CO_2 Emissions: No Change in the Trend in Sight

At least since the Third Report by the Intergovernmental Panel on Climate Change (IPCC)[1] it has become generally accepted that global warming is mainly due to human activities – especially the emission of greenhouse gases from energy consumption. Four years ago a protocol was agreed at the World Climate Conference in Kyoto under which the industrial countries undertook to reduce their greenhouse gas emissions by about 5.2% from the 1990 level by 2008/2012. These targets were noticeably reduced at the conference in Bonn in July 2001 – to about 1.8% – but this did at least prevent the international negotiations from collapsing altogether.

At the seventh conference of the Protocol countries that is now taking place in Marrakesh the conditions are to be established for the Kyoto Protocol to take effect.[2] However, it should not be overlooked that this is only the first step on the way to effective climate protection. The trend in worldwide emissions is not even in accord with the present objectives, which are hardly ambitious, and over the long term much more demanding reduction targets are regarded as essential. Particularly now that the United States has abandoned the Kyoto Protocol, the process will depend heavily on whether Europe, which has now taken on the leading role in climate protection, can firm up that position by taking concrete action. Germany, as the biggest emitter in Europe, will have an important part to play here. Considerable success has been achieved to date, but the trend in emission reduction is now very much weaker and steps must be taken to change this.

Survey of the worldwide development[3]

So far hardly any countries are on the reduction path outlined in the Kyoto Protocol. Worldwide CO_2 emissions rose markedly in the 1990s, and in the year 2000 they can be assumed to have been around 8% higher than in 1990 (cf. table 1). This conceals very different developments in the individual regions. While CO_2 emissions have increased by a good 11% in the OECD countries,[4] which should undertake to reduce their greenhouse gas emissions under the Kyoto Protocol, they have risen by nearly one-third in the countries that have not joined the Climate Framework Convention (the Non-Annex I Countries).[5]

In the economies in transition, on the other hand,[6] there was a fall of around 40%, mainly as a result of the economic collapse (cf. figures 1 and 2). In the EU-15 group CO_2 emissions may have been slightly lower in the year 2000 than in 1990, but that was mainly due to the marked reduction in Germany and Great Britain. Without these two countries CO_2 emissions in the rest of the EU would have been about 11% higher.

The United States has by far the highest emission of CO_2; its share of worldwide CO_2 emissions in 2000 was a good quarter (cf. figure 3). Hence any lasting success in global climate protection policy requires the participation of the United States. In the course of the 1990s CO_2 emissions by the United States increased by just under 17%, which is more than twice as much as the worldwide average. The United States has by far the highest per capita emission of all the big countries at more than

[1] Climate Change 2001: The Scientific Basis. Contribution of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, New York 2001; cf. also the IPCC reports on the Internet (*http://www.ipcc.ch*).

[2] Cf. Die letzte Etappe vor dem Inkrafttreten des Kyoto-Protocolls, Federal Ministry of the Environment, Berlin, 15 October 2001 (*http://www.bmu.de/download/dateien/klimakonferenz_sieben.pdf*).

[3] The main sources of the data used in this Report are: International Energy Agency (IEA): CO_2 Emissions from Fuel Combustion, 2000 Edition, Paris 2000; BP Statistical Review of World Energy, June 2001; European Environment Agency (EEA): Annual European Community Greenhouse Gas Inventory 1990-1999, Technical Report No. 60 (*http://www.reports.eea.eu.int/technical_report_No_60/en*), April 2001; European Commission 2000 – Annual Energy Review, Brussels, January 2001; Jahresbericht 1999 der Bundesregierung an das Sekretariat der Klimarahmenkonvention der Vereinten Nationen, Treibhausgasinventare für die Bundesrepublik Deutschland für die Jahre 1990 bis 1998. The data on CO_2 emissions in these sources generally only cover the years up to 1998 (countries outside the EU-15) or 1999 (EU-15). The emission data up to and including 2000 given in this Report were projected (except for the figures for Germany) on the basis of the data on energy consumption up to 2000 in the BP statistics, which are shown by countries and by energy sources. For Germany original estimates by DIW Berlin have been made on the basis of the energy balance sheets and the evaluation tables relating to these.

[4] Not including South Korea, Mexico, Poland, the Czech Republic and Hungary. In this definition the OECD countries are identical with the list in Annex II to the United Nations Framework Agreement (known as the Annex II Countries).

[5] The Annex I countries are all the countries that have undertaken obligations on climate protection under Article 4 of the United Nations Framework Agreement on Climate Change (the Climate Framework Convention). They include all the developed countries (including the countries in transition). Accordingly the Non-Annex I countries are those that have not undertaken such obligations, mainly the developing countries and the newly developed countries.

[6] The transition countries here include Poland, the Czech Republic, Hungary, the Russian Federation, Ukraine, Bulgaria, Estonia, Croatia, Latvia, Lithuania, Romania, Slovakia, Slovenia and Belarus.

Table 1

CO_2 Emissions in OECD Countries and in Other Selected Countries and Regions from 1990 to 2000[1]

	1990	1995	1996	1997	1998	1999	2000	Change 1990 to 2000 (%)
	CO_2 emissions in mill. t							
Austria	48.8	51.1	52.7	53.5	53.0	53.3	51	4.5
Belgium	104.2	114.6	118.0	113.9	114.5	110.0	113	8.3
Denmark	51.9	59.3	72.5	62.9	58.7	55.5	52	0.6
Finland	57.4	59.4	64.7	63.3	60.9	60.3	59	3.5
France	360.3	359.2	374.4	368.1	388.7	383.6	383	6.3
Germany	986.8	877.1	899.8	868.0	862.1	832.0	831	–15.8
Greece	76.5	79.8	82.0	86.5	91.2	90.5	93	21.2
Ireland	29.6	32.4	33.6	35.7	37.7	39.6	41	38.4
Italy	409.0	418.2	413.5	416.0	429.0	431.0	430	5.2
Luxembourg	8.7	6.8	6.8	5.4	4.6	4.5	4	–48.5
The Netherlands	159.2	175.2	183.0	179.3	178.9	172.1	178	12.0
Portugal	39.7	47.5	45.9	47.6	50.8	52.7	59	47.9
Spain	207.2	234.2	222.2	238.0	247.5	258.6	269	30.0
Sweden	51.6	53.7	58.1	52.4	53.6	52.0	50	–3.8
Great Britain	568.7	534.3	552.6	529.1	531.3	518.0	527	–7.3
EU-15	3 159.5	3 102.7	3 179.9	3 119.8	3 162.6	3 113.7	3 141	–0.6
USA	4 843.8	5 122.5	5 262.6	5 467.6	5 409.8	5 509.2	5 650	16.7
Canada	421.3	452.3	463.8	479.2	477.3	479.0	495	17.4
Japan	1 048.5	1 133.6	1 161.6	1 160.3	1 128.3	1 158.6	1 177	12.3
Australia	258.7	277.4	297.5	311.4	310.7	311.0	320	23.8
New Zealand	24.1	27.5	29.7	31.4	30.5	33.0	33	38.6
Norway	28.5	30.4	29.7	32.7	34.3	34.2	33	15.6
Iceland	2.0	2.0	2.2	2.1	2.1	2.1	2	5.0
Switzerland	41.1	38.2	39.0	40.6	40.8	39.7	39	–6.1
OECD countries[2]	9 827.5	10 186.6	10 466.0	10 645.1	10 596.4	10 680.5	10 890	10.8
PR China	2 358.1	2 995.3	3 144.1	3 112.2	2 852.7	2 523.5	2 467	4.6
Russia	2 457.5	1 531.7	1 513.0	1 461.6	1 415.8	1 442.5	1 466	–40.3
India	594.7	831.2	861.4	890.2	908.2	924.7	968	62.8
Africa	598.9	675.0	688.2	707.5	728.7	739.3	753	25.7
Middle East	600.1	799.0	848.1	892.0	924.2	954.2	982	63.7
Latin America	625.1	746.8	793.4	823.0	866.4	866.4	866	38.6
Asia[3]	835.6	1 121.5	1 193.7	1 229.3	1 208.6	1 251.8	1 318	57.8
Others[4]	3 399.9	3 229.6	3 292.4	3 292.4	3 217.0	3 201.9	3 285	–3.4
World	21 297.3	22 116.7	22 800.3	23 053.3	22 717.9	22 584.8	22 997	8.0

1 CO_2 emissions in the EU countries from 1990 to 1999 according to the national emission inventories; for the selected non-EU countries according to the International Energy Agency (IEA); estimate for 2000 (EU) or 1999 and 2000 (non-EU countries) with the changes in CO_2 emissions calculable on the basis of the BP Statistical Review of World Energy (2001). — 2 Not including Turkey, South Korea, Mexico, Poland, the Czech Republic and Hungary. — 3 Not including PR China, Japan and India. — 4 Including high seas bunkers and international air traffic.

Sources: European Environment Agency (EEA); International Energy Agency (IEA); BP; DIW Berlin calculations.

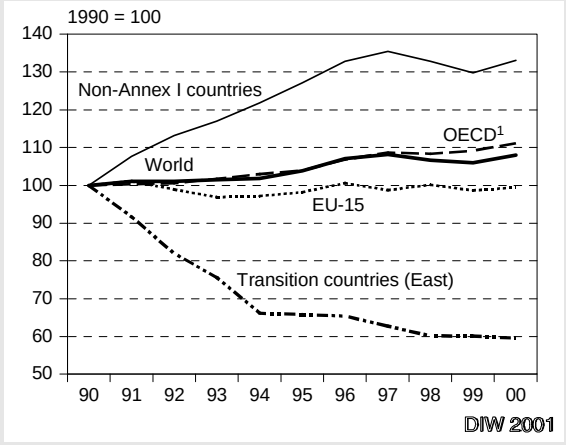
20 tonnes of CO_2; the figure for Germany is around 10 t and that for the EU-15 a good 8 t. But per capita emission on a worldwide average is rather less than 4 t; in the PR China it is just under 2 t and in India scarcely 1 t (cf. figure 4).

The second largest emitter, with a share of nearly 11%, is the PR China. The development there is remarkable in that, judging by the available data, a considerable reduction has been achieved after a strong increase up to 1996 (+33% from 1990). In 2000 CO_2 emissions were a good fifth lower than in 1996. This was due to two causes: firstly, total energy consumption has fallen strongly since 1996 (by altogether 18% by 2000) as the result of considerable improvements in energy productivity, and secondly, the structure of energy sources has shifted noticeably in favour of low-emission sources. Consumption of oil in particular has risen strongly, while the use of coal fell by nearly 30% from 1996 to 2000. A contributory factor here was no doubt that more than 30 000 small coal pits are said to have been closed in the second half of the 1990s.[7] However, CO_2 emissions

[7] Cf. Energy Information Administration: China Country Analysis Brief, Washington, April 2001 (*http://www.eia.doe.gov/emeu/cabs/china.html*). In view of the very rapid and radical fall in both energy consumption and CO_2 emissions, however, statistical effects (errors or omissions in the figures) cannot be entirely excluded.

Figure 1

Worldwide CO_2 Emissions by Groups of Countries from 1990 to 2000



1 Not including South Korea, Mexico, Poland, the Czech Republic and Hungary.
Sources: IEA; European Commission; European Environment Agency (EEA); BP; estimates by DIW Berlin.

in 2000 were still higher than in 1990, although only by around 5%. But great successes appear to have been achieved throughout the entire period here, both in increasing energy productivity and in changing to less pollutive energy sources. Hence the PR China has made a considerable contribution to lessening the worldwide rise in emissions.

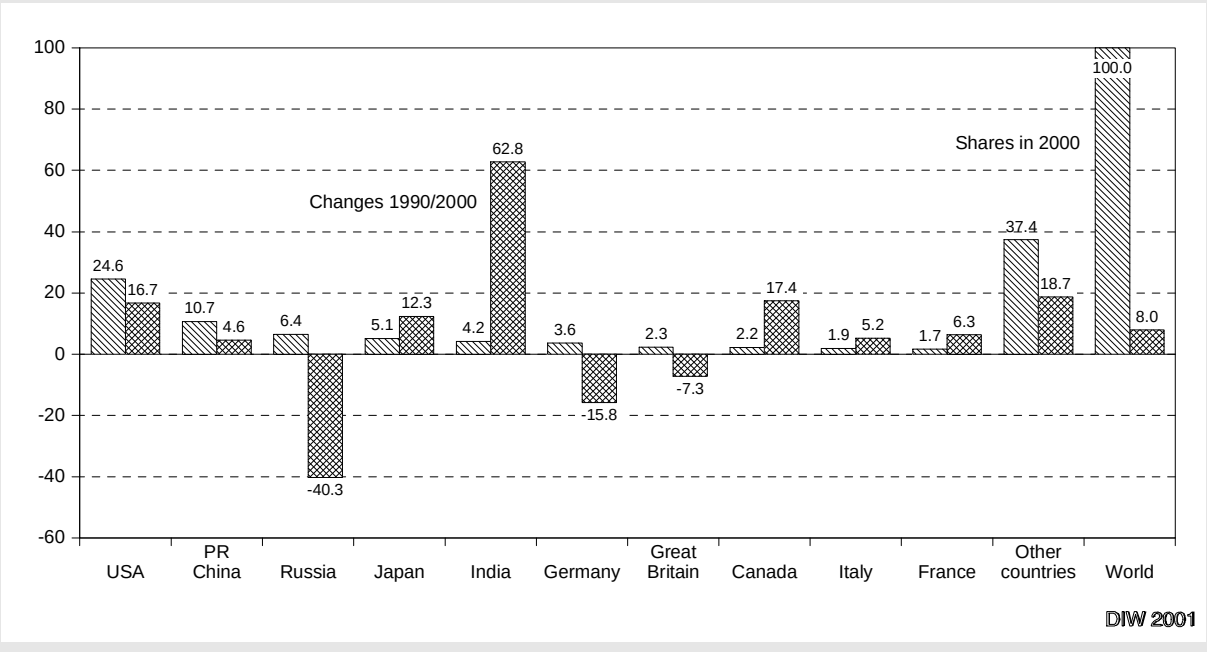
Altogether it is evident that among the ten biggest emission countries CO_2 emissions in 2000 were only lower than in 1990 in Russia (40%), Germany (16%) and Great Britain (7%), while in all the other countries they were considerably higher. The strongest rise was in India (63%), followed after a big gap by Canada and the United States, with around 17% each, Japan (12%), France (6%) and Italy and the PR China with about 5% each. CO_2 emissions by all other countries together rose by just under 19%.

In absolute terms CO_2 emissions increased most in the United States from 1990 to 2000, by a good 800 million t; the United States accounted for nearly half the estimated worldwide increase of about 1.7 billion t; the strongest decline in absolute terms was in Russia at nearly 1 billion t.

If the changes in emissions between 1990 and 2000 in the ten biggest emission countries and in the other groups of countries are weighted with their share of emissions in 1990 the result is a picture of their contribution to the relative changes in worldwide CO_2 emissions as a whole. According to this calculation the United States again contributed about half of the total rise with 3.8 percentage points; of the ten biggest emission coun-

Figure 2

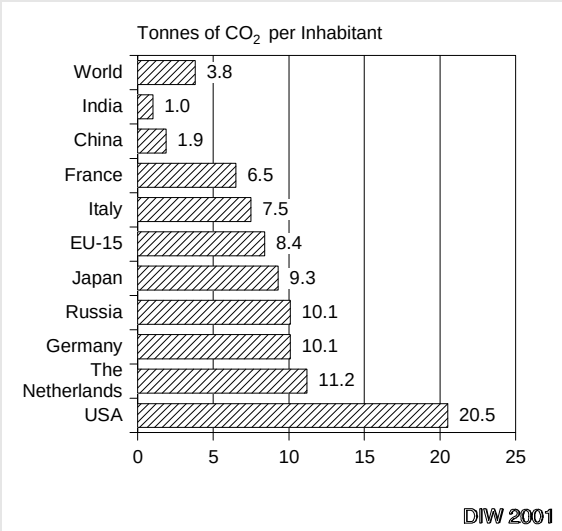
Shares in Worldwide CO_2 Emissions in 2000 and Changes in 2000 from 1990 for the Ten Biggest Emitting Countries



Sources: IEA; European Commission; European Environment agency (EEA); BP; estimates by DIW Berlin.

Figure 3

CO_2 Emissions per Inhabitant in Selected Countries and Regions in 2000



Sources: IEA; European Environment Agency (EEA); BP; calculations by DIW Berlin.

tries it is followed by India, Japan and the PR China. All the other Asian countries together made a considerable contribution with 2.3 percentage points (cf. figure 4).

Factors influencing the changes in CO_2 emissions

It is interesting to establish the causes of the changes in CO_2 emissions in individual countries and regions in recent years. The main factors that influenced these are:

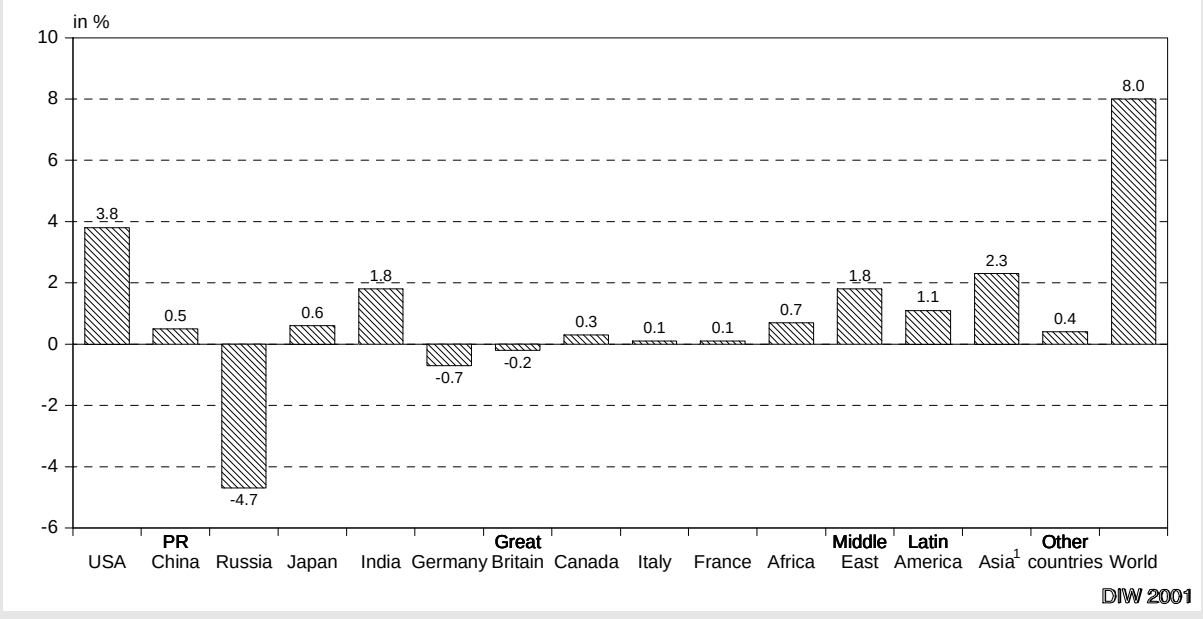
- population (the demographic component)
- per capita gross domestic product (the income component)
- energy intensity in the economy as a whole (the energy-intensity component) and
- the CO_2 content of primary energy consumption (the energy-mix component).

Using the method of component analysis[8] the influence of these factors on the changes in CO_2 emissions can be estimated. This analysis was made for the year 2000 compared with 1990. As current macroeconomic and demographic data were not available in every case, especially for the year 2000, estimates have been made for some of the countries included. But this should not have essentially affected the conclusions.

[8] On the method of component analysis used here see Jochen Diekmann, Wolfgang Eichhammer, Anja Neubert, Heilwig Rieke, Barbara Schlomann and Hans-Joachim Ziesing, Energie-Effizienz-Indikatoren, Statistische Grundlagen, theoretische Fundierung und Orientierungsbasis für die politische Praxis, Heidelberg 1999.

Figure 4

Contributions of the Biggest Emitters to Relative Changes in Worldwide CO_2 Emissions from 1990 to 2000

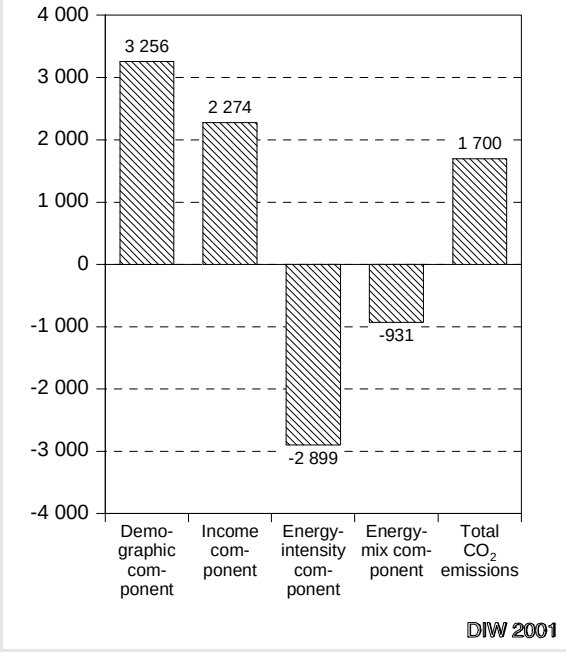


1 Not including Japan, PR China and India.
Sources: Calculations by DIW Berlin.

Figure 5

Components of Worldwide CO_2 Emissions

Absolute changes in 2000 from 1990 in million t



Sources: IEA; European Commission; European Environment Agency (EEA); BP; estimates by DIW Berlin.

If the method is applied to the changes in worldwide CO_2 emissions as a whole it appears that the increase in emissions can mainly be explained by the growth in population and – to a rather lesser extent – by the global growth in per capita GDP. However, the rise in energy productivity[9] – by around 14% or 1.3% on average per year from 1990 to 2000 – like the changes in the structure of energy sources in favour of non-emissive or lower emissive energy sources, has succeeded in noticeably braking the rise in emissions (cf. figure 5).

The results for the individual countries show (cf. table 2):

– With the exception of Ukraine and the Russian Federation the *population component* in itself led to a more or less marked increase in CO_2 emissions. That is most evident in India, New Zealand, the PR China and Australia, as well as in Canada and the United States. Within the EU-15 group population only plays a larger part in Luxembourg, Ireland, the Netherlands and Austria. Worldwide the larger population in 2000 compared with 1990 caused around 15% more CO_2 emissions.
– The *income effect,* that is the increase in real per capita GDP, made a considerable contribution to the increase in emissions everywhere, again with the exception of Ukraine and Russia. Its influence was particularly strong in the PR China, Ireland and India, while it was weakest in Switzerland, Japan and Sweden. Worldwide the increase in per capita incomes from 1990 to 2000 in itself led to just under 11% more CO_2 emissions.
– The *energy-intensity* effect varies greatly. In most of the countries it caused a reduction in emissions. That was particularly the case in the PR China, Ireland, Luxembourg, India, Denmark and Germany, as well as the Netherlands and the United States, where there has been a clear improvement in energy productivity in the economy as a whole within the period in question. Conversely, it can be established that energy productivity has also deteriorated noticeably in Portugal, for example, and in Ukraine; the same applies, though to a lesser extent, to Spain, Russia and Japan. In the EU-15 group as a whole the energy-intensity effect did reduce emissions, but the contribution was very much smaller than in the United States. Worldwide the contribution of this effect led to a reduction in CO_2 emissions by nearly 14%.
– The *changes in the structure of energy sources* led to a reduction in CO_2 emissions in the majority of cases; thus, the energy-mix has shifted in favour of non-emissive or lower emissive energy sources. The opposite applies, however, to India and – to a lesser extent – to New Zealand and Canada. Worldwide CO_2 emissions were lowered by a good 4% by the change in the energy mix.

All in all, the picture of the effects caused by the components examined is differentiated. Independently of that, however, it remains to be said that in most countries the influences that increase emissions still predominate.

The position of the EU-15 group

At least since the Bonn Climate Conference in July 2001, the EU has taken the leading role in the implementation of the Kyoto Protocol and in fulfilling the obligations to reduce emissions then undertaken. The attitude of the EU in this is in clear contrast to that of the United States, which has abandoned the Kyoto Protocol. Unlike the United States the EU still holds to the objective of reducing its emissions of greenhouse gases[10] by altogether 8% by 2008/2012 – which is more than the average for all industrial countries. But the 'burden sharing'

[9] Energy productivity is defined as real GDP per unit of energy consumption; the reciprocal figure is energy intensity.

Table 2

Components of the Rates of Change in CO_2 Emissions in EU-15 and Selected Countries 2000 compared with 1990

	Demographic component	Income component	Energy-intensity component	Energy-mix component	CO_2 emissions
	Weighted changes in percentage points[1]				Changes (%)
Austria	5.0	18.4	–13.4	–5.6	4.5
Belgium	3.0	18.1	2.8	–15.6	8.3
Denmark	3.8	23.0	–23.1	–3.1	0.6
Finland	3.8	17.4	–2.9	–14.8	3.5
France	3.8	14.9	–3.5	–9.0	6.3
Germany	3.2	13.8	–21.9	–10.9	–15.8
Greece	4.9	20.2	3.9	–7.8	21.2
Ireland	9.8	85.6	–55.4	–1.6	38.4
Italy	0.8	13.2	–2.1	–6.6	5.2
Luxembourg	11.5	32.1	–45.0	–47.1	–48.5
The Netherlands	6.3	23.6	–17.6	–0.4	12.0
Portugal	1.7	29.4	30.7	–13.9	47.9
Spain	1.8	25.9	8.3	–6.0	30.0
Sweden	3.5	12.0	–15.5	–3.8	–3.8
Great Britain	3.6	15.1	–9.9	–16.1	–7.3
EU-15	3.1	16.5	–9.5	–10.7	–0.6
USA	10.5	24.3	–16.1	–2.1	16.7
Canada	11.0	15.4	–9.3	0.3	17.4
Japan	2.8	10.5	5.5	–6.6	12.3
Australia	12.8	24.9	–13.5	–0.5	23.8
New Zealand	15.5	15.3	2.1	5.8	38.6
Norway	6.2	28.2	–9.1	–9.7	15.6
Iceland	8.0	17.9	–3.9	–17.0	5.0
Switzerland	6.6	1.6	–3.8	–10.5	–6.1
Ukraine	–3.3	–56.1	19.0	–13.0	–53.5
Russia	–1.5	–32.6	2.9	–9.1	–40.3
PR China	12.9	98.7	–104.2	–2.8	4.6
India	23.3	49.7	–28.8	18.6	62.8
World	15.3	10.7	–13.6	–4.4	8.0

1 The sum of the weighted changes is the total change in CO_2 emissions.
Sources: European Environment Agency (EEA); International Energy Agency (IEA); BP; DIW Berlin calculations.

that has been agreed means that there are marked differences in the reductions that individual countries in the EU have undertaken to make.

Emissions in Germany, for example, will have to be reduced by 21%, which is around three-quarters of the total reduction the EU has undertaken to make. However, Germany had already fulfilled more than 60% of this undertaking by 1998, so that its share in the fall in emissions to be achieved by 2008/2012 from the 1998 level will only be a good quarter. On that view many of the other EU countries will be forced to reduce their emissions of greenhouse gases much more during that period than would correspond to their share of emissions in 1998.

Measured by these obligations the EU is still far from achieving its targets – though not as far as the United States. Altogether greenhouse gas emissions were reduced by 2.5% on average for all the EU-15 countries from 1990 to 1998, but that was solely due to the strong reductions achieved by Germany and Great Britain and – though quantitatively of less importance – by Luxembourg. Without these countries greenhouse gas emissions in the rest of the EU were 7.4% higher in 1998 than in 1990 (cf. table 3). In this context the European Commission itself has pointed out that the special situation in Germany and Great Britain could change very quickly.[11]

[10] Under the Kyoto Protocol the following six greenhouse gases are to be reduced, measured in CO_2 equivalents: carbon dioxide (CO_2), methane (CH_4, dinitrous oxide (N_2O), part-halogenated hydro-fluorocarbons (HFO), perfluorated hydro-carbons (PFC) and sulphur hexafluoride (SF_5).

Table 3

Greenhouse Gas Emissions in the EU from 1990 to 1998 and Reduction Targets for 2008/2012

	1990	1998	1990/1998	Reduction target for 2008/2012 (%)
	Mill t CO_2 equivalent		Changes in %	
Austria	75.4	78.5	4.1	–13.0
Belgium	136.0	144.6	6.3	–7.5
Denmark	69.5	75.6	8.7	–21.0
Finland	72.5	76.0	4.7	0.0
France	538.5	543.6	1.0	0.0
Germany	1 201.1	1 011.6	–15.8	–21.0
Greece	103.9	119.5	15.0	25.0
Ireland	53.4	63.7	19.1	13.0
Italy	514.6	538.1	4.6	–6.5
Luxembourg	14.1	5.8	–58.4	–28.0
The Netherlands	208.9	225.9	8.2	–6.0
Portugal	62.6	73.7	17.8	27.0
Spain	301.9	360.4	19.4	15.0
Sweden	69.4	70.2	1.2	4.0
Great Britain	727.1	657.7	–9.5	–12.5
EU total	4 148.9	4 044.9	–2.5	–8.0

Deviations in the sums due to rounding.
Source: European Commission, COM (2000)88, final, 8.3.2000

In fact, the development to date in these two countries cannot simply be projected into the future, as essential influences in the past – the structural changes in Germany after reunification and the decline of the coal industry in Great Britain after privatisation – will not be repeated.[12]

Particularly marked failure to meet the target is evident to date in Italy, the Netherlands, Belgium, Austria and Denmark; instead of being reduced as required, greenhouse gas emissions there have actually risen more or less strongly from 1990 to 1998.

If the changes in the EU-15 group are compared with those in the United States and Japan, using the component analysis method, it is evident that the high increase in CO_2 emissions in the United States is mainly a result of the powerful growth in the economy as a whole and the growing population; however, the improvement in energy productivity has played a very much greater role in the United States than in the EU-15 (cf. figure 6). For example, from 1990 to 2000 energy productivity in the EU-15 rose by only around 1% on average per year, but the figure for the United States for the same period was 1.5%. The differences between the United States and the EU-15 are particularly great if Germany and Great Britain are excluded. Without these two countries energy productivity nearly stagnated in the EU, and the influence of the changes in the energy-mix that reduced emissions play only a very slight part. Compared with the development in Japan, however, the EU is still doing quite well, for in Japan energy productivity actually deteriorated from 1990 to 2000.

But if the EU-15 intend to continue to take the lead in global climate protection their climate protection policy activities will need to be very greatly intensified, in view of the trend in emissions during the 1990s as outlined here. Only with very much greater efforts could the agreed targets be reached. According to studies now available[13] the potentials are there in the EU (cf. table 4). The studies show that it would, for instance, be possible to reduce greenhouse gas emissions in the EU by 9%

[11] Cf. Press release by the European Commission: Greenhouse Gas Emissions in the Community (*http://europa.eu.int/comm/environment/climat/gge_press.htm*).

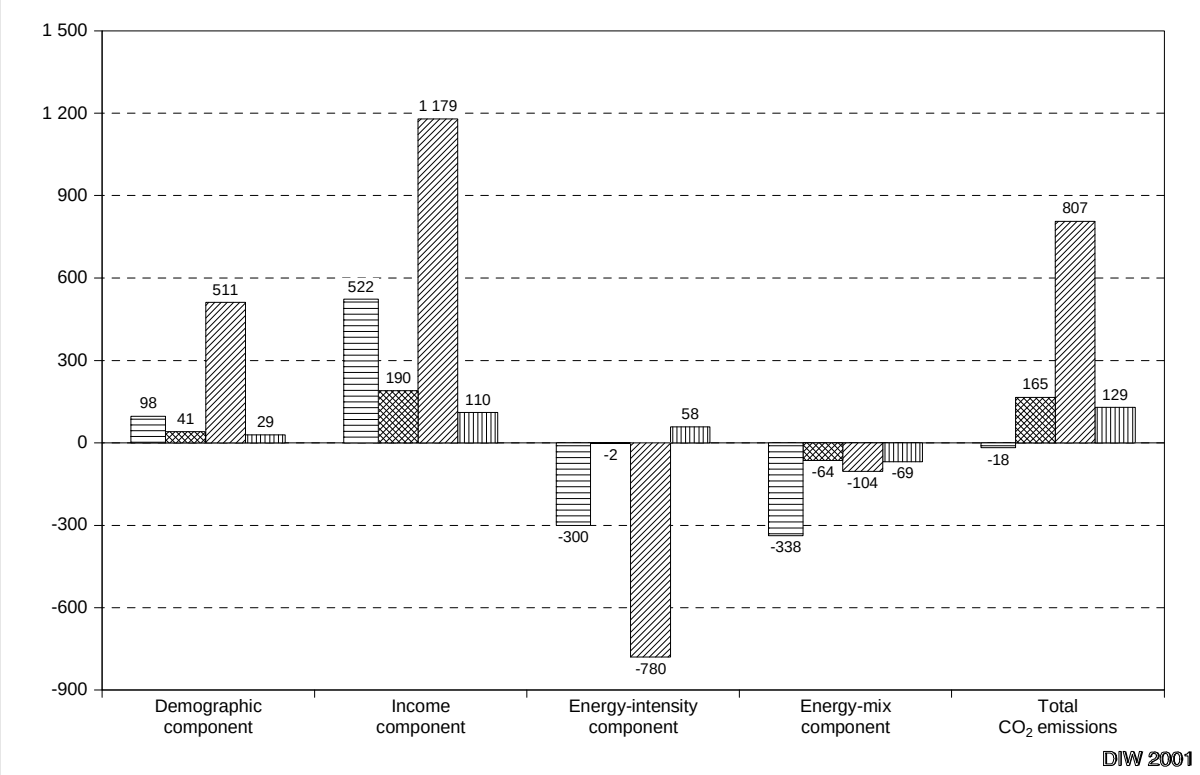
[12] For an analysis of greenhouse gas emissions in Germany and Great Britain see Greenhouse gas reductions in Germany and the UK – Coincidence or policy-induced? An analysis for international climate policy, study on behalf of the German Federal Ministry of the Environment (BMU) and the German Federal Environmental Agency (UBA), Fraunhofer Institute for Systems and Innovation Research (ISI), Science Policy and Technology Policy Research (SPRU) and German Institute for Economic Research (DIW Berlin), June 2001.

[13] Cf. K. Biok, D. de Jager and Chr. Handriks: Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change, March 2001. (*http://www.europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm*).

Figure 6

Components of CO_2 Emissions in the EU-15, the United States and Japan

Absolute changes in 2000 from 1990 in million t CO_2



Sources: IEA; European Environment Agency (EEA); BP; calculations by DIW Berlin.

with marginal costs of 20 euro per tonne of CO_2 equivalent, compared with a reference trend in which a slight rise must be expected. Altogether, according to these estimates the costs within the EU of meeting the reduction obligations undertaken would only amount to 0.06% of total European GDP in 2010. The main concern must be to achieve a major increase in energy productivity and the use of low-emissive or non-emissive energy sources. The signals have been set in that direction with the European Climate Change Programme (ECCP), and this must now be implemented in Europe and at national level.[14]

[14] Cf. European Commission: Political Concepts and Measures by the EU to Reduce Greenhouse Gas Emissions: On a European Climate Change Programme (ECCP), COM (2000) 88 final, 8.3.2000 (*http://www.europea.eu.int/comm/environment/climat/ecop.htm*); and European Commission: European Climate Change Programme (ECCP), Long Report, June 2001 (*http://www.europa.eu.int/comm/environment/climat/eccp_longreport_0106/pdf*). The European Environmental Agency 'sees no room for complacency and warns that further major efforts to reduce emissions are needed to achieve the Kyoto targets', quoted in European Commission press release Greenhouse Gas Emissions in the Community, loc. cit.

Reduction in CO_2 emissions in Germany slows down

Within the EU Germany made the biggest contribution to climate protection in the 1990s. From 1990 to 2000 energy-induced CO_2 emissions fell here by nearly 16% (around 15% adjusted for temperature changes). Beside the effects of the economic adjustment process in the new Federal Länder climate protection policy played a considerable part in this.[15] However, it cannot be overlooked that as the effects of reunification subsided the reduction rate has noticeably slackened in recent years.

That is particularly evident from the development in emissions adjusted for temperature effects: this shows that nearly 87% (about 133 million t) of the absolute reduction in CO_2 emissions for the total period from 1990 to 2000 was achieved in the first half of the decade; from 1995 to 2000 there was only a fall of around 20 million t. Last year actual emissions of CO_2 practically stag-

[15] Cf. Greenhouse gas reductions in Germany and the UK – Coincidence or policy induced?, loc. cit.

Table 4

Greenhouse Gas Emissions: Cost-effective Reduction Potentials in the EU[1] by Sectors until 2010

	Emissions in 1990[2]	Changes in emissions from 1990 to 2010 in the reference case with existing measures	Cost-effective reduction potential compared with the reference development up to 2010
	Million t CO_2 equivalent	(%)	
Energy sector	1 422	–6	–13
Industry	757	–9	–12
Transport	753	31	–4
Households	447	0	–6
Services	176	14	–15
Agriculture	417	–5	–4
Waste disposal	166	–18	–13
Total	4 138	1	–9

1 Reduction potentials with marginal costs of 20 euros/t CO_2 equivalent. — 2 Contains data for fluoride gases for 1995.
Source: ECOFYS, AEA, National Technical University of Athens.

nated from the previous year, while adjusted for temperature effects they actually rose again slightly (cf. table 5 and figure 7). This essentially confirms a preliminary estimate that was published at the start of this year.[16]

Sectorally the development is differentiated (table 6 and fig. 8). The biggest absolute decline in (non-temperature adjusted) CO_2 emissions from the base year 1990 was in the energy sector at just under 78 million t (–18%); it is followed by industry with a fall of nearly 52 million t (–31%) and trade, the crafts and services with a good 30 million t (–34%); private households emitted just under 15 million t less than in 1990 in 2000 (– 2%).

Only in the transport sector were emissions in 2000 higher than in 1990, by a good 20 million t or 13%. But for the first time since 1994 emissions were reduced in this sector last year, by just under 2%. This was almost entirely due to road transport, while air traffic again showed a strong rise (6%).

Emissions by private households fell more strongly than emissions by the transport sector in 2000 at just under –5% and in the crafts, trade and services by nearly 4%. But it must be remembered here that energy consumption by private households is strongly dependent on the temperature, as room heating accounts for a large share – about three-quarters for private households and around half for the crafts, trade and services. According to a rough calculation temperature-adjusted CO_2 emissions in both sectors probably fell by only just under 2% in 2000.

[16] Höhere CO_2 -Emissionen im Jahre 2000, ed. Hans-Joachim Ziesing, in: *Wochenbericht des DIW,* no. 6/2001.

Table 5

Actual and Temperature-adjusted Energy-induced CO_2 Emissions in Germany from 1990 to 2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999[1]	2000[1]
Actual CO_2 emissions in million t	987.2	951.6	903.2	892.9	876.8	876.1	899.6	867.2	859.7	833.0	832.6
Changes from ...											
1990 in million t		–35.6	–84.0	–94.2	–110.3	–111.1	–87.6	–120.0	–127.5	–154.1	–154.6
1990 (%)		–3.6	–8.5	–9.5	–11.2	–11.3	–8.9	–12.2	–12.9	–15.6	–15.7
Previous year in million t		–35.6	–48.4	–10.2	–16.1	–0.7	23.5	–32.4	–7.5	–26.7	–0.4
Previous year (%)		–3.6	–5.1	–1.1	–1.8	–0.1	2.7	–3.6	–0.9	–3.1	–0.1
Temperature-adjusted CO_2 emissions in million t	1 013.5	947.3	919.4	894.5	898.0	880.6	872.6	871.2	869.9	853.0	860.1
Changes from ...											
1990 in million t		–66.1	–94.1	–119.0	–115.5	–132.9	–140.8	–142.3	–143.6	–160.5	–153.4
1990 (%)		–6.5	–9.3	–11.7	–11.4	–13.1	–13.9	–14.0	–14.2	–15.8	–15.1
Previous year in million t		–66.1	–28.0	–24.9	3.5	–17.3	–8.0	–1.4	–1.3	–16.9	7.1
Previous year (%)		–6.5	–3.0	–2.7	0.4	–1.9	–0.9	–0.2	–0.2	–1.9	0.8

Based on the following energy consumption data: 1990 to 1998 energy balance sheets; calculation of preliminary data for 1999 and 2000 based on evaluation tables for the energy balance sheet as per October 2001.
1 Preliminary estimate.
Sources: Federal Environmental Office; Working Group on Energy Balance Sheets; German Meteorological Office; DIW Berlin calculations.

Emissions in the energy sector and industry, unlike those in these sectors, grew again noticeably last year, by a good 2% each. The main reason in the energy sector was the growth in the number of vehicles on the road. The growth in industry was relative in view of the strong growth in output, which – measured by the production index for manufacturing – was 6.3% higher in 2000 than in 1999.

In the structure of CO_2 emissions by groups of emitters there were clear shifts last year against the background of the development outlined here (cf. figure 9). As before, the energy sector remains by far the biggest emitter; but transport has now displaced industry in second place, and industry is roughly level with private households. The crafts, trade and services sector plays a relatively minor part in emissions.

Conclusion

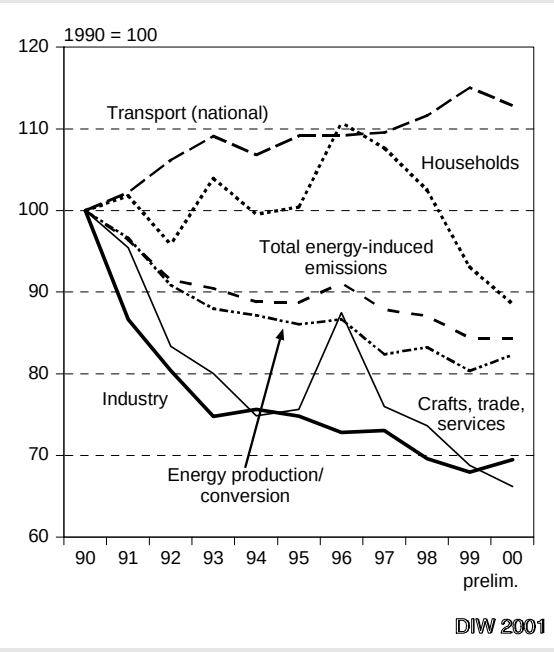
The development to date in worldwide CO_2 emissions is in crass contrast to the requirements of climate protection. A change in the trend towards lasting reduction of emission levels is not evident on a global scale, and that applies to most of the countries who undertook obligations under the Kyoto Protocol.

It is evident that reduction obligations undertaken in many EU member states are also not likely to be fulfilled. If the European Union wants to remain credible in the leading role it has adopted in the international climate protection negotiations it will have to take concrete steps to realise the targets agreed. That could increase the chances of motivating other industrial countries, which are still hesitating to take similar steps.

Judging the present level of CO_2 emissions reached in Germany by the German Government's target of a 25% reduction from the 1990 level by the year 2005, CO_2 emissions will need to fall by another 100 million t. It must be stressed that the chances of achieving this in the few remaining years are not very high.[17] The obligation to reduce greenhouse gas emissions by 21% by 2008/2012 undertaken as part of European burden sharing deserves less scepticism. That target at least should be met with a consistent continuation and intensification of the climate protection policy that has been started in

Figure 8

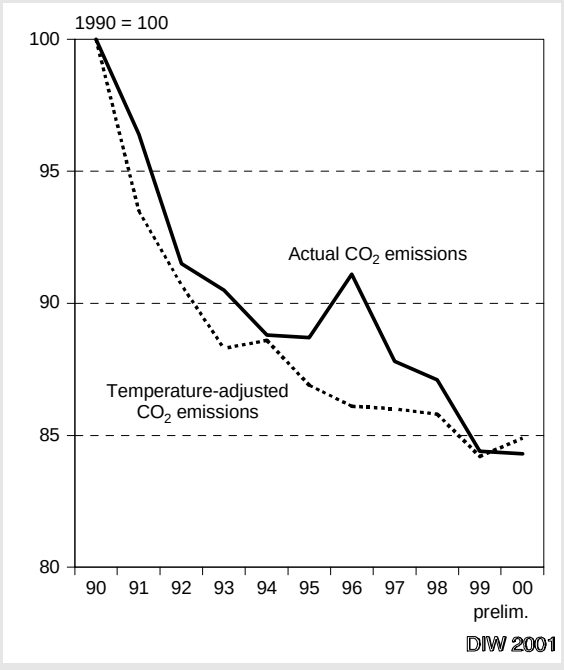
Development in Energy-induced CO_2 Emissions in Germany by Sectors from 1990 to 2000



Sources: Federal Environmental Office; AG Energiebilanzen; calculations by DIW Berlin.

Figure 7

Development in Actual and Temperature-adjusted Energy-induced CO_2 Emissions in Germany from 1990 to 2000



Sources: Federal Environmental Office; German Meteorological Office; AG Energiebilanzen; calculations by DIW Berlin.

Table 6

Energy-induced CO_2 Emissions in Germany by Sectors from 1990 to 2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999[1]	2000[1]
						CO_2 Emissions in million t (unadjusted)					
Energy production/ conversion	440.6	425.9	400.4	387.7	384.1	379.2	382.0	363.1	366.9	354.1	362.7
Industry	169.7	147.1	136.5	127.0	128.4	127.0	123.7	124.0	118.2	115.4	118.0
Transport (national)[2]	158.0	161.6	167.8	172.5	168.8	172.5	172.6	173.1	176.4	181.9	178.3
Households	128.4	130.7	123.1	133.5	127.8	129.0	142.3	138.2	131.7	119.5	113.7
Crafts, trade, services[3]	90.4	86.2	75.4	72.3	67.7	68.4	79.1	68.7	66.6	62.1	59.8
Total energy-induced emissions	987.2	951.6	903.2	892.9	876.8	876.1	899.6	867.2	859.7	833.0	832.6
Industrial processes[4]	27.7	24.8	25.4	25.3	27.0	26.6	24.8	25.5	26.2	26.5	26.5
Total emissions	1 014.8	976.4	928.5	918.2	903.8	902.7	924.4	892.6	885.8	859.5	859.1
						Structure of CO_2 emissions (%)					
Energy production/ conversion	43.4	43.6	43.1	42.2	42.5	42.0	41.3	40.7	41.4	41.2	42.2
Industry	16.7	15.1	14.7	13.8	14.2	14.1	13.4	13.9	13.3	13.4	13.7
Transport (national)	15.6	16.5	18.1	18.8	18.7	19.1	18.7	19.4	19.9	21.2	20.8
Households	12.7	13.4	13.3	14.5	14.1	14.3	15.4	15.5	14.9	13.9	13.2
Crafts, trade, services[3]	8.9	8.8	8.1	7.9	7.5	7.6	8.6	7.7	7.5	7.2	7.0
Total energy-induced emissions	97.3	97.5	97.3	97.2	97.0	97.0	97.3	97.1	97.0	96.9	96.9
Industrial processes[4]	2.7	2.5	2.7	2.8	3.0	3.0	2.7	2.9	3.0	3.1	3.1
Total emissions	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
						Changes in CO_2 emissions from previous year (%)					
Energy production/ conversion		–3.3	–6.0	–3.2	–0.9	–1.3	0.7	–4.9	1.0	–3.5	2.4
Industry		–13.3	–7.2	–7.0	1.2	–1.1	–2.6	0.3	–4.7	–2.4	2.3
Transport (national)		2.2	3.8	2.8	–2.1	2.2	0.0	0.3	1.9	3.1	–1.9
Households		1.8	–5.9	8.4	–4.2	0.9	10.3	–2.8	–4.8	–9.2	–4.9
Crafts, trade, services[3]		–4.6	–12.6	–4.0	–6.4	1.0	15.7	–13.1	–3.1	–6.6	–3.7
Total energy-induced emissions		–3.6	–5.1	–1.1	–1.8	–0.1	2.7	–3.6	–0.9	–3.1	–0.1
Industrial processes[4]		–10.3	2.3	–0.5	6.7	–1.2	–6.7	2.5	2.7	1.2	0.0
Total emissions		–3.8	–4.9	–1.1	–1.6	–0.1	2.4	–3.4	–0.8	–3.0	0.0
						Changes in CO_2 emissions from 1990 (%)					
Energy production/ conversion		–3.3	–9.1	–12.0	–12.8	–13.9	–13.3	–17.6	–16.7	–19.6	–17.7
Industry		–13.3	–19.6	–25.2	–24.3	–25.2	–27.1	–27.0	–30.4	–32.0	–30.5
Transport (national)		2.2	6.2	9.1	6.8	9.2	9.2	9.5	11.6	15.1	12.8
Households		1.8	–4.2	3.9	–0.5	0.4	10.8	7.7	2.5	–6.9	–11.5
Crafts, trade, services[3]		–4.6	–16.6	–20.0	–25.1	–24.4	–12.5	–24.0	–26.4	–31.2	–33.8
Total energy-induced emissions		–3.6	–8.5	–9.5	–11.2	–11.3	–8.9	–12.2	–12.9	–15.6	–15.7
Industrial processes[4]		–10.3	–8.2	–8.7	–2.6	–3.8	–10.2	–7.9	–5.4	–4.3	–4.3
Total emissions		–3.8	–8.5	–9.5	–10.9	–11.0	–8.9	–12.0	–12.7	–15.3	–15.3

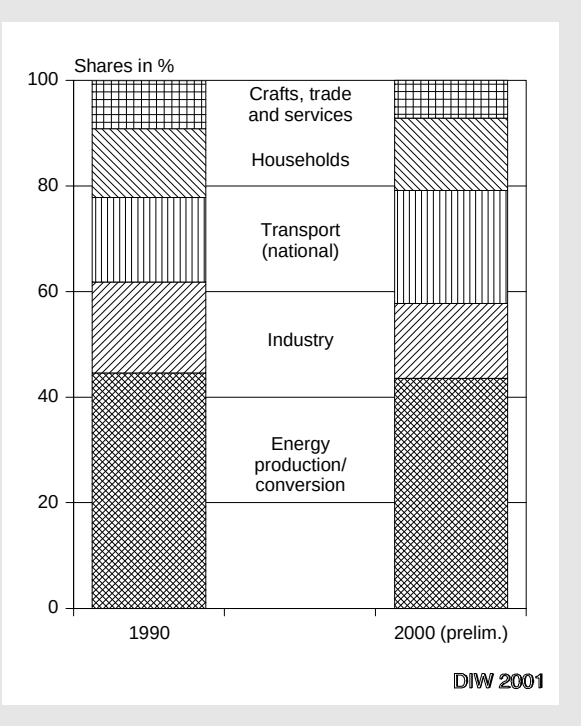
Note: Sectoral definitions as in the energy balance sheets for the Federal Republic of Germany; calculations of preliminary data for 1999 and 2000 based on the evaluation tables for the energy balance sheet as per October 2001.

1 Preliminary estimate. — 2 Without international air traffic (80% of total tanked fuel consumption in Germany is for air traffic). — 3 Including military offices. — 4 Data from the Federal Environmental Office.

Sources: Federal Environmental Office; Working Group on Energy Balance Sheets; DIW Berlin calculations.

Figure 9

Structure of Energy-induced CO_2 Emissions in Germany by Sector in 1990 and 2000



Sources: Federal Environmental Office; AG Energiebilanzen; calculations by DIW Berlin.

Germany is continued and intensified. But it must not be forgotten that in the long-term view an even greater reduction in greenhouse gas emissions is needed. Energy and environmental policy need to be much more decisively reoriented; what matters most is to achieve a considerable improvement in energy productivity, an even greater use of low-emissive energy sources and much greater use of renewable energy sources.

Hans-Joachim Ziesing

[17] Cf. Höhere CO_2-Emissionen im Jahre 2000, loc. cit; Klimaschutzpolitik auf dem richtigen Weg, aber weitere Schritte unabdingbar, ed. Hans-Joachim Ziesing, in: *Wochenbericht des DIW,* no. 32-33/2000. Cf. also the energy prognosis for 2001 by ESSO AG, in which a noticeable growth in CO_2 emissions is actually expected again for the years 2000 to 2005.