

Contents

Worldwide CO₂ Emissions Reached New Record High

- Worldwide development of greenhouse gas emissions
- Emission development in the EU
- Factors influencing the development of greenhouse gas emissions
- Conclusion: boosting of efforts essential in order to reach the reduction targets

Editorial Board

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Worldwide CO₂ Emissions Reached New Record High¹

Hans-Joachim Ziesing

Worldwide climate protection suffered another serious set-back last year. According to preliminary estimates, energy-induced emissions of carbon dioxide (CO₂) – the most important greenhouse gas by far – increased by approx. 4.5% on a worldwide basis in 2004 in comparison to the previous year; compared to 1990, the increase amounted to more than one fourth.

For the total greenhouse gas emissions, only information on those countries committing to emission limitation or reduction according to the Kyoto Protocol is available (Annex B countries – without USA and Australia). In those countries, greenhouse gas emissions rose by an estimated 1% in the past year. In comparison to the base year 1990, in 2004 they were lower by almost 15%. This was basically a consequence of the drastic emission reduction in the so-called transformation countries (Economies in Transition) in Central and Eastern Europe (1990 to 2004: -35%); however, starting in 1998, a considerable emission increase occurred again in those countries (1998 to 2004: an increase of approx. 10%).

All things considered, a measurable success in international climate protection policy is still missing – instead of the targeted reduction, greenhouse gas emissions continued to rise in most of the countries. Upon the Kyoto Protocol becoming effective as of February 2005, those countries that ratified the Protocol now have the binding obligation to reach the promised emission target by the commitment period 2008/2012. For the majority of the countries, this will only be possible with materially intensified climate protection measures within the relatively short remaining time. In EU countries, emissions trading can make a significant contribution. However, a prerequisite therefore is the corresponding specification in the allocation plans still to be prepared for the commitment period 2008/2012.

¹ This is a continuation of the series of reports concerning worldwide emission development published in the past few years. See the most recent contribution by Hans-Joachim Ziesing: Worldwide Climate Protection Policy – Still No Visible Success. In: *DIW Economic Bulletin*, vol. 41, no. 10, October 2004.

Worldwide development of greenhouse gas emissions

There are only incomplete data on the current worldwide development of the emissions of the six greenhouse gases (in addition to CO₂: CH₄, N₂O, HFCs, PFCs and SF₆) specified in the Kyoto Protocol. While they are available for countries with quantified emission limitations or reduction obligations (Annex B countries), they are only available up to 2003. Therefore, the figures for 2004 had to be estimated.

Pursuant to the results of these estimates, the greenhouse gas emissions in the group of the Annex B countries² increased by approximately 1% in 2004 in comparison to 2003. Compared to the base year 1990³, they were lower by almost 15% (cf. table 1). This means that the common reduction target for the first commitment period 2008/2012 of a total of almost 5% has already been fulfilled and exceeded.

However, this decline is almost entirely due to the strong economic slump in the transformation countries. There, the greenhouse gas emissions in 2004 were 35% lower compared to the level in the base year. Indeed, the emissions in those countries seemed to have reached their lowest level in 1998, as ever since then the emissions continued to rise every year – from 1998 to 2004 by a total of approx. 10%.

In comparison thereto, the total increase in all 'Western' industrialized countries listed in Annex B of the Kyoto Protocol (Annex II countries) amounted to more than 3% within the entire period under review. In the USA, who, just like Australia, did not ratify the Protocol and therefore is not included in this group, the greenhouse gas emissions rose by more than 14% and in Australia by even more than 25%. In total, the increase of emissions in those two countries in 2004 amounted to almost 1 billion tonnes of carbon dioxide equivalent emissions compared to the base year; that is approximately five times the total emission increase in the other Annex II countries. Within this group of countries, only Germany (approx. 240 million tonnes of carbon dioxide equivalent emissions) and Great Britain (approx. 100 million tonnes of carbon dioxide equivalent emissions) had emission reductions that actually made a difference.

² Unless otherwise stated, the following data concerning the Annex B countries correspond to the Annex II countries ('Western' industrialized countries), each without USA and Australia.

³ Base year for CO₂, CH₄, N₂O is 1990. For HFCs, PFCs and SF₆ 1995 can be chosen as the base year. Transformation countries can also use previous years or periods as a basis (e.g. Poland: 1988; Hungary 1985 to 1987). Unless there is no information about base years deviating from 1990, the corresponding values are adopted from the national inventories; otherwise values for 1990 are used as a rule.

The estimated changes in the greenhouse gas CO₂ – the most important by far – are also an indication for the fact that the worldwide emission development has moved even further away from the set targets (cf. table 2 and cf. figure 1).

This means that the total energy-induced worldwide CO₂ emissions reached a new record high of approx. 27.5 billion tonnes by an increase of 4.5% in 2004. In comparison to 1990, this is an increase of more than 25%. With the exception of the transformation countries, the CO₂ emissions increased considerably in almost all countries. In 2004, they were still 1.3% higher than in the previous year and 16% higher than in 1990 in the OECD countries; in the EU-15, the increase amounted to 0.7% compared to the previous year and to approx. 4.5 % compared to 1990.

In the transformation countries, the CO₂ emissions in 2004 were approx. 36% below the 1990-level. In 1999, they reached their lowest level with just under 2.5 billion tonnes; however, by 2004 they increased to more than 2.6 billion tonnes; that was 1.6% more than in the previous year. Thus the upward trend which began in 2000 after a steady decline in the 90ies continued sustainably.

At 9%, the CO₂ emissions in the developing and newly industrializing countries (non-Annex I countries) continued to rise tremendously. The overall considerable emission rise (almost 75%) in this group of countries from 1990 to 2004 significantly increased their share in the worldwide CO₂ emission – from roughly one third in 1990 to more than 45% in 2004. However, the per capita emissions with approx. 2 tonnes of carbon dioxide per person correspond to merely one sixth of the relevant values in the industrialized countries (roughly 11 tonnes of carbon dioxide per person). Within the group of developing countries, the People's Republic of China had the highest increase expressed in absolute numbers; there, the emissions in 2004 are estimated to have been higher by approx. 580 million tonnes of carbon dioxide or by approx. 15% than in 2003. However, in this context, we must expressly point out the partially quite inaccurate data concerning the changes in the level and the structure of energy consumption and the associated emissions in China.⁴

Emission development in the EU

Greenhouse gas emissions

According to the most recent national emissions inventories of the member states, the total greenhouse gas

⁴ Please see the corresponding details in *DIW Economic Bulletin*, vol. 41, no. 10, October 2004. See footnote 1.

Table 1

Greenhouse Gas Emissions in the Countries with Quantified Emission Limitation or Reduction Commitment under the Kyoto Protocol (Annex B Countries)¹

	Base year 1990 (1995) ²	1990	1995	2000	2001	2002	2003	2004 ³	1990 (1995) ² to 2004	Reduction or limitation targets by 2008/2012 ⁴	Required emission changes by 2008/2012 from 2004	Agreed upon emission cap 2008/2012 ⁴
	Greenhouse gas emissions in million t CO ₂ equivalents								Changes (%)		Million t CO ₂ equivalents	
EU-15	4 253.9	4 239.7	4 132.1	4 102.4	4 148.7	4 128.8	4 183.3	4 194.8	-1.4	-8.0	-6.8	3 909.1
Australia ⁵	423.4	423.4	443.8	504.5	512.8	514.9	519.5	534.4	26.2	8.0	-14.4	457.3
Iceland	3.3	3.3	3.1	3.3	3.2	3.1	3.1	3.0	-8.0	10.0	19.6	3.6
Japan	1 237.0	1 187.3	1 326.9	1 336.2	1 301.4	1 330.0	1 339.1	1 333.3	7.8	-6.0	-12.8	1 162.8
Canada	595.9	595.9	646.3	720.2	712.0	718.9	740.2	745.3	25.1	-6.0	-24.8	560.1
New Zealand	61.5	61.5	64.3	69.7	72.6	73.2	75.3	75.1	22.0	0.0	-18.1	61.5
Norway	50.2	50.2	49.6	53.8	55.3	53.5	54.8	54.0	7.7	1.0	-6.2	50.7
Switzerland	52.4	52.4	50.9	51.3	52.1	51.2	52.2	52.1	-0.7	-8.0	-7.4	48.3
USA ⁵	6 088.1	6 088.1	6 407.4	6 953.2	6 806.9	6 858.1	6 900.2	6 961.5	14.3	-7.0	-18.7	5 661.9
Total Annex II countries ⁶	12 765.7	12 701.8	13 124.5	13 794.5	13 664.9	13 731.8	13 867.8	13 953.6	9.3	-6.7	-14.6	11 915.3
Annex II countries excl. USA and Australia	6 254.2	6 190.3	6 273.3	6 336.9	6 345.2	6 358.9	6 448.1	6 457.6	3.3	-7.3	-10.2	5 796.1
Estonia ⁷	43.5	43.5	22.3	19.7	19.4	19.5	21.4	21.7	-50.1	-8.0	84.2	40.0
Latvia ⁷	25.4	25.4	12.5	10.1	10.7	10.6	10.5	10.7	-57.8	-8.0	118.1	23.4
Lithuania ⁷	50.9	50.9	31.2	20.9	20.4	19.6	17.2	16.6	-67.3	-8.0	181.5	46.9
Poland ⁷	564.4	458.9	417.4	386.7	382.2	370.2	384.0	389.1	-31.1	-6.0	36.3	530.6
Slovakia ⁷	72.1	72.1	53.4	48.6	51.3	50.9	51.6	51.9	-28.0	-8.0	27.9	66.3
Slovenia	20.2	18.6	18.6	19.0	19.9	20.1	19.8	19.9	-1.2	-8.0	-6.9	18.6
Czech Republic ⁷	192.1	192.1	153.2	147.7	148.1	142.9	145.5	149.0	-22.5	-8.0	18.7	176.8
Hungary ⁷	122.2	103.4	83.6	81.0	83.8	80.8	83.2	81.8	-33.1	-6.0	40.4	114.9
Russia ⁸	3 030.7	3 030.7	2 060.5	1 894.4	1 906.0	1 927.1	2 008.9	2 060.5	-32.0	0.0	47.1	3 030.7
Ukraine	978.2	978.2	600.8	464.1	487.4	489.2	527.1	550.7	-43.7	0.0	77.6	978.2
Bulgaria	138.4	119.9	87.3	65.7	66.4	63.5	69.2	71.9	-48.1	-8.0	77.1	127.3
Croatia	31.8	31.8	22.5	25.9	27.1	28.4	29.9	30.1	-5.3	-5.0	0.3	30.2
Romania	265.1	232.9	174.7	127.4	131.0	135.9	142.9	143.5	-45.9	-8.0	70.0	243.9
Total transition countries	5 535.1	5 358.5	3 737.8	3 311.2	3 353.6	3 358.8	3 511.3	3 597.5	-35.0	-1.9	50.9	5 427.7
Total Annex B countries	18 300.7	18 060.2	16 862.3	17 105.7	17 018.5	17 090.6	17 379.1	17 551.1	-4.1	-5.2	-1.2	17 342.9
Annex B countries excl. USA and Australia	11 789.2	11 548.7	10 011.1	9 648.1	9 698.8	9 717.7	9 959.4	10 055.1	-14.7	-4.8	11.6	11 223.7
Memo item:												
Malta	2.2	2.2	2.7	2.9	2.8	2.9	2.9	2.9	30.9	-8.0	-29.7	2.0
Cyprus	6.0	6.0	7.2	8.5	8.5	8.8	9.2	9.3	54.1	-8.0	-40.3	5.6

1 Greenhouse gas emissions excluding CO₂ emissions/removals from land-use change and forestry. — 2 Base year for CO₂ CH₄ N₂O is 1990. For HFC, PFC and SF₆ 1995 can be chosen as the base year. Transition countries can also use earlier years (Bulgaria and Poland 1988; Hungary 1985 to 1987; Romania 1989). Where data is available on other base years than 1990 the corresponding figures are taken from the national inventories; otherwise on principle the 1990 figures are used. — 3 Preliminary estimate based on the CO₂ emissions estimated for 2004 and assumptions for non-CO₂ emissions based on an extrapolation of the development from 2000 to 2003. — 4 Reduction targets compared with the base year; in the EU member states following the European burden sharing; figures for totals are weighted for changes. — 5 The USA and Australia no longer feel bound by the obligations laid down in the Kyoto Protocol. — 6 Annex II countries without Turkey, which is not an Annex B country, either. — 7 EU accession countries. — 8 Russia, estimated from 1997 onwards.

Sources: UNFCCC; EEA; DIW Berlin calculations.

emissions in the EU-25 increased by a significant 1.5% in 2003 compared to 2002. In this context, the accession countries had a particularly high increase at a rate of 2.6%; however, in the EU-15 the greenhouse gas emis-

sions also rose significantly by 1.3%. In accordance with preliminary estimates, in the EU-25, emissions should only have increased slightly in 2004, while the increase of 1% in the accession countries is again clearly

Table 2

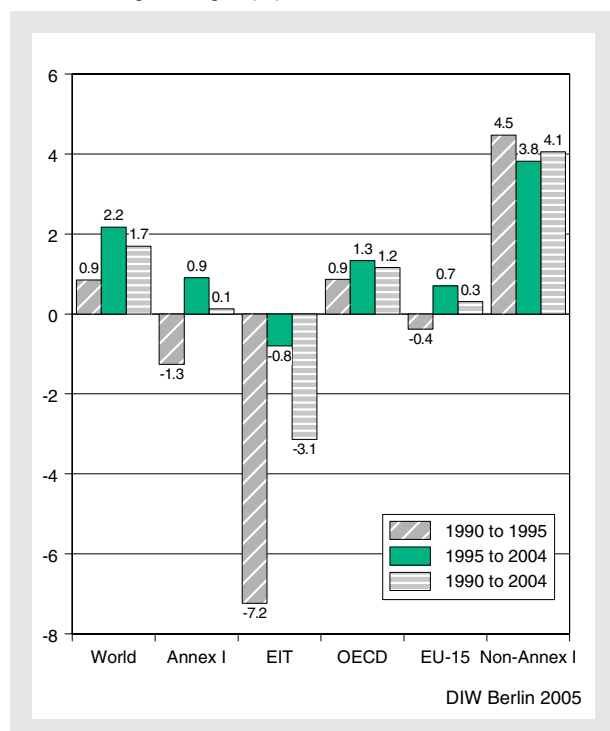
Energy-induced CO₂ Emissions from 1990 to 2004 in Selected Countries and Regions¹

	1990	1995	2000	2001	2002	2003	2004	1990 to 2004	2003 to 2004
	CO ₂ emissions in million t							Changes (%)	
EU-15	3 167.0	3 107.1	3 165.2	3 234.4	3 227.6	3 284.9	3 308.5	4.5	0.7
Australia	258.5	282.5	330.7	336.3	339.7	345.8	360.8	39.5	4.3
Iceland	1.7	1.8	1.8	1.8	1.9	1.8	1.8	7.4	0.0
Japan	1 048.3	1 132.2	1 161.4	1 139.0	1 175.5	1 188.1	1 189.5	13.5	0.1
Canada	427.8	456.0	526.0	520.1	528.4	545.6	550.5	28.7	0.9
New Zealand	22.7	24.1	27.8	29.7	29.8	31.2	30.2	33.3	-3.3
Norway	28.4	30.7	33.9	35.7	35.2	37.2	37.2	31.1	-0.2
Switzerland	40.3	40.2	40.6	41.4	40.6	41.7	41.6	3.4	-0.2
USA	4 836.4	5 149.4	5 693.5	5 592.9	5 645.3	5 694.3	5 773.0	19.4	1.4
Total Annex II countries ²	9 831.1	10 224.1	10 980.8	10 931.4	11 023.8	11 170.7	11 293.0	14.9	1.1
Total Annex II countries excl. USA and Australia	4 736.1	4 792.2	4 956.6	5 002.1	5 038.8	5 130.6	5 159.3	8.9	0.6
Korea	226.2	361.7	427.7	441.7	451.6	462.0	474.0	109.6	2.6
Mexico	292.0	312.6	362.0	360.0	365.2	382.2	393.1	34.6	2.9
Poland	371.5	338.0	302.5	307.3	298.8	310.9	319.4	-14.0	2.7
Slovakia	56.0	41.1	36.9	39.3	38.9	39.7	39.8	-28.8	0.4
Czech Republic	160.1	128.1	125.0	122.8	118.0	116.2	117.1	-26.8	0.8
Turkey	128.8	155.4	203.7	185.2	193.1	203.6	212.4	64.9	4.3
Hungary	67.6	57.8	54.5	56.1	54.8	57.6	56.4	-16.5	-2.0
Total OECD	11 133.2	11 618.7	12 493.1	12 443.8	12 544.2	12 742.9	12 905.3	15.9	1.3
Estonia	37.5	19.1	16.5	16.7	17.0	18.8	19.3	-48.4	2.7
Latvia	18.0	8.7	6.6	7.1	7.0	7.1	7.3	-59.8	2.7
Russia	2 326.0	1 567.3	1 493.0	1 495.8	1 482.7	1 513.9	1 529.6	-34.2	1.0
Ukraine	672.4	379.1	253.3	252.7	252.6	267.6	272.7	-59.4	1.9
Belarus	106.2	59.8	55.5	56.4	56.0	60.3	68.1	-35.8	12.9
Bulgaria	78.7	59.4	45.9	47.5	45.1	49.0	51.7	-34.3	5.3
Croatia	21.0	15.1	17.4	18.4	19.6	21.0	21.1	0.4	0.4
Lithuania	36.7	22.8	13.0	12.2	10.9	11.2	11.1	-69.7	-0.6
Romania	144.2	114.1	82.5	87.1	92.8	98.4	99.1	-31.2	0.8
Slovenia	13.5	14.0	14.4	15.3	15.4	15.1	15.2	12.6	0.8
Malta	1.9	2.3	2.4	2.4	2.5	2.5	2.5	31.4	0.7
Cyprus	4.1	5.1	6.0	5.9	6.0	6.3	6.4	57.0	0.7
PR China ³	2 289.0	3 012.4	3 020.8	3 093.4	3 307.4	3 882.4	4 461.7	94.9	14.9
India	594.7	792.1	973.9	985.5	1 016.5	1 055.5	1 127.8	89.6	6.9
Africa	547.2	603.1	695.5	717.5	743.1	776.6	809.4	47.9	4.2
Middle East	590.2	813.9	1 005.2	1 035.3	1 092.8	1 127.9	1 193.8	102.3	5.8
Latin America	603.4	720.9	853.0	853.5	844.6	843.5	889.5	47.4	5.4
Asia ⁴	672.9	906.9	1 139.8	1 197.9	1 240.9	1 280.9	1 358.6	101.9	6.1
Other countries	1 320.2	1 400.3	1 525.6	1 605.0	1 660.5	1 711.9	1 815.0	37.5	6.0
Bunker ⁵	648.9	700.3	822.5	793.9	817.4	833.7	850.4	31.1	2.0
World ⁶	21 859.9	22 835.4	24 535.7	24 743.3	25 274.8	26 326.6	27 515.6	25.9	4.5
World ⁶ without PR China	19 570.9	19 823.0	21 514.9	21 649.9	21 967.4	22 444.2	23 053.9	17.8	2.7
Annex I countries ⁷	14 069.3	13 203.8	13 701.4	13 651.4	13 726.3	13 961.2	14 133.5	0.5	1.2
Non-Annex I countries ⁷	7 141.7	8 931.3	10 011.9	10 298.1	10 731.2	11 531.7	12 531.7	75.5	8.7
Annex I economies in transition (EIT) ⁷	4 109.4	2 824.4	2 516.8	2 534.8	2 509.4	2 586.9	2 628.1	-36.0	1.6
Annex B countries ^{7, 8}	8 739.3	7 556.7	7 418.0	7 480.5	7 492.3	7 657.1	7 719.2	-11.7	0.8
Annex II countries ^{7, 9}	4 736.1	4 792.2	4 956.6	5 002.1	5 038.8	5 130.6	5 159.3	8.9	0.6

¹ Energy-induced emissions for countries with national emission inventories in accordance with UNFCCC (all OECD countries except Turkey, Mexico and South Korea, and including Estonia, Latvia, Lithuania, Slovenia, Belarus, Bulgaria, Romania), for all other countries CO₂ emissions from fuel combustion using the sectoral approach. Data from the national emissions inventories for the above countries from 1990 to 2003, for the other countries from 1990 to 2002, from the International Energy Agency (IEA 2004). Estimates for 2004 or 2003 and 2004 with changes in CO₂ emissions that can be calculated on the basis of the energy consumption data in the BP Statistical Review of World Energy (BP 2005); Germany for 2004 using the data from DIW Weekly Report No. 9/2005. Data for countries, regions and groups of countries without international marine and aviation bunkers. — 2 Annex II countries without Turkey; OECD countries without South Korea, Mexico, Poland, Czech Republic, Hungary and Slovakia. — 3 Including Hong Kong. — 4 Without PR China, Hong Kong, Japan, Korea and India. — 5 Data for 2003 and 2004 calculated with an increase of 2% each. — 6 Including international marine and aviation bunkers, and taking into account the data for countries for which national emissions inventories are available. — 7 Without international marine and aviation bunkers, and taking into account the data for countries for which national emissions inventories are available. — 8 Annex I countries except Turkey and Belarus, and Australia and the USA, which do not intend to ratify the Kyoto Protocol. — 9 Without Australia and the USA, which do not intend to ratify the Kyoto Protocol.

Sources: UNFCCC (national emissions inventories); EEA; BP; calculations by DIW Berlin.

Figure 1
Energy-induced Worldwide CO₂ Emissions from 1990 to 2004 by Groups of Countries
 Annual average changes (%)



Sources: UNFCCC; IEA; BP; DIW Berlin calculations.

higher in comparison with the 0.3% increase in the EU-15.

Expressed in absolute figures, from the base year to 2004, the greenhouse gas emissions in the EU-15 decreased by almost 60 million tonnes of carbon dioxide equivalent emissions. This decline is almost exclusively due to regressive emissions in Germany (-240 million tonnes)⁵ and in Great Britain (approx. -100 million tonnes). Not counting these two countries, the greenhouse gas emissions in the EU-15 in 2004 were higher by almost 280 million tonnes or more than 12% compared to the base year (cf. table 3). Spain showed the most significant increase at 130 million tonnes, followed at a great distance by Italy with 64 million tonnes, Greece with 27 million tonnes and Portugal with approx. 26 million tonnes.

With this, the EU-15 collectively moved away even further from the reduction of greenhouse gas emissions by the commitment period 2008/2012 promised within the framework of the Kyoto Protocol (by 8 %). In order

⁵ See Hans-Joachim Ziesing: 'Carbon Dioxide Emissions in Germany – Stagnating in 2004'. In: *DIW Berlin Weekly Report*, no. 9/2005 for further details on the development in Germany.

to even remotely reach this goal, the greenhouse gas emissions have to be reduced by approx. 7% or 286 million tonnes within the next four to eight years. The picture for most member countries of the EU-15 is even bleaker: In order to achieve the target, the emissions in Austria, Spain, Luxembourg and Denmark would have to be reduced by more than 20%, in Italy by almost 17%, in Finland by more than 12% and in Portugal by 11%. Therefore, together with Belgium, Ireland, the Netherlands and Greece that has already used up its permitted emission increase, 11 EU-15 countries are far from reaching their goal. In contrast, Great Britain, France and Sweden have already reached and exceeded their quota, and Germany is in close pursuit (cf. figure 2)

The situation in the accession countries is quite different. There, based on the reasons already mentioned, the targets have been reached and significantly exceeded already, with the exception of Slovenia. There, greenhouse gas emissions could yet be elevated by a total of 272 million tonnes or more than one third by the commitment period 2008/2012, without violating the agreed targets (cf. figure 3). The development of emissions in the past few years shows that these countries will definitely require a major part of this leeway.

Carbon dioxide emissions (CO₂)

In accordance with DIW Berlin estimates, CO₂ emissions in the EU-25 in 2004 increased by 0.8% in comparison to the previous year level, whereas the increase in the accession countries was twice as much at 1.6% (cf. table 4). Only Denmark and Finland significantly reduced their emissions, while the Netherlands, Spain, Portugal, Luxembourg and Belgium as well as Estonia, Latvia and Poland showed the highest emission increases.

Throughout the EU, CO₂ emissions in 2004 were lower by almost 1 % compared to 1990. This is essentially due to the development in the accession countries (exception: Slovenia); however, Germany, Great Britain and Sweden made considerable contributions. In most EU-15 countries, CO₂ emissions increased significantly within this period, e.g. in Spain and Portugal by more than 50% each, in Ireland by 42% and in Greece by approximately one third.

Factors influencing the development of greenhouse gas emissions

The changes in greenhouse gas emissions can be attributed to various influencing factors. The most important

Table 3

Greenhouse Gas Emissions in the EU-25 from 1990 to 2004 and Targets for 2008/2012

	Base year 1990 (1995) ¹	1990	1995	2000	2001	2002	2003	2004 ¹	Changes base year 1990 (1995) ² to 2004		Emission target by 2008/2012		Reduction in emission needed by 2008/2012 from 2003	
	Million t CO ₂ equivalents								%		Million t CO ₂ equivalents		%	
Belgium	146.8	145.7	152.2	147.4	146.2	145.3	147.5	149.7	2.9	2.0	-7.5	135.8	-13.9	-9.3
Denmark	70.7	70.7	77.8	69.7	71.2	70.4	75.5	70.3	-0.4	-0.6	-21.0	55.9	-14.4	-20.5
Germany	1 248.3	1 243.7	1 102.8	1 016.6	1 027.8	1 015.4	1 017.5	1 008.2	-240.1	-19.2	-21.0	986.1	-22.1	-2.2
Finland	70.5	70.5	71.6	70.2	75.8	77.3	85.6	80.2	9.8	13.9	0.0	70.5	-9.8	-12.2
France	567.5	567.5	564.4	561.1	564.3	554.0	557.7	558.4	-9.1	-1.6	0.0	567.5	9.1	1.6
Greece	111.7	109.5	114.5	132.5	133.6	133.6	137.6	138.8	27.0	24.2	25.0	139.7	0.9	0.7
Great Britain	751.4	748.0	690.6	651.5	663.5	643.7	651.1	653.1	-98.2	-13.1	-12.5	657.5	4.3	0.7
Ireland	54.0	53.8	58.2	69.0	70.7	69.4	67.6	67.3	13.3	24.7	13.0	61.0	-6.3	-9.4
Italy	510.5	511.4	527.6	551.4	556.2	555.0	569.8	574.1	63.6	12.5	-6.5	477.3	-96.8	-16.9
Luxembourg	12.8	12.8	10.0	9.5	9.8	10.8	11.3	11.6	-1.2	-9.4	-28.0	9.2	-2.4	-20.6
Netherlands	213.1	211.7	224.0	214.0	215.5	213.5	214.8	221.2	8.1	3.8	-6.0	200.3	-20.9	-9.5
Austria	78.5	78.6	80.2	81.1	84.9	86.4	91.6	90.6	12.0	15.3	-13.0	68.3	-22.2	-24.6
Portugal	59.9	59.9	70.1	80.5	81.5	86.0	82.8	85.4	25.6	42.7	27.0	76.0	-9.4	-11.0
Sweden	72.2	72.2	73.4	67.3	68.3	69.5	70.6	69.7	-2.5	-3.5	4.0	75.1	5.4	7.8
Spain	286.1	283.9	314.7	380.5	379.3	398.6	402.3	416.2	130.1	45.5	15.0	329.0	-87.2	-20.9
EU-15	4 253.9	4 239.7	4 132.1	4 102.4	4 148.7	4 128.8	4 183.3	4 194.8	-59.1	-1.4	-8.0	3 909.1	-285.7	-6.8
EU-15 excl. Germany and Great Britain	2 254.2	2 248.0	2 338.8	2 434.3	2 457.3	2 469.8	2 514.7	2 533.5	279.3	12.4	0.5	2 265.5	-268.0	-10.6
Estonia	43.5	43.5	22.3	19.7	19.4	19.5	21.4	21.7	-21.8	-50.1	-8.0	40.0	18.3	84.2
Latvia	25.4	25.4	12.5	10.1	10.7	10.6	10.5	10.7	-14.7	-57.8	-8.0	23.4	12.7	118.1
Lithuania ²	50.9	50.9	31.2	20.9	20.4	19.6	17.2	16.6	-34.3	-67.3	-8.0	46.9	30.2	181.5
Malta ³	2.2	2.2	2.7	2.9	2.8	2.9	2.9	2.9	0.7	30.9	-8.0	2.0	-0.9	-29.7
Poland ²	564.4	458.9	417.4	386.7	382.2	370.2	384.0	389.1	-175.3	-31.1	-6.0	530.6	141.4	36.3
Slovakia	72.1	72.1	53.4	48.6	51.3	50.9	51.6	51.9	-20.2	-28.0	-8.0	66.3	14.5	27.9
Slovenia	20.2	18.6	18.6	19.0	19.9	20.1	19.8	19.9	-0.2	-1.2	-8.0	18.6	-1.4	-6.9
Czech Republic	192.1	192.1	153.2	147.7	148.1	142.9	145.5	149.0	-43.2	-22.5	-8.0	176.8	27.8	18.7
Hungary	122.2	103.4	83.6	81.0	83.8	80.8	83.2	81.8	-40.4	-33.1	-6.0	114.9	33.1	40.4
Cyprus	6.0	6.0	7.2	8.5	8.5	8.8	9.2	9.3	3.3	54.1	-8.0	5.6	-3.7	-40.3
Total accession countries	1 099.2	973.2	801.9	745.0	747.0	726.3	745.4	753.0	-346.2	-31.5	-6.8	1 025.0	272.0	36.1
Total EU-25	5 353.0	5 212.9	4 934.0	4 847.5	4 895.6	4 855.1	4 928.7	4 947.8	-405.2	-7.6	-7.8	4 934.1	-13.7	-0.3

¹ Base year for CO₂, CH₄, N₂O is 1990, for HFC, PFC and SF₆ 1995 can be chosen as the base year; transition countries can also use earlier years or periods (Poland 1988, Hungary 1985 to 1987). Where data on other base years than 1990 are available the corresponding figures from the national inventories are taken, otherwise on principle the figures for 1990 are used. — ² Data for 2002 estimated. — ³ CO₂ emissions (some estimated), as no information on greenhouse gas emissions was available.

Sources: National emission inventories of EU member states, 2005 edition; European Environment Agency (EEA); DIW Berlin calculations.

ones include the development of the population (demographic component), the gross domestic product per capita (income component), the macroeconomic energy intensity (energy intensity component) as well as the CO₂ content of the primary energy consumption (energy mix component).

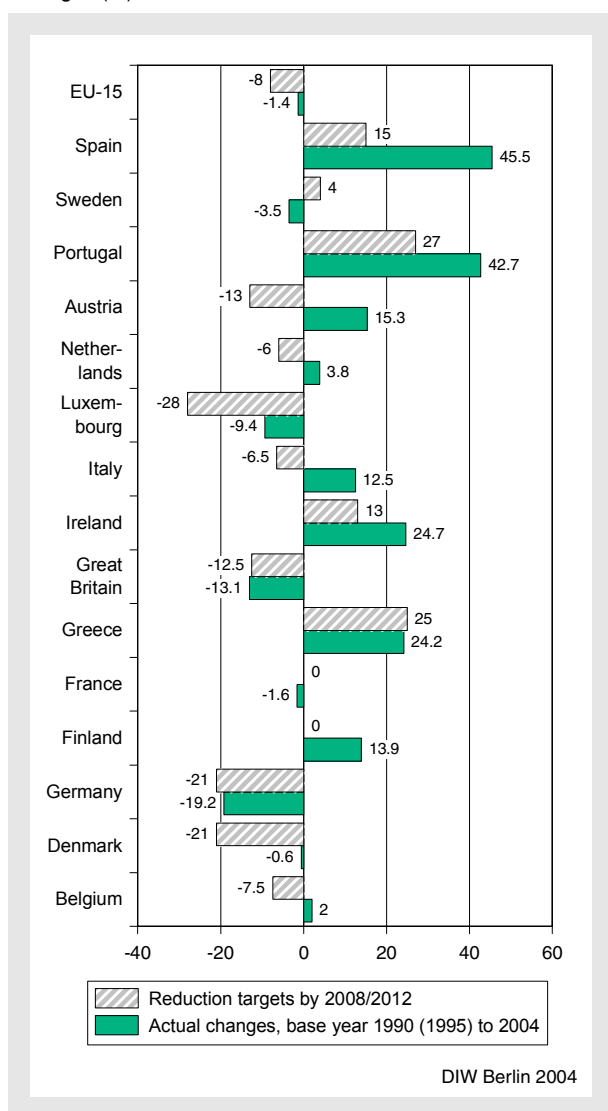
Based on the 'component analysis'⁶, the influence of these factors on the changes in greenhouse gas emis-

sions in the period from the base year 1990 until 2003 or 2004 respectively for the Annex II countries was estimated (cf. table 6 and cf. figure 5).

⁶ Concerning the method of component analysis applied here cf. Jochen Diekmann, Wolfgang Eichhammer, Anja Neubert, Heilwig Rieke, Barbara Schломann and Hans-Joachim Ziesing: 'Energie-Effizienz-Indikatoren. Statistische Grundlagen, theoretische Fundierung und Orientierungsbasis für die politische Praxis.' Heidelberg 1999.

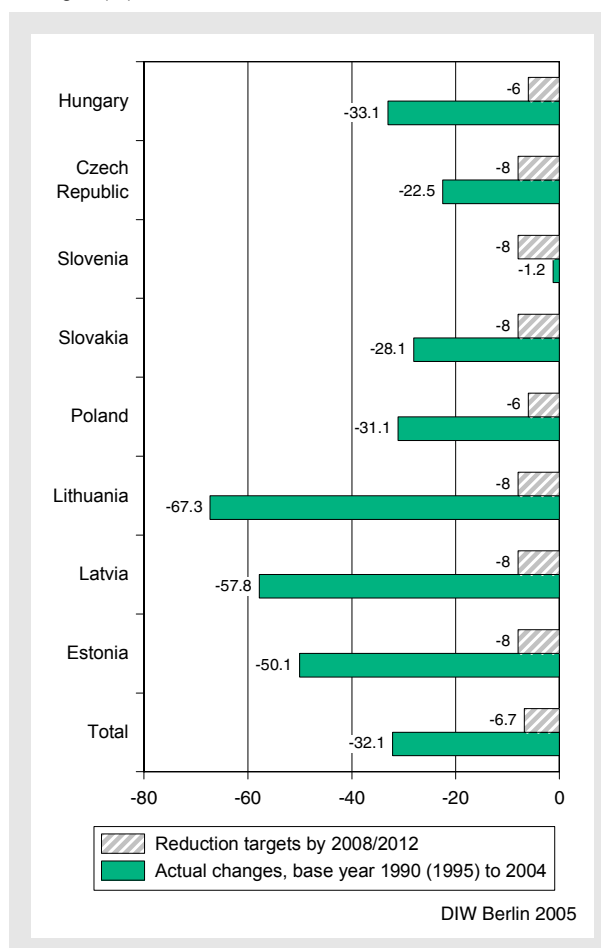
The emission increase in this group of countries by a total of almost 1.2 billion tonnes of carbon dioxide is due to the increased gross domestic product per capita (2782 million tonnes) and the higher number of residents (1116 million tonnes); in contrast thereto, there were the emission-reducing effects of the declining energy intensity (-1751 million tonnes) as well as changes in the energy source structure in favor of emission-free or emission-reduced energy-sources (-980 million tonnes).

Figure 2
Changes in Greenhouse Gas Emissions in the EU-15: Reduction or Limitation Targets by 2008/2012 and Development 1990 (1995) to 2004
Changes (%)



Sources: UNFCCC; European Commission; DIW Berlin calculations.

Figure 3
Changes in Greenhouse Gas Emissions in the EU Accession Countries¹: Reduction or Limitation Targets by 2008/2012 and Development 1990 (1995) to 2004
Changes (%)



1 Without Malta and Cyprus.

Sources: UNFCCC; European Commission; DIW Berlin calculations.

In contrast thereto, in the EU-15, emission-reducing effects of the energy mix and energy intensity components exceeded the growth effects based on the income and demographic component, resulting in a decline by a total of approx. 45 million tonnes of carbon dioxide equivalent emissions.

For individual Annex II countries, the picture is quite different:

The *population's influence* alone led to an increase in greenhouse gas emissions in all countries. Compared to the relative contributions, this is obvious in the larger countries, in particular in Australia/New Zealand, in the USA and in Canada. All in all, an increase of 8.8% (EU-15: 4.5%) in greenhouse gas emissions can be

Table 4

Energy-induced CO₂ Emissions from 1990 to 2004 in the EU-25¹

	1990	1995	2000	2001	2002	2003	2004	1990 to 2004	2002 to 2004
	CO ₂ emissions in million t							Changes (%)	
Belgium	108.9	114.0	113.8	113.9	113.2	116.4	119.4	9.6	2.6
Denmark	51.5	59.0	51.3	52.9	52.5	57.6	52.6	2.2	-8.7
Germany	988.9	876.1	834.6	850.4	841.1	841.7	834.4	-15.6	-0.9
Finland	54.3	56.4	55.6	61.3	63.0	71.0	65.7	20.9	-7.5
France	369.1	370.9	382.9	389.2	381.7	387.1	390.4	5.8	0.8
Greece	77.1	79.8	95.9	98.0	97.9	101.6	102.9	33.6	1.3
Great Britain	573.4	536.7	532.1	550.3	534.1	545.6	551.9	-3.7	1.2
Ireland	29.8	32.6	41.4	43.5	42.7	42.0	42.4	42.3	0.9
Italy	402.1	419.8	440.9	444.8	444.5	459.3	463.5	15.3	0.9
Luxembourg	10.5	9.0	8.2	8.6	9.4	10.0	10.2	-3.1	2.6
Netherlands	149.6	161.3	161.2	167.3	167.0	170.0	178.8	19.5	5.2
Austria	53.5	55.7	57.6	61.5	62.6	67.9	66.8	24.7	-1.6
Portugal	39.3	47.8	57.5	58.3	62.1	57.7	59.5	51.2	3.2
Sweden	51.7	52.9	48.1	48.9	50.4	51.2	50.3	-2.7	-1.8
Spain	207.3	235.2	284.0	285.7	305.5	305.9	319.8	54.2	4.5
EU-15	3 167.0	3 107.1	3 165.2	3 234.4	3 227.6	3 284.9	3 308.5	4.5	0.7
Estonia	37.5	19.1	16.5	16.7	17.0	18.8	19.3	-48.4	2.7
Latvia	18.0	8.7	6.6	7.1	7.0	7.1	7.3	-59.8	2.7
Lithuania	36.7	22.8	13.0	12.2	10.9	11.2	11.1	-69.7	-0.6
Malta	1.9	2.3	2.4	2.4	2.5	2.5	2.5	31.4	0.7
Poland	371.4	337.9	302.3	307.1	298.6	310.7	319.2	-14.1	2.7
Slovakia	56.0	41.1	36.9	39.3	38.9	39.7	39.8	-28.8	0.4
Slovenia	13.5	14.0	14.4	15.3	15.4	15.1	15.2	12.6	0.8
Czech Republic	160.1	128.1	125.0	122.8	118.0	116.2	117.1	-26.8	0.8
Hungary	67.6	57.8	54.5	56.1	54.8	57.6	56.4	-16.5	-2.0
Cyprus	4.1	5.1	6.0	5.9	6.0	6.3	6.4	57.0	0.7
EU accession countries	766.8	636.9	577.5	584.9	569.0	585.2	594.4	-22.5	1.6
EU-25	3 933.8	3 744.0	3 742.7	3 819.3	3 796.6	3 870.1	3 902.9	-0.8	0.8

¹ Energy-induced emissions from data in the national emission inventories of all EU-25 countries except Malta and Cyprus for 1990 to 2003; for Malta and Cyprus IEA data on combustion-induced CO₂ emissions 1990 to 2002. Estimates for 2004, or 2003 and 2004, with the changes in CO₂ emissions calculated on the basis of the energy consumption data in the BP Statistical Review of World Energy (BP 2005); 2004 for Germany using the data from DIW Weekly Report No. 9/2005. All data without international marine and aviation bunkers.

Sources: UNFCCC (national emission inventories); EEA; IEA; BP; DIW Berlin calculations.

attributed to the population development in the Annex II countries.

The *income effect*, i.e. the augmentation of the real gross domestic product per capita, made the largest contribution to the increased emissions in all countries, whereas the relative influence in the smaller countries such as Ireland and Luxembourg, but also in Norway, Spain, Australia/New Zealand and Greece was particularly pronounced. Switzerland, Japan and Germany had an only weak income effect. In the Annex II countries, the increase in greenhouse gas emissions due to a higher

per-capita income taken on its own totaled an approximate 22% (EU-15: 23%).

The *energy intensity effect* showed no common trend. With the exception of Portugal, Iceland and Spain, it had a more or less emission-reducing effect in all Annex II countries. This is particularly true of Ireland, Luxembourg and Norway – followed at a considerable distance by Australia/New Zealand, Great Britain, USA and Germany. Finland, Italy, Japan, Belgium and Switzerland showed much weaker effects. In all Annex II countries collectively, the energy intensity

Table 5

The Influence of Various Components on the Absolute and Relative Changes in Greenhouse Gas Emissions in the Annex II Countries in 2004 and 2003 from 1990

	Demographic component		Income component		Energy intensity component		Energy mix component		Total greenhouse gas emissions	
	Changes in greenhouse gas emissions									
	Absolute ¹	Relative ²	Absolute ¹	Relative ²	Absolute ¹	Relative ²	Absolute ¹	Relative ²	Absolute ¹	Relative ²
Belgium	6.4	4.4	33.3	22.9	−4.6	−3.2	−31.0	−21.3	4.0	2.8
Denmark	3.5	4.9	16.7	23.6	−11.9	−16.8	−8.7	−12.3	−0.4	−0.6
Germany	44.1	3.5	200.9	16.2	−273.7	−22.0	−206.8	−16.6	−235.5	−18.9
Finland	3.4	4.8	17.2	24.4	−0.3	−0.5	−10.5	−14.9	9.8	13.9
France	31.6	5.6	107.2	18.9	−36.4	−6.4	−111.6	−19.7	−9.1	−1.6
Greece	10.7	9.8	37.9	34.6	−15.4	−14.1	−4.0	−3.6	29.3	26.7
Great Britain	22.4	3.0	211.2	28.2	−169.2	−22.6	−159.3	−21.3	−94.9	−12.7
Ireland	8.9	16.5	49.2	91.4	−33.5	−62.2	−11.0	−20.5	13.5	25.1
Italy	8.1	1.6	97.1	19.0	−14.5	−2.8	−27.9	−5.5	62.8	12.3
Luxembourg	2.1	16.3	5.9	46.5	−5.4	−42.3	−3.8	−29.9	−1.2	−9.4
Netherlands	18.2	8.6	49.2	23.2	−17.9	−8.4	−40.0	−18.9	9.5	4.5
Austria	4.2	5.3	20.2	25.7	−7.0	−9.0	−5.3	−6.8	12.0	15.3
Portugal	3.8	6.4	17.3	28.9	8.5	14.3	−4.1	−6.9	25.6	42.7
Sweden	3.5	4.8	16.4	22.7	−13.6	−18.8	−8.8	−12.2	−2.5	−3.5
Spain	21.3	7.5	105.4	37.1	26.9	9.5	−21.3	−7.5	132.3	46.6
EU-15	119.7	5.3	544.4	24.2	−112.5	−5.0	−266.1	−11.8	285.5	12.7
EU-15 excl. Germany and Great Britain	82.8	17.1	157.1	32.4	−113.8	−23.5	−16.2	−3.3	109.9	22.7
Australia/New Zealand	82.8	17.1	157.1	32.4	−113.8	−23.5	−16.2	−3.3	109.9	22.7
Iceland	0.4	12.6	0.6	19.6	0.4	12.6	−1.7	−50.8	−0.2	−6.1
Japan	40.6	3.4	175.8	14.8	−34.2	−2.9	−30.4	−2.6	151.8	12.8
Canada	86.6	14.5	153.5	25.8	−108.8	−18.3	13.0	2.2	144.4	24.2
Norway	3.9	7.8	18.0	35.8	−16.8	−33.4	−0.4	−0.9	4.6	9.2
Switzerland	4.8	9.1	1.1	2.2	−2.0	−3.8	−4.1	−7.8	−0.2	−0.4
USA	998.9	16.4	1 502.3	24.7	−1 352.2	−22.2	−336.9	−5.5	812.1	13.3
Total Annex II countries	1 115.5	8.8	2 781.5	21.9	−1 750.6	−13.8	−980.3	−7.7	1 166.1	9.2

1 Changes in million t CO₂. — 2 Relative changes from 1990 (%).

Sources: European Commission; UNFCCC (national emission inventories); IEA; DIW Berlin calculations.

effect resulted in a reduction in carbon dioxide emissions of almost 14 % (EU-15: approx. 13%).

In the individual countries, there are serious differences in development as well as in the level of energy efficiencies (cf. table 6).⁷ Iceland, Canada, Finland, Bel-

gium, Portugal as well as Australia/New Zealand have the lowest efficiency level by far (data for 2003). Japan, Switzerland, Denmark and Norway have the highest efficiency; Germany ranges approximately in the middle of the EU-15 countries.

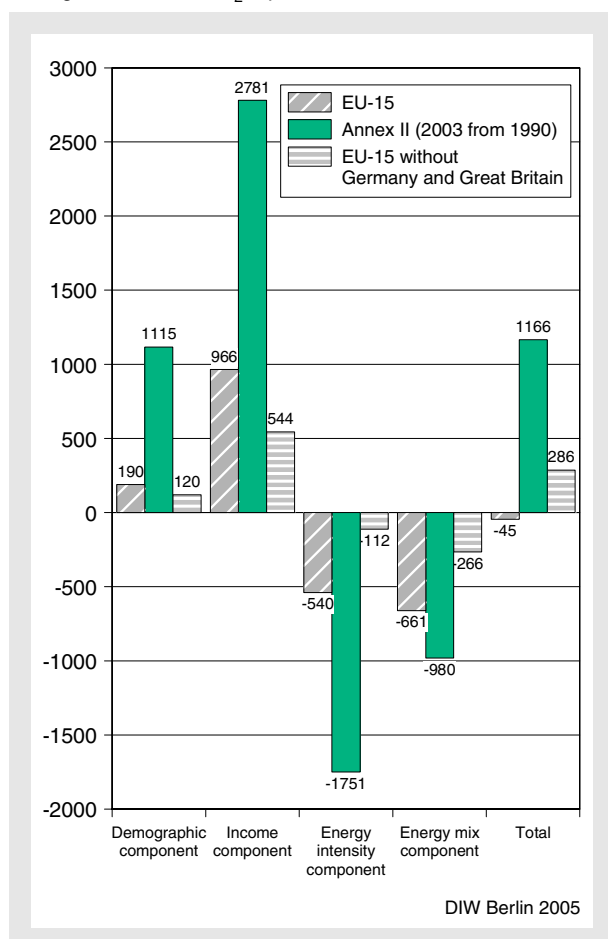
As measured by the improvements of energy efficiency (annual average) in the period from 1990 to 2003, amounting to an average of 1.0% in the Annex II countries (EU-15: 0.9%), Ireland and Luxembourg as well as

⁷ Energy efficiency is defined as the ratio between the real gross domestic product and the primary energy consumption of a national economy.

Figure 4

The Influence of Various Components on the Absolute Changes in Greenhouse Gas Emissions in the Annex II Countries in 2004 (2003) from 1990

Changes in million t CO₂ equivalents



Sources: UNFCCC; IEA; Eurostat; World Bank; DIW Berlin calculations.

Norway are far ahead; they are followed at a distance by Germany and Great Britain (at 1.7% each⁸), as well as Australia/New Zealand and USA (1.6% each).

The *changes in energy source structure* on their own lead to a reduction in greenhouse gas emissions in all countries, with the exception of Canada. There, the energy mix has changed in favor of emission-free or emission-reduced energy sources (especially natural gas). Particularly in Iceland, Luxembourg, Great Britain, Belgium, Ireland, France and the Netherlands, this fac-

⁸ This figure also includes the 'reunification effect' that lead to an accelerated increase in energy efficiency at the beginning of the 1990ies; within the period 1993 to 2004, the annual average in efficiency increase 'only' amounted to 1.2%.

tor played a significant role. There remains the remarkable fact that this effect plays a rather insignificant role in Norway, Japan, Australia/New Zealand and the USA. Overall, the emissions were reduced by almost 8% (EU-15: approx. 16%) due to the changed energy mix in the group of countries under review.

With the exception of Germany, Great Britain, Luxembourg, Sweden, France, Denmark, Iceland and Switzerland, the emission-increasing effects based on the income component and the demographic component in the Annex II countries were higher than the emission-reducing effects of the energy mix component and the energy intensity component. The USA, Japan, Canada, Spain and Australia/New Zealand are affected most by this. In these five countries, the greenhouse gas emissions in 2003 totaled an increase of almost 15% or 1.4 billion tonnes of carbon dioxide equivalent emissions compared to the level in the base year 1990/1995.

Conclusion: boosting of efforts essential in order to reach the reduction targets

Worldwide development of all greenhouse gas emissions such as carbon dioxide emissions is the cause for a growing concern of whether the binding emission limitations effective within the framework of the Kyoto Protocol shall actually be adhered to. With only very few exceptions, the signatory states are off-track concerning the targeted emission reduction. The situation is aggravated by the fact that the USA, with the highest emissions worldwide, show no intention whatsoever of eventually accession to the Kyoto Protocol, and by a virtually vehement increase in emissions in some of the less developed countries such as China and India.

All in all, the Annex II countries still have a long way to go to reach their reduction targets: Instead of the initially specified reduction, this group of countries had a considerable increase from 1990 to 2004. A continued increase in emissions in the past year even points at a continuation of this trend. The situation in the EU-15 is only slightly better. Most member countries in the EU-15 are still far from fulfilling their reduction obligations they committed to in the course of the European 'burden sharing'.

Germany must reduce its greenhouse gas emissions by 21% by the commitment period 2008/2012; this figure constitutes three fourths of the total reduction quantity assumed by the EU. By 2004, the reduction should amount to 19%. Therefore, Germany has already fulfilled more than 90% of its absolute reduction obligation. Germany must fulfill only approx. 8% of the emis-

Table 6

The Development in Energy Productivity in the Annex II Countries from 1990 to 2002

	1990	1995	2000	2001	2002	2003	2004	1990 to 2003/04
	In 1000 US \$ (at 1995 prices) per t oil units							Change (%) per year
Belgium	3.79	3.79	3.85	3.89	4.07	3.89	3.91	0.2
Denmark	7.15	6.91	8.15	8.03	8.22	7.67	8.45	1.2
Germany	4.34	5.00	5.44	5.34	5.46	5.42	5.53	1.7
Finland	3.41	3.21	3.63	3.58	3.48	3.27	3.43	0.0
France	4.78	4.76	5.08	5.01	5.08	5.05	5.10	0.5
Greece	4.01	4.03	4.03	4.06	4.17	4.41	4.54	0.9
Great Britain	5.35	5.53	6.23	6.27	6.60	6.63	6.80	1.7
Ireland	4.46	5.22	6.61	6.65	7.03	7.17	7.44	3.7
Italy	6.01	6.07	6.26	6.34	6.36	6.19	6.18	0.2
Luxembourg	3.22	4.12	5.33	5.19	5.00	4.83	4.93	3.1
Netherlands	4.19	4.28	4.91	4.85	4.83	4.71	4.54	0.6
Austria	5.96	6.13	6.60	6.22	6.39	6.26	6.47	0.6
Portugal	4.56	4.26	4.20	4.26	4.12	3.96	4.05	-0.8
Sweden	4.22	4.08	5.04	4.72	4.84	5.16	5.10	1.4
Spain	4.73	4.50	4.51	4.52	4.48	4.38	4.38	-0.5
EU-15	4.81	5.00	5.39	5.35	5.45	5.39	5.46	0.9
Australia/New Zealand	3.22	3.47	3.59	3.76	3.75	3.97	.	1.6
Iceland	2.99	2.82	2.60	2.57	2.53	2.63	.	-1.0
Japan	9.21	8.86	9.10	9.22	9.19	9.46	.	0.2
Canada	2.56	2.51	2.84	2.93	3.00	3.01	.	1.3
Norway	5.70	6.20	6.85	6.86	6.93	7.80	.	2.4
Switzerland	8.83	8.81	9.30	8.88	9.18	9.18	.	0.3
USA	3.66	3.82	4.24	4.35	4.38	4.50	.	1.6
Total Annex II countries	4.62	4.73	5.08	5.16	5.19	5.27	.	1.0

Sources: World Bank; IEA; UNFCCC; DIW Berlin calculations.

sion reduction to be effected by the EU-15 by the commitment period 2008/2012 in comparison to 2004. As Great Britain, Sweden and France have reached and exceeded their reduction target already, the main adjustment must be effected in the remaining 11 EU member states. However, this means that in the majority of these countries, a drastic trend reversal must take place.

Emissions trading could contribute considerably, even though it is limited to the sectors of industry and energy industry. Here, the required emission reduction

by the commitment period 2008/2012 must be implemented by specifying relevant emission limitations ('caps'). Moreover, effective measures must be taken simultaneously in order to decrease emissions in the sectors not affected by emissions trading; those include transport (very expansive in most countries) and private households. The call for action in climate protection policy is as self-evident as the urgent necessity of implementing effective measures. Should this not happen, the targets will be missed.