi Arabia	3	0%	0.0	0.6	2.1
Rest of World	**455**	**28%**	**11.2**	**247.3**	**196.8**
World Total	**1640**		**102.8**	**758.3**	**778.7**

Note: CO_2 emissions from agriculture, shown above, are those resulting from fossil fuel combustion and are categorized as Energy sector emissions under IPCC methodologies. Indirect CO_2 emissions from electricity consumption, land clearing, and biomass burning are not included here.

VIII. Land Use Change and Forestry

Land use change and forestry account for 18 percent of global GHG emissions, second only to electricity and heat.

Table 15 shows CO_2 emissions from land use change and forestry in the major emitting countries. Together, these countries account for just over half of global emissions from this sector. Among the major emitters, the largest sources by far are Indonesia and Brazil, with 34 percent and 18 percent, respectively, of the global total. Most others either contribute less than 1 percent of global emissions, or are net sinks (sequestering more CO_2 than they emit in this sector).

Some countries that are not among the largest overall GHG emitters account for significant shares of the global total from land use change and forestry. They include Malaysia, Myanmar, and the Democratic Republic of Congo.

As discussed in the previous paper, Climate Data: Insights and Observations, emissions data from the land use change and forestry sector are subject to very large uncertainties (see Houghton, 2003).

Table 15

CO_2 from **Land Use Change & Forestry** 2000

Country	Millions of Tons of Carbon	% of World
Indonesia	700	33.6%
Brazil	375	18.0%
Mexico	26	1.3%
Canada	18	0.8%
Argentina	15	0.7%
Russia	15	0.7%
Pakistan	9	0.4%
Turkey	6	0.3%
Iran	2	0.1%
Japan	1	0.1%
Australia	1	0.1%
South Africa	1	0.0%
Korea (South)	0	0.0%
Germany	0	0.0%
Saudi Arabia	0	0.0%
United Kingdom	-1	-0.0%
Poland	-1	-0.0%
Italy	-1	-0.0%
France	-2	-0.1%
Spain	-2	-0.1%
India	-11	-0.5%
China	-13	-0.6%
United States	-110	-5.3%
Ukraine	—	—
Rest of World	**1051**	**50.5%**
World	**2079**	

Note: Italicized countries are those not among the top 25 emitters.

Appendix: About the Climate Analysis Indicators Tool

The Climate Analysis Indicators Tool (CAIT) is an information and analysis tool on global climate change developed by the World Resources Institute. CAIT provides a comprehensive and comparable database of greenhouse gas emissions data (including all major sources and sinks) and other climate-relevant indicators. CAIT can be used to analyze a wide range of climate-related data questions and to help support future policy decisions made under the Climate Convention and in other fora. Except where noted, all of the data in this report is derived from CAIT.

Key features include:

- All Countries and Regions. CAIT includes data and indicators for all of the Parties to the Climate Convention, plus some non-Parties that are members of the U.N. Several categories of regions are also included in CAIT, including major geographic regions (e.g., sub-Saharan Africa), political/economic regions (e.g., OECD, ASEAN), and UNFCCC regions (e.g., Annex I, G-77/China). Users can also create their own "user-defined regions" with members of their choosing.

- Complete Data. CAIT is the only available source for the "full basket" of all greenhouse gases (i.e., not just CO_2 from fossil fuels) for every country in the world. Thus, CAIT includes data on CO_2 emissions from energy and land-use change as well as non-CO_2 gases such as methane, nitrous oxide, and high-GWP gases. CAIT also includes greenhouse gas data at the sectoral level (based on IPCC guidelines), including for electricity & heat, transportation, manufacturing & construction, other fuel combustion, fugitive emissions, industrial processes, agriculture, waste, land-use change and forestry, and international bunkers. Emission projections from a variety of sources, extending to 2025, are also included in CAIT.

- Customizable and Interactive Features. Depending on the indicator(s), users can select different (1) timetables for evaluation (e.g., 1850 to 2000), (2) greenhouse gases, (3) sectors and (4) units to display (e.g., aggregate or per capita measures). Likewise, users can specify the countries or regions that appear in a table.

- Analysis Features. In addition to viewing indicators, there are several analysis features in CAIT that enable interesting comparisons between countries and across different indicators. Users can calculate and graph trends in different indicators across different time periods and countries. Country analysis and comparisons can also be done at the sector and gas levels.

- Supporting Documentation explains emissions sources and methodologies used in CAIT. CAIT data is drawn from a wide variety of sources, including the Carbon Dioxide Information Analysis Center (CDIAC), the Dutch National Institute of Public Health and the Environment (RIVM), EarthTrends (WRI), Richard Houghton, the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA), the World Bank, the World Health Organization (WHO), the United Nations Development Programme (UNDP), United Nations Framework Convention on Climate Change (UNFCCC), U.S. Environmental Protection Agency (EPA), and the U.S. Energy Information Administration (EIA).

CAIT is accessible free of charge at: http://cait.wri.org.

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Endnotes

1. See WRI (2004), pp. 15-20 available at http://cait.wri.org/downloads/cait_ghgs.pdf.

2. See WRI (2004).

3. See WRI (2004) and Houghton (2003).

4. See Baumert et al. (2004).

5. See forthcoming Baumert et al. (2005)

6. Agriculture includes methane (CH_4) from rice cultivation, manure management, and livestock (enteric fermentation) as well as nitrous oxide (N_2O) from agricultural soils and manure. Waste includes CH_4 from landfills and wastewater management and N_2O from sewage treatment. See IPCC (1996) and WRI (2004), pp. 15-20.

7. Differences between consumption and production reflect changes in stocks as well as exports and imports.

8. "Other energy industries" includes emissions from fuel combusted in petroleum refineries and in fossil fuel extraction (IEA, 2003).

9. However, this figure treats the EU-25 as a single entity. Otherwise, the top 10 countries contribute 70 percent of the world total.

10. This figure treats the EU-25 as a single entity. Otherwise, the top 10 countries contribute 67 percent of the world total.

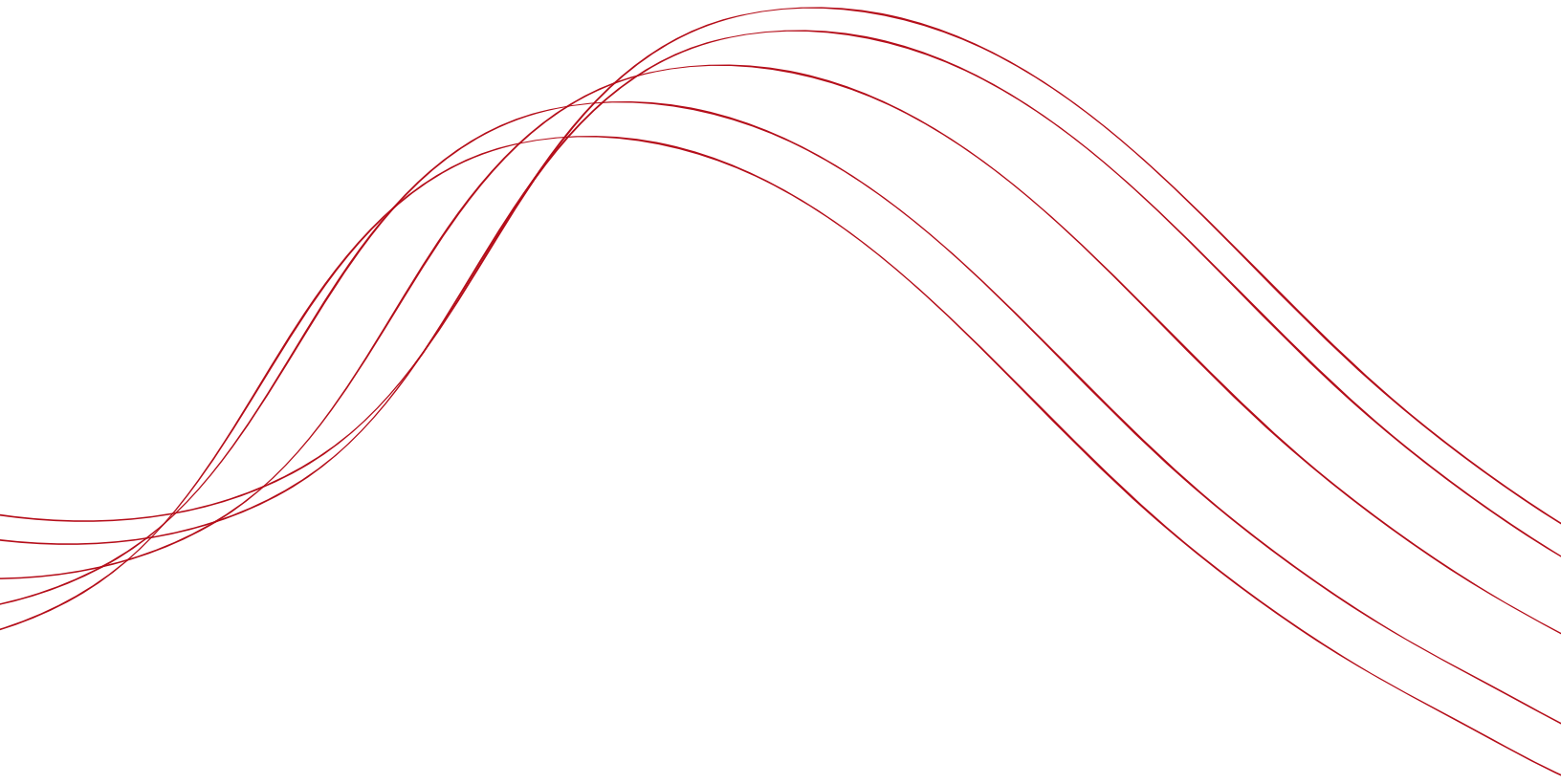
11. Under IPCC Guidelines (IPCC, 1996), emissions from international aviation are not counted against national emission totals and are not classified under national emissions from transportation.

12. Email correspondence with Michael Metcalf, President of the International Society of the Transport Aircraft Trading, February 11, 2005.

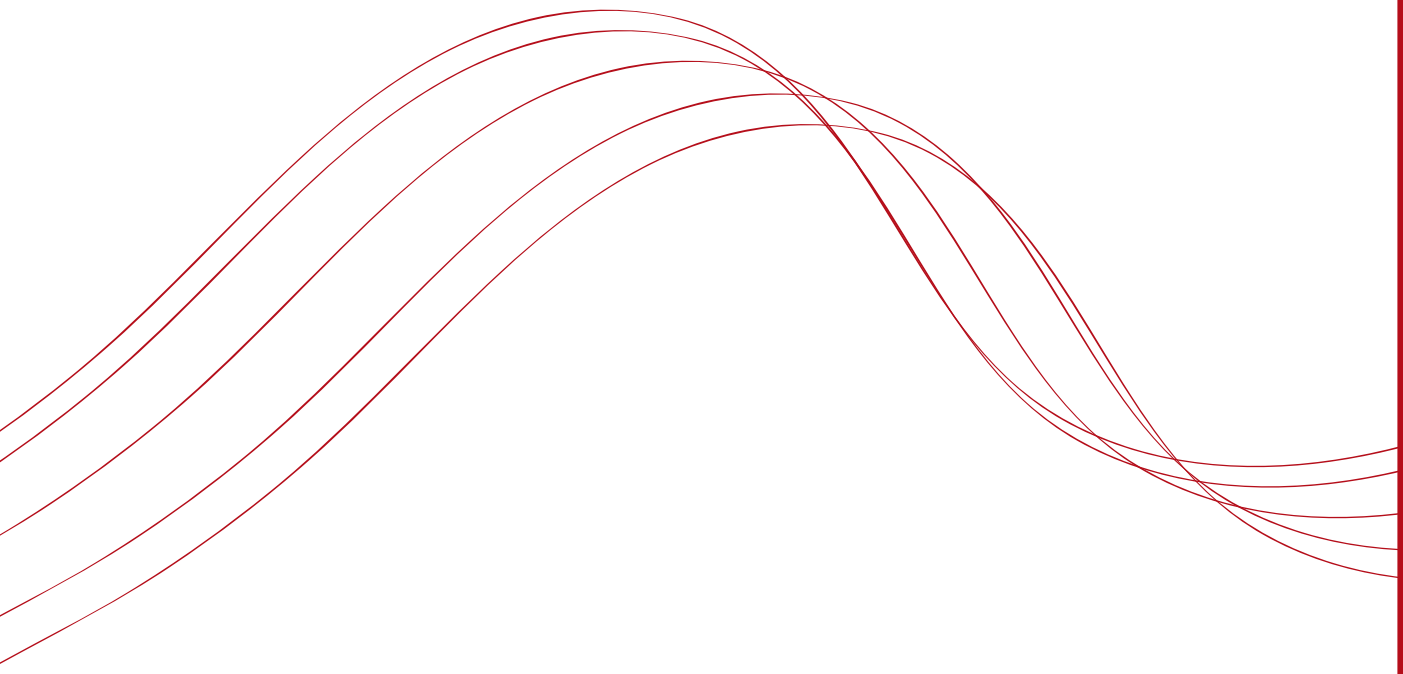
13. This covers *energy*-related CO_2 emissions from direct sources (IPCC Source Category 1 A 2) as well as *industrial process* related emissions of CO_2, CH_4, N_2O, and the high global warming potential gases, such as PFCs (IPCC Source Category 2). Due to data limitations, indirect CO_2 emissions from electricity and heat are not included in this section.

14. The real figure may be slightly smaller, since the International Iron and Steel Institute does not gather data from some countries.

15. Author calculations, based on data in CAIT and from IAI, 2002.



This paper is a companion to an earlier paper, *Climate Data: Insights and Observations.* The earlier report examined global and national-level emissions, energy, and socio-economic data for the world's largest greenhouse gas-emitting countries. This supplement looks at data by sector, again with a focus on major emitters. It is part of a Pew Center series on *Advancing the International Effort Against Climate Change.* The Pew Center was established by The Pew Charitable Trusts to bring a new cooperative approach and critical scientific, economic, and technological expertise to the global climate change debate. We inform this debate through wide-ranging analyses in four areas: policy (domestic and international), economics, environment, and solutions.



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