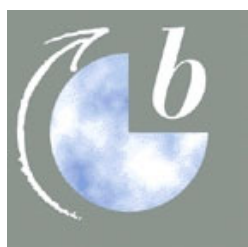


ANALYSIS OF BP STATISTICAL REVIEW OF WORLD ENERGY WITH RESPECT TO CO₂ EMISSIONS

5TH EDITION 2004

Werner Zittel and Manfred Treber



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Executive Summary

This briefing paper analyses the BP Statistical Review of World Energy with respect to CO₂ emissions from fossil fuel consumption. The focus is put on the classification of Annex B ("industrialized countries") and non-Annex B countries ("developing countries") as defined in the Kyoto Protocol.

The method applied here is to convert the fossil fuel consumption with specific emission factors for coal, oil and gas into CO₂ emissions. The resulting figures were then analysed in various ways. Though this method might be criticized as being too simple, the trends and relative changes are reproduced with sufficient accuracy.

Main trends of 2003 emissions compared to 2002 are:

- In 2003 world CO₂ emissions from fossil fuel consumption increased by about 3.8 percent. Since 1990 world CO₂ emissions have increased by about 18 percent.
- The emissions of Annex B countries increased by 2%. We believe that this can be attributed primarily to a stronger economy in 2003 despite high oil prices. In 2003 emissions from OECD countries increased slightly by 1.6%.
- The emissions of non-Annex B countries increased by about 7 percent in 2003 with a total increase of 51 percent compared to 1990, giving these countries a rising share in total emissions (presently about 43 percent).
- The largest relative increases over 1990 emissions can be witnessed in Thailand (+ 146%), Bangladesh (+136%), South Korea (+ 128%) and Malaysia (+121%)
- China increased its coal consumption for the third time after the strong reductions between 1998 and 2000. China's coal consumption in 2003 was the highest ever, so far. It consumed approximately 40 percent more than the second largest coal consumer, the USA.
- Emission trends of most countries seem to be influenced by high oil prices. Many countries increased their absolute coal consumption as well as the share of coal in primary energy use, most prominent Japan, Denmark, China and South Africa.
- However, there are some positive exceptions against the general trend, which keep on reducing the specific CO₂ emissions per energy unit, most prominent to be mentioned are Spain, Portugal and Ireland (Annex B) and Azerbaijan, Brazil, Turkey and Venezuela (non-Annex B).

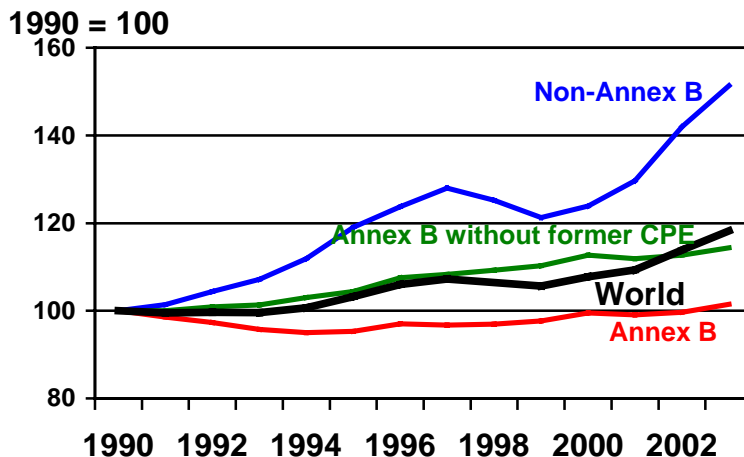


Figure: CO₂ emission trends. Note that the figure does not display absolute emissions but the relative changes compared to 1990.

Contents

1	Introduction	6
2	LBST methodology	6
3	Emissions statistics by country	7
3.1	Emissions of Annex B Countries	7
3.2	Emissions of Non-Annex B Countries using the LBST method	12
3.3	Emission changes 1990 to 2003	15
3.4	Development of CO ₂ emissions	16
4	Primary energy consumption	19
4.1	The share of fossil fuels	19
4.2	Coal consumption	20
5	References	22
6	Abbreviations	22

Analysis of BP Statistical Review of World Energy with respect to CO₂ emissions

1 Introduction

In this paper we analyse the energy consumption of nearly all countries in the year 2003 with respect to their CO₂ emissions. Basic data are taken from the BP Statistical Review of World Energy [1] which is published annually. With simplified emission factors for coal, oil and gas the energy consumption is converted into direct CO₂ emissions due to combustion of fossil fuels. Although the derived results do not take into account country-specific differences in fuel quality and preparation, the resulting trends should provide reliable results – even if the absolute emission figures are not represented correctly.

The main emphasis is put on the difference between Annex B countries (industrialised countries) and non-Annex B countries as defined by the Kyoto protocol. Existing trends in energy consumption patterns are exhibited and shown to explain the changing patterns of CO₂ emissions.

Finally, we give explicit explanations for several countries to demonstrate the regional and country-specific choices which lead to different emission patterns.

2 LBST methodology

The applied method of one separate emission factor for coal, oil and gas consumption, neglecting country and sector specific deviations, may be criticized as oversimplifying the situation. In order to give an impression of that effect, the baseline emissions for each Annex B country are first compared to these simplified results. The deviation between both figures is about 6% in total. Most large emitters are represented accurately within a 10 % margin. However, in the case of individual countries, large deviations occur, in the worst case by as much as 35 % (The Netherlands). Therefore, some caution must be taken when working with the absolute values presented here (e.g. for comparisons with different statistics). However, relative annual changes which are mainly due to relative changes of the energy supply situation are presumably represented with sufficient accuracy. We are confident that at least the major trends are presented correctly.

We chose the following emission factors:

Oil:	260 g CO ₂ /kWh,
Natural Gas:	195 g CO ₂ /kWh,
Coal:	330 g CO ₂ /kWh

Even with these (with respect to the IPCC recommendation) slightly reduced factors our results are on average 5 percent above those reported in the National Communications by Annex B countries. This difference was not investigated in further detail. A major reason for the difference might be the fact that non-energetic use of fossil fuel consumption is not separated in these statistics. Non-energetic use usually doesn't result in direct CO₂ emissions.

3 Emissions statistics by country

Our calculations give total worldwide CO₂ emissions from combustion of fossil fuels of about 21 Gt in the base year 1990. Two-thirds of these emissions can be attributed to Annex B countries (for a list of these countries see table 1). Total emissions increased by about 18 % 1990-2003. Emissions of the Annex B countries increased slightly by 1.5 %, whereas the emissions of the non-Annex B countries increased by 51 %.

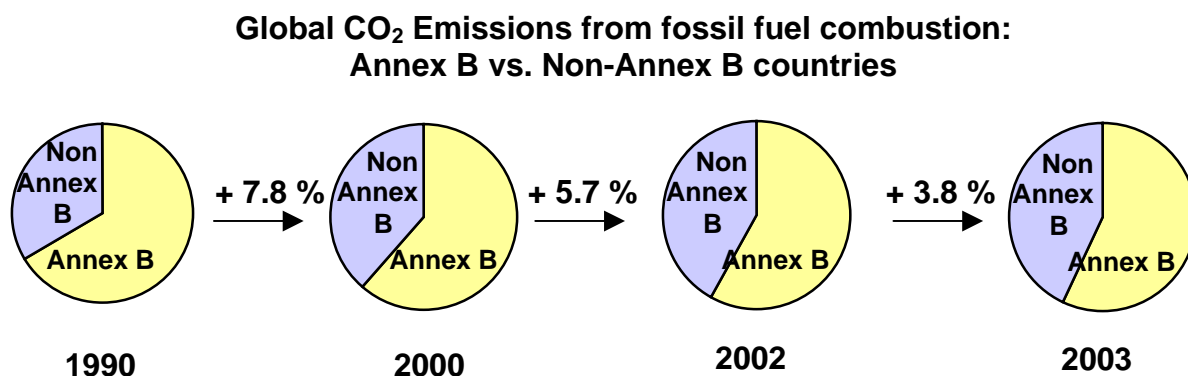


Figure 1: Shares of Annex B countries and non-Annex B countries in global carbon emissions from fossil fuel combustion.

3.1 Emissions of Annex B Countries

The following table 1 lists the Annex B countries and their CO₂ emissions from fossil fuel combustion.

The first column next to the country's name indicates the baseline 1990 emissions as reported to the UNFCCC (United Nations Framework Convention on Climate Change). The second column presents the 1990 emissions according to the LBST method (derived from BP world energy statistics from fossil fuel consumption with the emission factors for oil, gas and coal consumption explained above). To compare these two data sets, the third column shows the percentage of deviation of the LBST figures from the reported baseline emissions. The fourth and fifth column show the 2002 and 2003 emissions which were also calculated using the LBST method and therefore should show the relative difference to the 1990 figures accurately. The last column gives the percentage of change in 2003 emissions compared to the 1990 figures.

Over the 1990 to 2003 period the Annex B countries increased their emissions by a total of 1.5 %. Disaggregating the data exhibits that the restructuring of the former centrally planned economies (CPEs), the so-called "economies in transition" is responsible for that small increase. The total CO₂ emissions of Annex B countries without the CPEs were 12,247,000 Gg in 2002 compared to 10,710,000 Gg in 1990. This corresponds to an increase of 14 %. Apart from the economies in transition, the only decrease in emissions is reported for Germany (including the former GDR, -11 %), UK (-5 %), Sweden (-2 %) and Switzerland (-1%).

Table 1: CO₂ Emissions from fossil fuel combustion of Annex B countries (in Gg)

	1990 Emission UNFCCC Data	1990 from BP Energy Statistics (LBST method)	Deviation BP over UNFCCC	2002 from BP Statistics (LBST)	2003 from BP Statistics (LBST)	Difference between 2003 and 1990 emissions in %
Australia	262,623	272,000	+ 3.6 %	364,600	360,700	33 %
Austria	46,620	58,100	+ 24.7 %	66,200	72,000	24 %
Belgium/Luxemb	118,052	136,100	+ 15.3 %	157,000	162,400	19 %
Bulgaria	76,484	72,600	- 5.1 %	46,100	49,900	- 31 %
Canada	412,000	470,000	+ 14.1 %	569,800	587,400	25 %
Czech Republic	160,073	164,700	+ 2.9 %	120,500	122,700	- 25 %
Denmark	50,898	54,200	+ 6.5 %	55,400	60,500	12 %
Estonia	37,184	n.a.	--			
Finland	53,900	51,000	- 5.4 %	57,900	65,600	29 %
France	364,315	402,500	+ 10.5 %	411,700	420,200	4 %
Germany	986,832	1,002,000	+ 1.5 %	876,200	884,900	- 11 %
Greece	77,256	78,200	+ 1.2 %	102,200	107,200	37 %
Hungary	68,105	69,200	+ 1.6 %	55,400	56,700	- 18 %
Iceland	1,674	2,200	+ 31.4 %	3,100	3,100	41 %
Ireland	29,038	26,000	-10.5 %	41,400	39,800	53 %
Italy	400,047	424,700	+ 6.1 %	468,000	482,200	3 %
Japan	1,052,964	1,142,300	+ 8.5 %	1,289,100	1,335,400	17 %
Latvia	24,209	n.a.	--	n.a.	n.a.	--
Liechtenstein	208	n.a.	--	n.a.	n.a.	--
Lithuania	37,332	36,200	- 3.0 %	13,800	14,300	- 60 %
Monaco	106	n.a.	--	n.a.	n.a.	--
Netherlands	157,530	212,000	+ 34.6 %	248,000	249,500	18 %
New Zealand	22,240	28,400	+ 27.7 %	36,000	37,000	30 %
Norway	26,403	34,000	+ 28.8 %	38,400	39,700	17 %
Poland	371,433	374,800	+ 1.0 %	298,400	312,500	- 17 %
Portugal	43,281	44,200	+ 2.1 %	70,200	71,100	61 %
Romania	165,382	163,800	- 1.0 %	96,100	101,300	- 38 %
Slovakia	56,585	53,500	- 6.0 %	40,600	41,300	- 23 %
Slovenia	13,294	n.a.	--	n.a.	n.a.	--
Spain	207,592	230,900	+ 11.2 %	348,900	355,200	54 %
Sweden	51,328	59,200	+ 15.4 %	55,800	57,700	- 2 %
Russian Federation	2,298,900	2,299,700	+/- 0 %	1,549,400	1,538,500	- 33 %
Switzerland	40,330	43,400	+ 7.6 %	43,400	42,800	-1 %
Ukraine	672,075	736,500	+ 9.6 %	326,700	326,300	- 56 %
United Kingdom	558,091	605,200	+ 8.4 %	570,300	575,200	- 5 %
United States of America	4,928,900	5,333,800	+ 8.2 %	6,195,400	6,236,500	17 %
Total	13,873,284	14,681,400	+ 5.8 %	14,628,900	14,899,900	+ 1.5 %

Table 1.a: Comparison 1990 and 2000 UNFCCC-data and BP (LBST-method)

	1990 Emission		Deviation BP over UNFCCC	2000 Emission		Difference between 2000 and 1990 emissions in % UNFCCC	Difference between 2000 and 1990 emissions in % LBST
	UNFCCC	BP-Stat. LBST method		UNFCCC	BP-Stat. LBST method		
Australia	277,867	272,000	-2.1 %	347,006	346,800	24.9 %	27.5 %
Austria	62,297	58,100	-6.7 %	66,102	62,800	6.1 %	8.1 %
Belgium/Luxemb	130,716	136,100	+ 4.1 %	132,439	161,600	1.3 %	18.7 %
Bulgaria	103,856	72,600	- 30.1 %	48,440*)	44,900*)	- 53.4 %	- 38.2 %
Canada	471,563	470,000	-0.3 %	571,427	547,200	21.2 %	16.4 %
Czech Republic	163,990	164,700	+ 0.4 %	127,902	121,200	- 22.0 %	- 26.4 %
Denmark	52,635	54,200	+ 3.0 %	52,852	56,600	0.4 %	4.4 %
Estonia	--	n.a.	--	--	n.a.	--	--
Finland	62,466	51,000	- 18.4 %	62,305	53,400	-0.3 %	4.7 %
France	394,067	402,500	+ 2.1 %	401,923	420,200	2.0 %	4.4 %
Germany	1,014,500	1,002,000	- 1.2 %	857,908	878,200	- 15.4 %	- 12.4 %
Greece	84,336	78,200	- 7.3 %	103,727	99,100	23.0 %	26.7 %
Hungary	83,676	69,200	- 17.3 %	59,445	54,700	- 29.0 %	- 21.0 %
Iceland	2,065	2,200	+ 6.5 %	2,444	3,100	18.4 %	40.9 %
Ireland	31,599	26,000	-17.7 %	43,925	39,700	39 %	52.7 %
Italy	439,478	424,700	- 3.4 %	463,381	463,900	5.4 %	9.2 %
Japan	1,119,319	1,142,300	+ 2.1 %	1,237,107	1304,000	10.5 %	14.2 %
Latvia	--	n.a.	--	--	n.a.	--	--
Liechtenstein	--	n.a.	--	--	n.a.	--	--
Lithuania	39,535	36,200	- 8.4 %	16,694**)	16,600	- 57.8 %	- 54.1 %
Monaco	--	n.a.	--	--	n.a.	--	--
Netherlands	159,630	212,000	+ 32.8 %	173,527	238,500	8.7 %	12.5 %
New Zealand	25,267	28,400	+ 12.4 %	30,852	34,300	22.1 %	20.8 %
Norway	35,163	34,000	- 3.3 %	41,273	39,200	17.4 %	15.3 %
Poland	476,625	374,800	-21.4 %	314,812	303,400	- 33.9 %	- 19.1 %
Portugal	44,109	44,200	+ 0.2 %	62,150	68,700	40.9 %	55.4 %
Romania	194,826	163,800	- 15.9 %	n.a.	91,800	---	- 44.0 %
Russian Fed.	2,372,300	2,299,700	- 3.1 %	1,495,920 ^{x)}	1,608,700	- 36.9 %	- 30.0 %
Slovakia	59,746	53,500	- 10.5 %	41,472	38,700	- 30.6 %	- 27.7 %
Slovenia	--	n.a.	--	--	n.a.	--	--
Spain	227,233	230,900	+ 1.6 %	306,632	328,200	34.9 %	42.1 %
Sweden	56,065	59,200	+ 5.6 %	55,855	54,700	- 0.4 %	- 7.6 %
Switzerland	44,420	43,400	-2.3 %	43,853	42,600	-1.3 %	-1.8 %
Ukraine	703,792	736,500	+ 4.6 %	314,445**)	324,400	- 55.3 %	- 56 %
United Kingdom	583,705	605,200	+ 3.7 %	542,743	575,300	- 7.0 %	- 4.9 %
United States of America	4,998,515	5,333,800	+ 6.7 %	5,840,039	6,249,000	16.8 %	17.2 %
European Comm	3,341,803	3,656,300	+ 9.4 %	3,324,800		-0.5 %	
Total	14,515,361	14,681,400	+ 1.1 %	13,858,600	14,671,50	-4.5%	- 0.1 %

*) 1999

**)1998

x) 1996

Table 2: Relative CO₂ Emissions from fossil fuel combustion of Annex B countries (in percent), relative and absolute change of primary energy use (PEV) and substitution between fossil fuels

country	rel. CO ₂ -emission 2003/2002 (in percent)	TPEC 2003 (Mtoe)	TPEC-change 2003/2002 (in percent)	fossil fuel changes		
				oil (Mtoe)	gas (Mtoe)	coal (Mtoe)
Australia	-1%	115.6	- 0.6%	0.1	1	-1.7
Austria	8.3%	31.9	0.9%	1.3	0.7	--
Belgium/Luxemburg	3.9%	66.9	3.5%	1.3	1	-0.2
Bulgaria	8.1%	19.4	1.9%	0.1	--	0.3
Canada	3.1%	291.4	2.1%	4.2	1.7	0.3
Czech Republic	1.9%	43.4	5.2%	0.4	0.3	0.1
Denmark	9.1%	19.6	6.6%	-0.3	0.1	1.5
Estonia	--	--	--	--	--	--
Finland	13.4%	28.9	8.0%	0.5	0.4	1.4
France	2.2%	260.6	1.6%	1.3	1.9	0.2
Germany	1.0%	332.2	0.7%	-2.3	2.7	2.5
Greece	4.9%	43.4	5.8%	0.8	0.3	0.5
Hungary	2.3%	23.7	1.3%	-0.2	1	0.2
Iceland	0.0%	2.6	0.7%	--	--	--
Ireland	-3.8%	13.9	-3.6%	-0.4	--	-0.1
Italy	3.0%	181.9	2.9%	-0.8	5.5	4.1
Japan	3.6%	504.8	-0.4%	5.1	4.2	5.6
Latvia	--	--	--	--	--	--
Liechtenstein	--	--	--	--	--	--
Lithuania	3.3%	9.2	6.8%	--	0.2	--
Monaco	--	--	--	--	--	--
Netherlands	0.6%	90.0	0.3%	0.7	-0.6	0.2
New Zealand	2.8%	18.4	1%	0.3	-0.8	0.5
Norway	3.3%	38.0	-11.5%	0.2	0.3	--
Poland	4.7%	91.3	4.9%	1.1	1.2	2.1
Portugal	1.3%	26.7	8.8%	0.4	0.2	-0.2
Romania	5.4%	39.8	3%	0.4	1.1	0.4
Slovakia	1.9%	19.0	-1.7%	0.2	-0.1	0.1
Slovenia	--	--	--	--	--	--
Spain	1.8%	141.5	5.1%	1.7	2.7	-1.3
Sweden	3.2%	46.4	-4.4%	0.6	--	0
Russian Federation	4.2%	670.8	3.7%	1.2	15.2	7.4
Switzerland	-1.6%	29.4	-0.5%	-0.3	0.1	--
Ukraine	-0.1%	133.3	-0.2%	0.7	-2.3	0.7
United Kingdom	0.9%	223.2	0.5%	-1.5	0.1	2.4
United States of America	0.7%	2297.8	0.05%	6.9	-8.9	14.5
Total	1.9%	5855	-0.1%	23.7	29.2	41.5

On average, though primary energy consumption was stable, carbon dioxide emissions increased by almost 2 percent. This was due to the substitution of non emitting sources (renewables, nuclear) by fossil fuels, with an over proportional rise of coal consumption. We believe that emphasis of coal was predominantly due to the rising oil (and gas) prices world wide and especially in the United States. It must be stated that on average the behaviour is in striking contrast to what these countries have agreed upon at Kyoto, and most of them have also ratified.

Some countries have increased their CO₂ emissions while reducing the primary energy consumption, most prominent are Norway, Japan and New Zealand. Others, like Austria, Denmark or Russia have increased emissions much stronger than their primary energy consumption.

Norway and Austria have special conditions due to their huge CO₂ free hydro power generation the annual fluctuations of which influence this balance considerably. However the other mentioned countries have substituted carbon free or carbon-poor energy sources by carbon-rich coal consumption.

A third group of countries, Ireland (-3.8%), Switzerland (-1.6%) and Australia (-1%), have reduced CO₂ emissions, while another group has increased its emissions at a lower rate than the primary energy use. The last group has substituted coal or oil by less polluting fuels, predominantly natural gas. Most prominent to be mentioned are Portugal and Spain. But also Australia merits to be mentioned for its substitution of coal by gas.

The emissions of the Annex B countries, excluding the former CPEs, increased twice as much as the average (14%). This strong increase seems to be due to a rebounding world economy. Apart from the small reduction in Ukraine (-0.1%) none of the former CPEs continued to reduce its emissions.

Due to the crudeness of this analysis, based on the BP energy statistics, the figures should be seen as a fast survey on trends. For deeper analysis, the identified key countries should be investigated in more detail to get conclusive figures.

The following figure 2 shows the ranking of Annex B countries according to their 1990 baseline emissions, based on national communications.

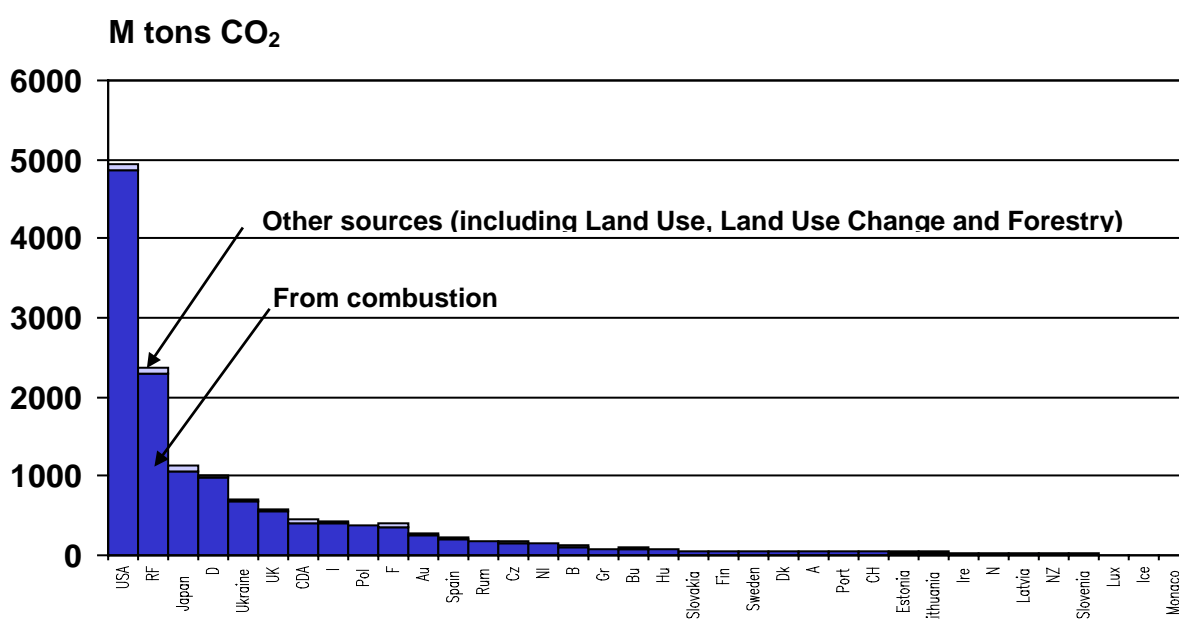


Figure 2: Ranking of Annex B countries according to their 1990 CO₂ emissions. Note that in addition to table 1 also the emissions and sinks (LULUCF) other than from combustion are included. Data are taken from UNFCCC [2].

Note that the four largest emitting countries, the USA, the Russian Federation (RF), Japan and Germany covered two-thirds of Annex B emissions in 1990. (In both calculations, with UNFCCC figures and with BP energy data). In 2003 this share amounted to 67 percent.

3.2 Emissions of Non-Annex B Countries using the LBST method

Table 3 lists the major CO₂ emitters among non-Annex B countries and their CO₂ emissions from fossil fuel combustion. These figures are derived from fossil fuel combustion applying the emissions factors for oil, gas and coal as specified above.

Table 3: CO₂ emissions of non-Annex B countries (in Tg) calculated with the LBST method described above. Numerous countries which only have very little CO₂ emissions are not listed.

Country	1990 Emissions	2000 Emissions	2002 Emissions	2003 Emissions	Change 2003/2002	Change 2003/1990
Algeria	70.8	69.8	72.3	76.1	5.2 %	8 %
Argentina	100.4	131.9	115.0	125.4	9 %	25 %
Azerbaijan	58.1	29.8	26.7	26.9	0.7 %	- 54 %
Bangladesh	16.6	31.2	36.9	39.1	6 %	136 %
Belarus	107.4	54.1	49.2	53.0	7.7 %	- 51 %
Brazil	220.2	325.6	331.3	328.1	- 1 %	49 %
Chile	32.5	58.4	54.5	54.8	0.6 %	69 %
China	2405	2485.7	3,452.4	3,958.0	14.7 %	65 %
China-Hongkong	40.1	48.4	64.3	67.9	5.6 %	69 %
Colombia	50.4	52.1	50.3	52.8	5 %	5 %
Ecuador	12.9	17.7	18.0	18.6	3.3 %	44 %
Egypt	88.6	122.0	124.8	130.8	4.8 %	48 %
India	612.6	1022	1,086.9	1,112.3	2.3 %	82 %
Indonesia	145.9	269.7	299.4	307.3	2.6 %	111 %
Iran	192.4	301.4	324.8	329.7	1.5 %	71 %
Kazakhstan	244.3	130.3	140.1	157.2	12.2 %	- 36 %
Kuwait	29.3	50.8	50.7	58.3	15 %	99 %
Malaysia	64.3	118.3	136.5	142.2	4.2 %	121 %
Mexico	272.6	360.5	360.3	371.3	3.1 %	36 %
Pakistan	63.2	102.8	105.3	104.6	-0.7 %	66 %
Peru	18.9	24.9	23.2	25.0	7.8 %	32 %
Philippines	38.5	66.5	68.7	73.9	7.6 %	92 %
Saudi Arabia	222.7	289.5	306.6	326.3	6.4 %	47 %
Singapore	70.3	104.7	117.0	113.7	- 2.8 %	62 %
South Africa	323.0	381.4	390.8	413.3	5.8 %	28 %
South Korea	249.5	518.6	556.0	569.1	2.4 %	128 %
Taiwan	127.5	244.7	263.2	277.4	5.4 %	118 %
Thailand	84.4	176.4	194.5	207.9	6.9 %	146 %
Turkey	137.8	209.4	195.1	198.3	1.6 %	44 %
Turkmenistan	34.7	34.9	39.0	41.0	5.1 %	18 %
UAE	72.7	100.8	117.6	121.5	3.3 %	67 %
Uzbekistan	128.8	120.2	131.1	119.6	-8.8 %	- 7 %
Venezuela	101.0	124.6	139.7	132.2	- 5.4 %	31 %
Total*	6,437	8,179	9,442	10,134	7.4%	57.4 %

* includes only those non-Annex B countries listed above

In total, emissions of all non-Annex B countries rose by 57 percent over the thirteen-year period with strongest increases recorded in Thailand (146 %), Bangladesh (136%), South Korea (128%) Malaysia (121 %), Taiwan (118 %) and Indonesia (111%). The next largest changes with emissions increases of more than 80 percent are reported from Kuwait, Phillipines and India. Although China reduced its emissions during the late 90's, it still increased its emissions significantly by 65% compared to the 1990 level. Though over the entire period only former CPE countries showed a (strong) emission reduction, it is worth mentioning that 2003 several other countries reduced emissions compared to 2002, namely Venezuela, Singapore, Brazil, and Pakistan. All of them except Pakistan reduced their emissions for the second year in

row. Furthermore, Colombia might be worth mentioning as it reduced its emissions by more than 14 % since 1997.

This short analysis reveals that even among members of the non-Annex B countries, the respective emissions developed quite differently depending on varying economic conditions, but also depending on different political decisions. Further details might be extracted from table 4 below and the succeeding discussion.

The following figure 3 shows a ranking of non-Annex B countries according to their calculated 1990 emissions. In addition to the 1990 figures, the development over the last five years is shown.

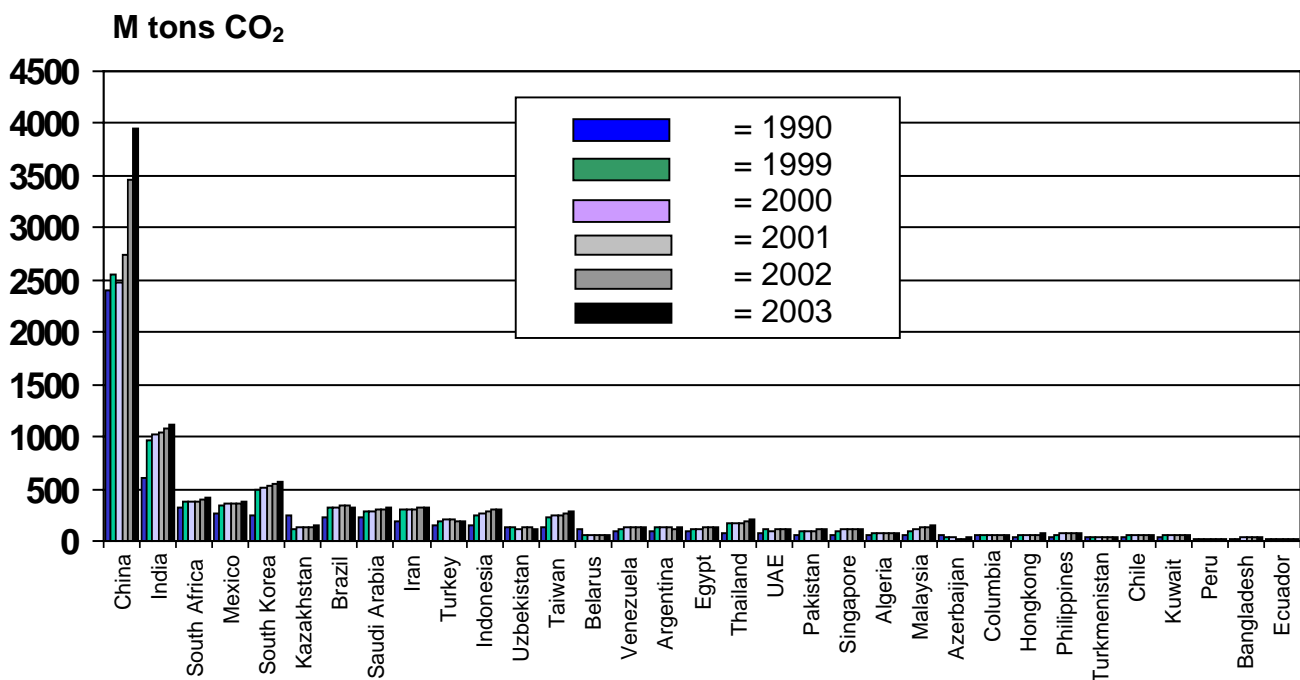


Figure 3: Ranking of non-Annex B countries according to their 1990 emissions (blue bars). The green, violet, light grey, dark grey and black bars show the emissions of 1999 to 2003 respectively.

South Korea, being the fifth largest emitter in 1990, has clearly become the third largest CO₂ emitting non-Annex B country. The four countries with the largest emissions, China, India, South Korea and South Africa, covered approximately 54 percent of all non-Annex B emissions in 2003, which is slightly more than in 1990.

Table 4: Relative CO₂ Emissions from fossil fuel combustion of non-Annex B countries (in percent), relative and absolute change of primary energy use (PEV) and substitution between fossil fuels (TPEC = Total Primary Energy Consumption). Numerous countries which only have very little CO₂ emissions are not listed.

country	rel. CO ₂ -emission 2003/2002 (in percent)	TPEC- change 2003/2002 absolute	TPEC-change 2003/2002 (in percent)	fossil fuel changes		
				oil (Mtoe)	gas (Mtoe)	coal (Mtoe)
Algeria	5.2%	29.9	5%	0.3	1.1	0.1
Argentina	9%	58.7	7.7%	0.4	3.9	0.1
Azerbaijan	0.7%	12.1	9.8%	0.6	0.2	--
Bangladesh	6%	15.8	6.2%	0.2	0.7	--
Belarus	7.7%	21.1	6.8%	0.9	0.5	--
Brazil	- 1.0%	181.4	2.1%	-1.4	1.3	-0.5
Chile	0.6%	24.2	0.6%	-0.2	0.4	--
China	14.7%	1178.3	13.8%	27.3	2.8	105.5
China-Hongkong	5.6%	21.0	3.1%	0.2	-0.7	1.2
Colombia	5.0%	26.2	3.8%	--	-0.1	0.6
Ecuador	3.3%	7.8	1.6%	0.2	--	--
Egypt	4.8%	52.0	4.9%	0.7	1.7	--
India	2.3%	345.3	2.2%	2	1.3	4.3
Indonesia	2.6%	107.0	2.5%	0.8	0.9	0.9
Iran	1.5%	129.1	1.6%	0.8	0.9	-0.1
Kazakhstan	12.2%	49.6	11.1%	-0.5	1.3	4.1
Kuwait	15.0%	21.2	13.6%	2.3	0.3	--
Malaysia	4.2%	54.4	4.7%	1.4	1.5	-0.5
Mexico	3.1%	138.1	2.1%	1.2	2.4	0.2
Pakistan	-0.7%	44.8	2%	-1	0.5	0.3
Peru	7.8%	12.5	5.3%	0.5	0.1	--
Philippines	7.6%	25.4	8%	--	0.8	0.9
Saudi Arabia	6.4%	121.9	6.5%	3.6	3.9	--
Singapore	- 2.8%	38.9	-2.5%	-1.4	0.4	--
South Africa	5.8%	116.9	5.4%	0.6	--	5.4
South Korea	2.4%	212.0	3.4%	1	1.1	2
Taiwan	5.4%	94.8	4.5%	1.7	0.1	2.3
Thailand	6.9%	74.0	7%	2.3	2	0.5
Turkey	1.6%	74.3	3.8%	0.6	3.3	-1.6
Turkmenistan	5.1%	16.9	6%	-0.3	1.3	--
UAE	3.3%	48.8	3.3%	0.6	0.9	--
Uzbekistan	-8.8 %	51.7	-8.7%	-0.3	-4.7	--
Venezuela	- 5.4%	64.1	-3%	-3.1	0.8	--
Total	7.4%	3470.2	8%	42	29.9	125.7

Though the overall emissions have increased by 7.4 percent, this increase is moderate with respect to the expected rise of energy consumption which jumped by 8 percent. On average, the non-Annex B countries have, at least, reduced the share of fossil fuels in the energy mix by even stronger additions of non emitting sources (renewables, nuclear). Some countries like Uzbekistan (-8.8%), Venezuela (-5.4%), Singapore (-2.8%) , Brazil (-1%) and Pakistan (-0.7%) reduced their emissions while others increased them underproportionally with respect to energy use.

As a prominent example, Brazil might be mentioned which increased primary energy use by 2.1 percent while still decreasing carbon dioxide emissions by 1 percent. The overproportional emission reduction in Venezuela is due to the strong reduction of oil supplies (-11.5%). Other "leadership" comes from Pakistan or Turkey. Most of these countries switched from coal or oil to less polluting fuels, due to development of own gas reserves (Brazil, Turkmenistan) or increasing gas imports (Turkey), or increased the share of renewables. Brazil, e.g. increased its hydropower production by almost 7%.

3.3 Emission changes 1990 to 2003

Figure 4 lists both Annex B and non-Annex B countries according to a ranking of their relative emission changes from 1990 to 2003. As specified above the emerging markets of Thailand, South Korea and Malaysia exhibit the strongest CO₂ emission increases by more than 120 %. Bangladesh increased its emissions by more than 130 percent, though still remaining at a very low absolute and per capita level.

The Annex B countries are marked with red bars. In Europe, the strongest relative increase was recorded in Portugal, Spain and Ireland (more than 50 percent). A reduction of emissions relative to 1990 occurred in Germany, Switzerland, Sweden and UK. Germany profits to some extent from the inclusion of the former German Democratic Republic. But its reduction is also due to additional factors.

Early emission reductions in former centrally planned economies (CPE, also called Economies in Transition) are shrinking due to recent developments. Turkmenistan is the first former CPE which already has exhausted its reduction budget.

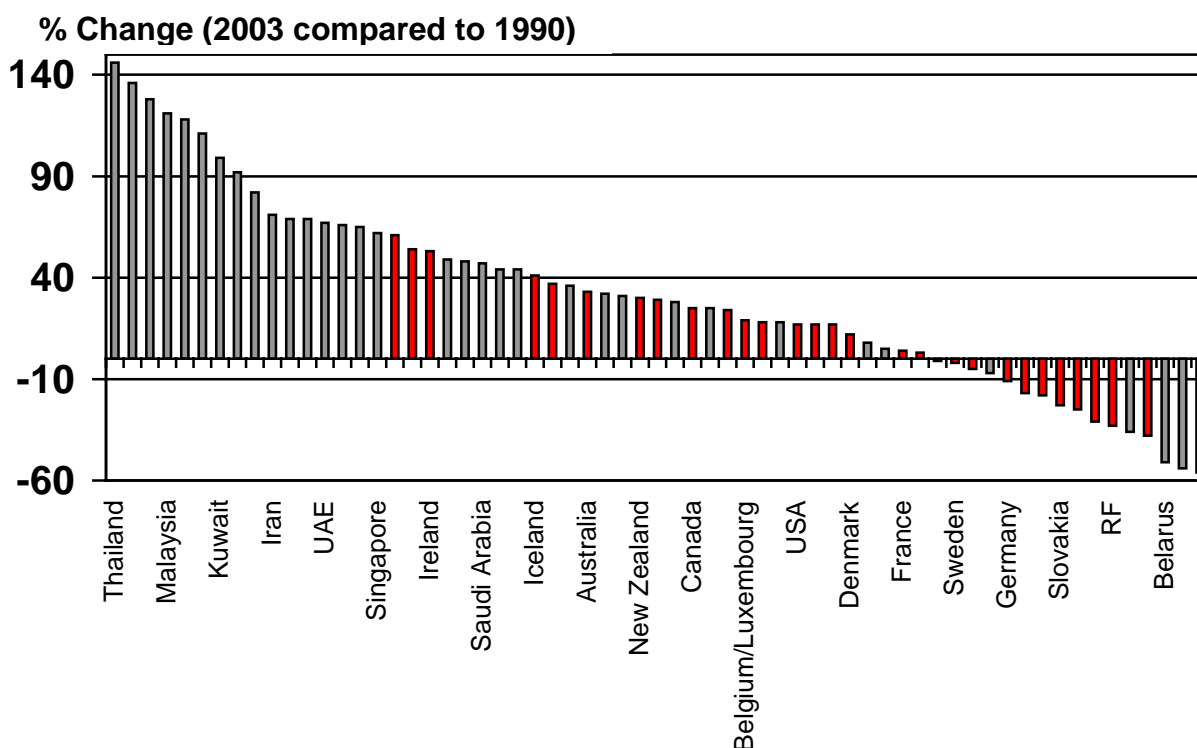


Figure 4: Relative changes of CO₂ emissions in 2003 compared with 1990. Annex B countries are marked with red bars.

Not all country names are shown in the figure. The complete sequence is as follows: Thailand, Bangladesh, South Korea, Malaysia, Taiwan, Indonesia, Kuwait, Philippines, India, Iran, Chile, China-Hongkong, UAE, Pakistan, China, Singapore, Portugal, Spain, Ireland, Brazil, Egypt, Saudi Arabia, Ecuador, Turkey, Iceland, Greece, Mexico, Australia, Peru, Venezuela, New Zealand, Finland, South Africa, Canada, Argentina, Austria, Belgium/Luxembourg, Netherlands, Turkmenistan, USA, Japan, Norway, Denmark, Algeria, Colombia, France, Italy, Switzerland, Sweden, UK, Uzbekistan, Germany, Poland Hungary, Slovakia, Czech Republic, Bulgaria, RF, Kazakhstan, Romania, Belarus, Azerbaijan, Ukraine

As already mentioned, in 2003 several Annex B and non-Annex B countries reduced their emissions. However, this was by far not sufficient to keep world wide carbon dioxide emissions stable.

3.4 Development of CO₂ emissions

Figure 5 shows the development of CO₂ emissions over time. The thick black line shows the development of the world's CO₂ emissions from fossil fuel consumption according to the LBST method.

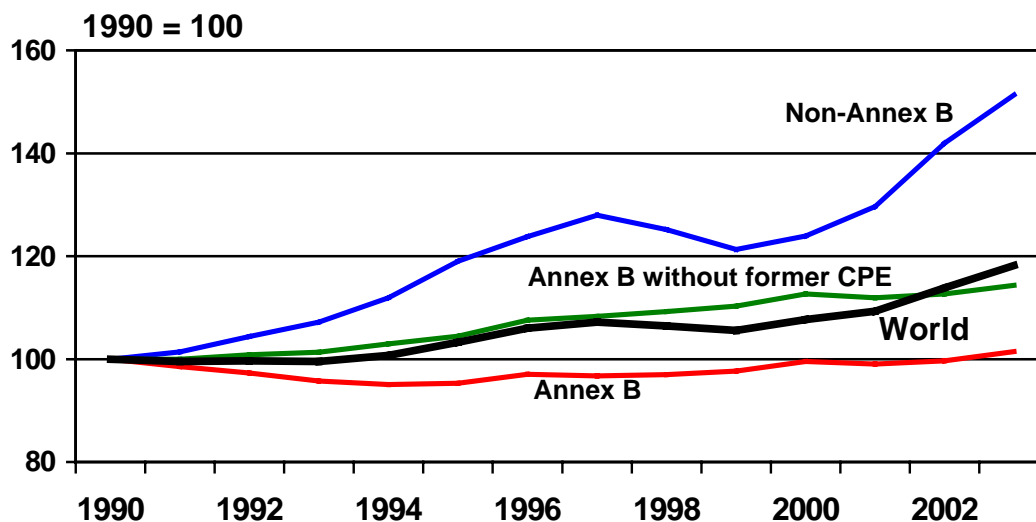


Figure 5: Development of CO₂ emissions from fossil fuel consumption. The thick black line indicates the total of global emissions. The various thin lines show the emissions from Annex B and non-Annex B countries as marked in the figure. Note that the figure does not display absolute emissions but the relative changes compared to 1990.

The 18 percent increase in global CO₂ emissions results from a very heterogeneous time development in time: in the first period until about 1994 the emissions were almost constant. This is composed of a strong increase of emissions from non-Annex B countries and a decrease in Annex B countries. When further splitting the emissions from Annex B countries into those from OECD countries and former CPE countries it becomes clear that the decrease of Annex B countries' emissions was almost entirely attributable to the development in the former CPEs. The OECD countries' emissions also rose over this period.

Between 1994 and 1996 global emissions rose by about 3 percent per year. This is due to an increase in emissions by both Annex B and non-Annex B countries.

Between 1996 and 1999 global CO₂ emissions were reduced slightly. Since emissions from Annex B countries still increased (slightly) over that period, this reduction is almost completely due to a reduction in emissions by non-Annex B countries (e.g. from the Asian crisis). During the last three years emissions increased again in non-Annex B countries, while OECD and Annex B countries' emissions remained roughly constant since 2000.

The Economies in Transition started to increase their energy consumption and CO₂ emissions in the late 90's, but still at a lower rate than expected by most observers. Australia, Japan and the USA steadily increased their emissions throughout the nineties, by about 15-20 percent or even more. Thus, these nations were ignoring their aim of returning to their 1990 levels by the year 2000, as adopted in the Climate Convention.

The European Union decreased its emissions until 1994. This was mainly due to reductions in Germany (which profited from the inclusion of the former GDR) and in the UK. Germany, which is also explicitly listed in the figure, showed a steady decrease of emissions over the 90's, indicating that the former GDR contributed only partly to that emission reduction. Other effects are also responsible for this development, such as a continuous shift from coal to less carbon intensive fuels.

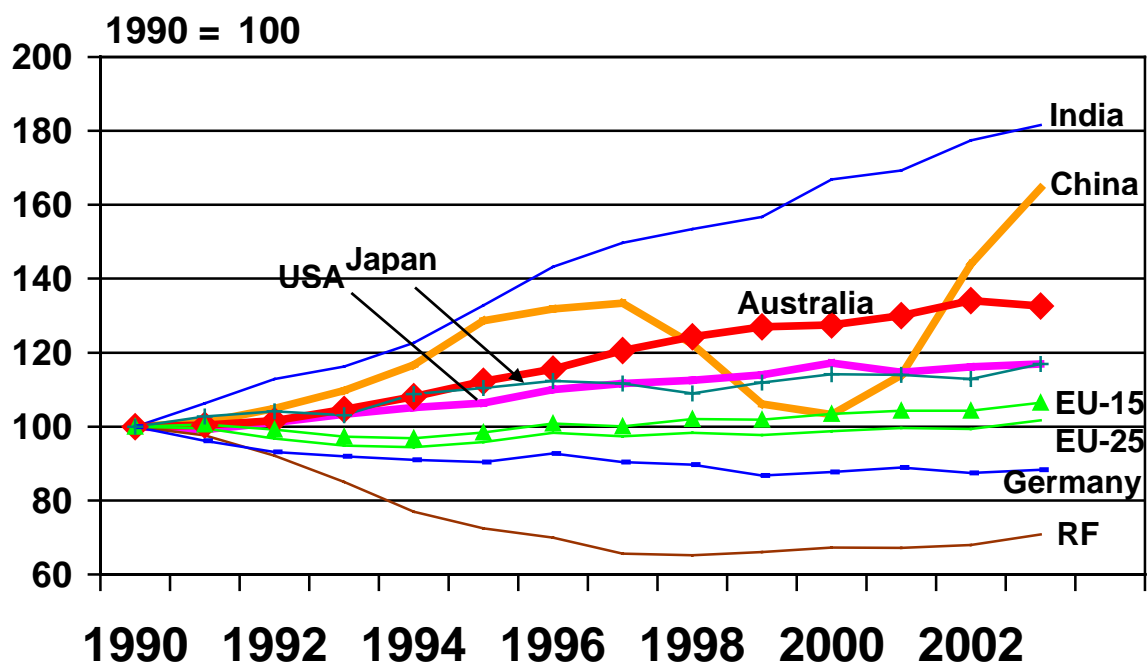


Figure 6: Trend of CO₂ emissions by leading Annex B and non-Annex B countries. Note that the figure does not display absolute emissions but the relative changes compared to 1990.

The Russian Federation (RF) experienced the strongest emission reduction with a rate of almost 35 percent. As expected the reduction was strongest within the first few years. Over the last years emissions have already been increasing again slightly.

The most remarkable change with global impact happened in China. After a steady increase until 1997, emissions decreased for three consecutive years. The decrease in global CO₂ emissions in 1998 and 1999 (see figure 5) was almost completely due to this effect (in 2000, the increases in India outweighed the decrease in China's emissions). The years 2001-2003 were then marked by strong emissions increases. In contrast, the second largest non-Annex B emitter, India, still shows a stable steady emissions increase already since 1990. Between 1990 and 2003, this increase amounts to more than 80 percent, although over the second half of the investigated period, it showed weak signs of levelling out. The strong fluctuations in China's emissions over the last years, however, cause some doubt over whether the statistics are correct. It seems to be more likely that the emission reduction 1998-2000 was not as steep as is indicated by the statistics. Nevertheless, due to the dip during the late 90ies, the increase of total emissions since 1990 is much smaller than most forecasters had predicted at that time.

Figure 7 shows that these changes in CO₂ emissions are not only due to a reduction of primary energy consumption, but also to a switch from carbon rich to less carbon rich energy sources. However, over the last two years this trend reversed again

towards carbon richness. It is very likely that this reversal was triggered by the huge price increases of oil and gas.

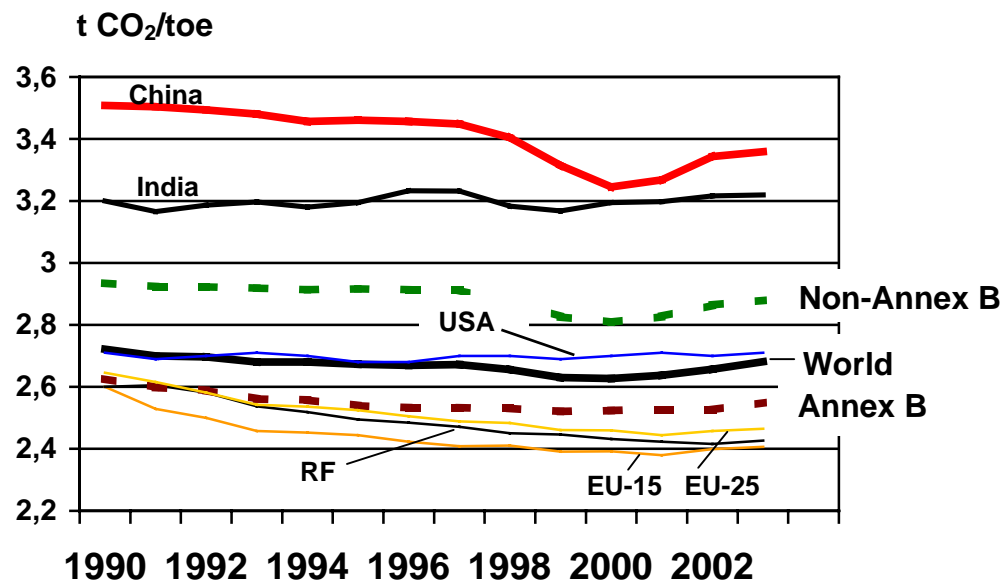


Figure 7: Average CO₂ emissions per unit of primary energy consumed for various leading countries and regions

On average, specific carbon emissions per primary energy unit were reduced by about 1.5 percent between 1990 and 2003. It should be noted that the BP Statistical Review of World Energy includes only the commercially traded energy sources of oil, gas, coal, nuclear power and hydropower. All forms of renewable energy (except large hydro) are excluded from these statistics and not considered in this analysis. When comparing the figures presented here with figures from the first three editions of this report, it should be noted that BP last year has changed the statistical basis for the calculations. Nuclear energy and hydroenergy have formerly been converted into primary energy with different factors. Now through a new method they are given a larger share on primary energy in total. Taking into account these changes, hydropower electricity is now converted into primary energy by the factor 2.63 (formerly 1.2), while nuclear energy is now also converted by the factor 2.63 (formerly 3).

The figure also exhibits that China still has by far the most carbon-rich energy economy, emitting about 3.3 t of carbon dioxide per consumed ton of oil equivalent primary energy.

Apart from the Russian Federation, nearly all countries increased the carbon intensity of their energy supply over the last two years – even the European Union with its ambitious emissions reduction goals. This may be a reflection of the increased oil prices, which skyrocketed first time in 2000 and now are close to US\$40/barrel. The 2003 average price was about 20% above the 2001 prices. There are some indications that this development is already related to geological oil supply restrictions [4].

4 Primary energy consumption

4.1 The share of fossil fuels

Figure 8 shows the change in energy mix in Annex B and non-Annex B countries. The general trend of a reduction in the share of coal in the world energy mix was reversed over the last few years, mainly triggered by the increased share of coal in non-Annex B countries' primary energy mix. At present, the share of coal in non-Annex B countries (about 34 %) ranges far above the share of coal in Annex B countries' energy mix (about 21 %).

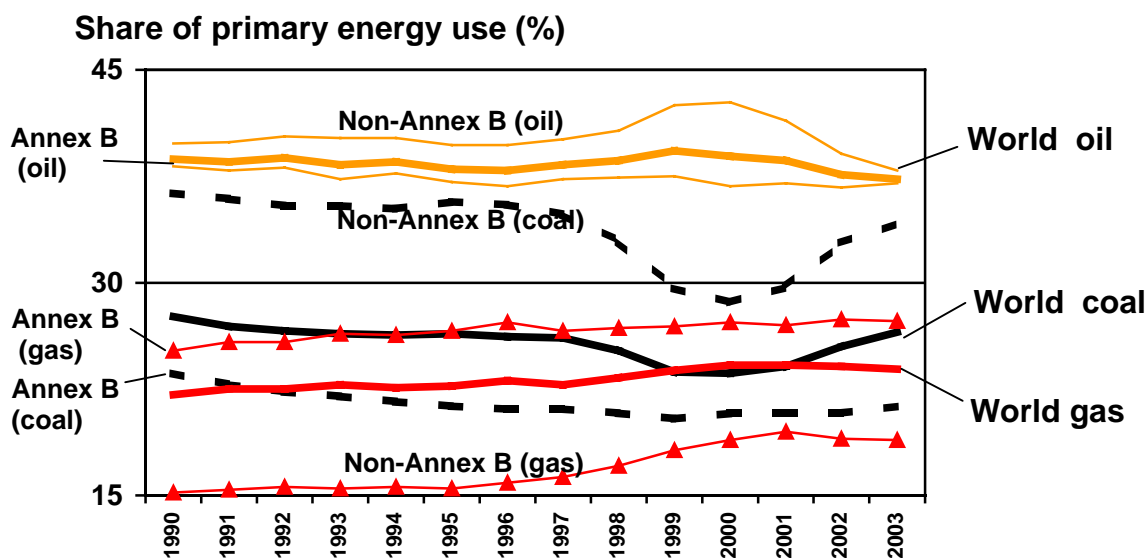


Figure 8: Development of the shares of oil, gas and coal in the primary energy mix from 1990 to 2003. For each thick line (representing world averages) a pair of lines is shown indicating the respective figures for Annex B and non-Annex B countries (broken lines: coal; thin lines: oil and gas).

As a general trend it may be concluded that the share of coal is on the rise and the other fossil fuels oil and gas have reduced their share over the last three years. This might be a first consequence of rising oil and gas scarcity world wide.

Until 1999/2000 mainly the non-Annex B countries increased their oil consumption while strongly decreasing their coal consumption. This effect reversed over the last three years. This behaviour might be connected to the strong oil price fluctuations over the last years: In 1999 oil prices hit an historical low as they fell below 10 US\$, whereas the prices in 2000 - 2002 ranged above 25 US\$ per barrel, and above US\$30/barrel in 2003.

One is tempted to deduce from this analysis that the less wealthier non-Annex B countries are most vulnerable to high oil prices and are affected first if prices increase even further.

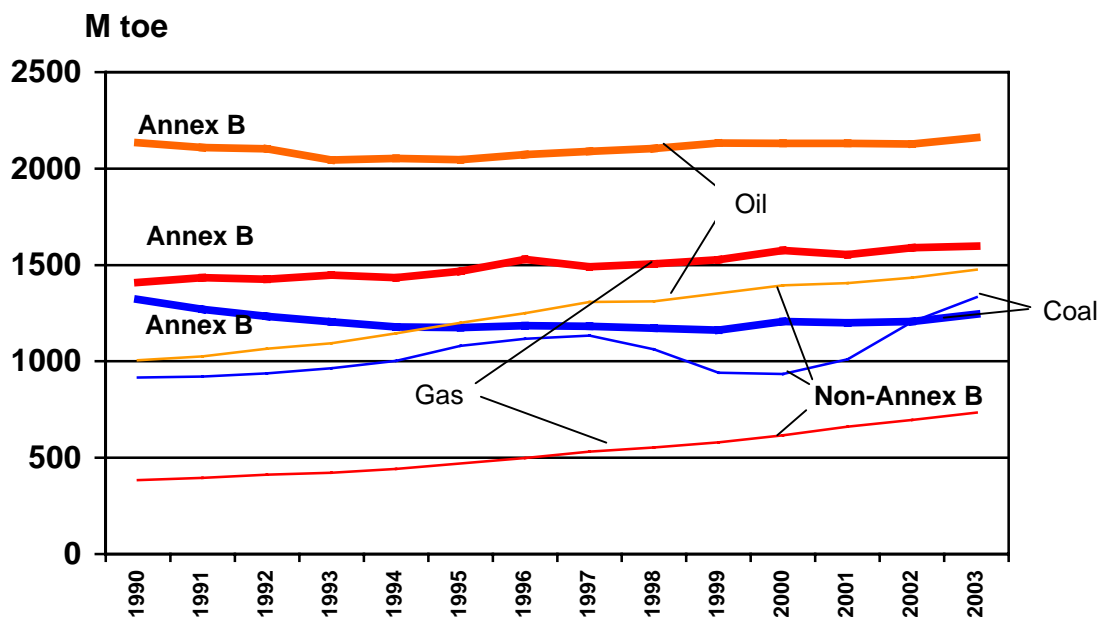


Figure 9: Consumption of oil, gas and coal in Annex B and non-Annex B countries. Thick lines represent Annex B countries, thin lines show data for non-Annex B countries

Figure 9 shows the development of fossil fuel consumption in Annex B and non-Annex B countries in absolute figures. On average, between 1990 and 2003 gas consumption in Annex B countries rose by about 11 %, while oil consumption remained nearly constant (1 % change) and coal consumption decreased by 5 %. In non-Annex B countries, gas consumption increased by 91 %, oil consumption by 47 % and coal consumption by about 45 %.

4.2 Coal consumption

Since coal has by far the highest specific CO₂ emissions, a reduction in coal consumption shows the strongest effects in terms of reducing carbon dioxide emissions.

Figure 10 shows the coal consumption since 1990 for the world, the Annex B and non-Annex B countries and several large consumers.

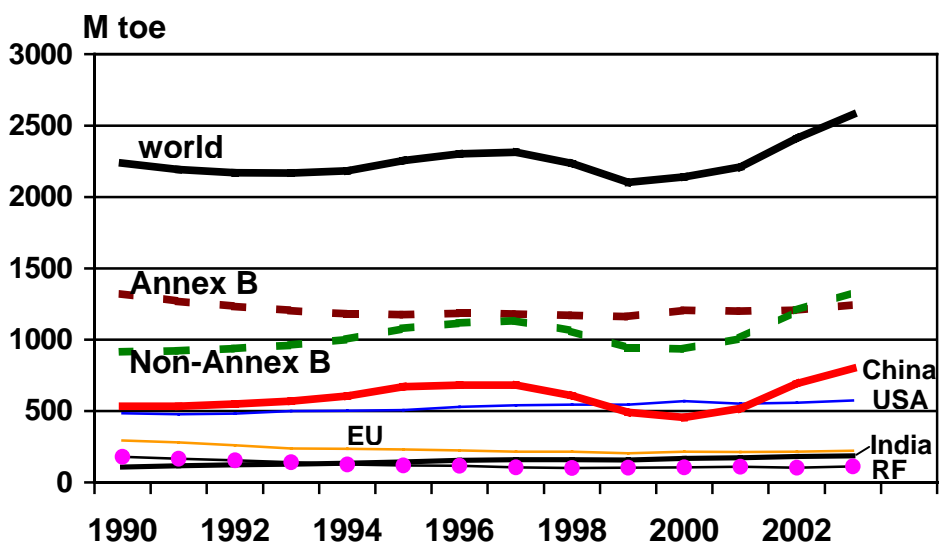


Figure 10: Coal consumption for the world, Annex B and non-Annex B countries. The development for various leading countries and regions is also shown.

World coal consumption increased by about 15 percent since 1990. The disaggregation in Annex B and non-Annex B countries shows that consumption decreased in the first half of the nineties in Annex B countries and was almost constant for the second half of the period. This decrease is partly due to a decrease of the total energy consumption of the Economies in Transition.

The non-Annex B countries increased their coal consumption by about 24 percent until 1996. During the late 90's coal demand significantly decreased in China. However, this trend has reversed into a strong increase in coal consumption since 2001.

Figure 11 shows the share of coal in the energy consumption of individual regions. Worldwide, the share of coal has been slightly reduced from 27.6 percent in 1990 to 23.6 percent in 2000. This reduction is mainly due to the non-Annex B countries where even India, with its large absolute increase, reduced the share of coal consumption. It should, however, be mentioned that this trend was reversed during the last years. Due to high oil prices India (and even China) reinforced their domestic coal production and consumption while the economic crisis in the USA resulted in an overall reduction of energy consumption including coal. During the last years the share of coal in primary energy demand increased again, presumably due to high oil prices.

China's reduction during the late 1990's was even more pronounced, as already mentioned. Most remarkable is the reduction of the share of coal in the European Union from 22 % to 15 % in 2002. The United States of America kept the share of coal nearly constant over the last ten years. Moreover, Japan is one of the very few Annex B countries which increased the share of coal in the past years from 17 % to above 20 %.

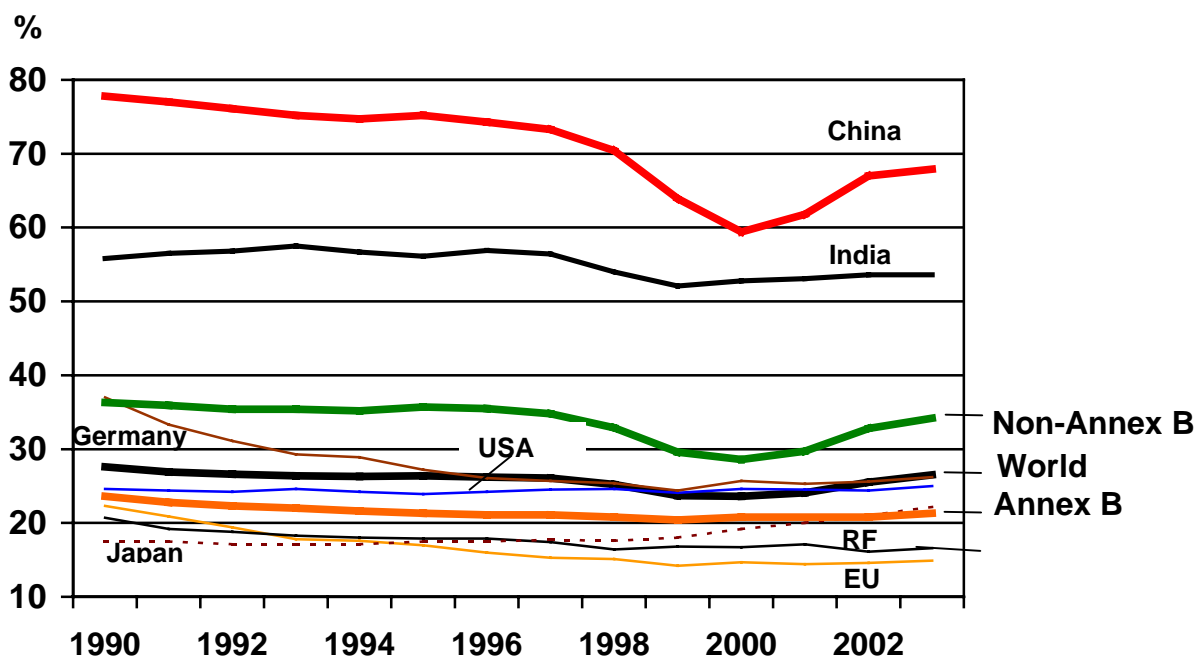


Figure 11: Share of coal consumption in primary energy use in the world, in Annex B, non-Annex B countries and several leading countries and regions.

5 References

- 1 BP Statistical Review of World Energy 2004 (see www.bp.com)
- 2 CO₂ emissions of Annex B countries in 1990 (see www.unfccc.int)
- 3 Analysis of BP Statistical Review of World Energy with respect to CO₂ emissions, 1st, 2nd, 3rd, and 4th edition, Germanwatch and LBST, 2000/2001/2002/2003 (see www.germanwatch.org)
- 4 See “Association for the study of Peak Oil and Gas”, at www.peakoil.net

6 Abbreviations

CPE	Centrally planned economies (Former CPE are identical to EIT)
EIT	Economies in Transition
EU	European Union
FCCC	Framework Convention on Climate Change
GDR	Former German Democratic Republic (since 1990 part of Germany)
Gg	Gigagram (identical to kt = kiloton)
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change and Forestry
Mtoe	Million tons of oil equivalent
RF	Russian Federation
Tg	Teragram (identical to 1 million tons)
TPEC	Total primary energy consumption
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America