Foreword

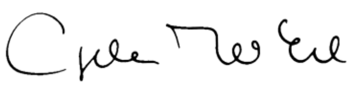
Effective climate protection is one of the central focuses of sustainable development. A solution to the climate problem can be found only through co-ordinated national and international strategies.

On 16 April 1997, the Federal Government approved its Second National Report pursuant to the United Nations' Framework Convention on Climate Change. Regular reporting in this area is one of the obligations Germany has accepted whithin the framework of the UN Framework Convention on Climate Change.

The report outlines greenhouse-gas emissions trends in Germany and presents projections for the future. It describes some 130 individual measures that federal authorities have taken through a complex federal climate protection programme, and it provides an overview of similar measures of the *Länder*, of communities, of industry and of other relevant groups. A separate chapter is devoted to Germany's specific situation following unification and to the reasons for the differences in emissions trends in the old and new Federal *Länder*.

From 1990 to 1995, emissions of the most important greenhouse gases were reduced as follows in Germany: carbon dioxoide (CO_2) by 12 %, methane (CH_4) by 16% and nitrous oxide (N_2O) by 7%. The studies described in the report indicate that the measures approved to date could achieve a CO_2 reduction of about 15% by the year 2005 (compared with the emissions level in 1990). In other words, a great deal has already been accomplished. On the other hand, considerable additional efforts will have to be made to achieve the national objective - 25% lower CO_2-emissions by the year 2005, in comparison with the 1990 emissions level. The 4th Report of the "CO_2-Reduction" Interministerial Working Group has the task of providing the Federal Cabinet with recommendations for additional measures that will permit the ambitious climate protection objective to be reached.

Sustainable development does not occur by itself; great efforts are required to achieve it. This is true in both the national and international political arenas. In 1997, the Special Session of the UN General Assembly on Sustainable Development, and the Third Conference of the Parties to the Framework Convention on Climate Change (for adoption of a climate protection protocol) will take place. In this same year, the Second National Report provides an overview of the efforts all concerned parties in Germany are making to contribute to global climate protection.



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Climate Protection in Germany

Second Report
of the Government
of the
Federal Republic of Germany
Pursuant to the United Nations
Framework Convention on the Climate Change

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Annexes

1. Summary

1.1 Introduction

The present report on climate protection in Germany is the Federal Government's second report to the Conference of the Parties pursuant to Article 12 of the Framework Convention on Climate Change. It is based on Germany's first national report pursuant to the Framework Convention on Climate Change, which was submitted in September 1994. The report updates earlier information and presents it in a format that complies with the guidelines for the preparation of national reports adopted by the 2nd Conference of the Parties (Resolution 9\CP.2); in addition, the chapter on projections of greenhouse gas emissions has been considerably expanded, and data is now also included for sulphur hexafluoride (SF_6), perfluorocarbons and hydrofluorocarbons (PFC and HFC) and sulphur dioxide (SO_2).

The terms “western Germany”/“old Federal *Länder*” refer to the territory of the Federal Republic of Germany until 3 October 1990 (Federal Republic of Germany's former territory including West Berlin); the terms “eastern Germany/ new Federal *Länder*” here refer to the territory of the former German Democratic Republic1 (including the eastern part of Berlin). The report is complicated by the difficulty that the reference year 1990 was the year of German reunification. A separate section discusses the causes of emissions trends since reunification on 3 October 1990.

The Framework Convention on Climate Change:

The Framework Convention on Climate Change was signed in Rio in June 1992. It came into force on 21 March 1994, and it has been ratified by 165 countries to date, including the European Union (status as of March 1997). The 1st Conference of the Parties (CoP) to the Framework Convention on Climate Change took place in Berlin from 28 March to 7 April 1995. The most important result of the Berlin climate conference was the “Berlin Mandate”, which establishes a framework for further negotiations regarding greater commitments by industrial countries to limiting and reducing greenhouse gas emissions.

Latest scientific findings/IPCC:

The Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which was adopted in December 1995, is used for as a reference regarding the latest scientific research. This scientific report makes a powerful case for the need for action. According to this report, relevant findings overall point to a recognisable human influence on global climate. This is a new position with respect to the first IPCC assessment report of 1990. Human activities have caused considerable increases in concentrations of greenhouse gases in the atmosphere. The mean global air temperature has increased by 0.3–0.6 °Celsius since the end of the 19th century, and the global sea level has risen by 10–25 cm in the last 100 years. If no countermeasures are taken, so the 2nd IPCC report, an increase in mean global air temperature of about 2 °Celsius (between 1 and 3.5 °Celsius), and an average sea-level increase of about 50 cm (between 15 and 95 cm), in comparison with relevant levels in 1990, must be expected by the year 2100.

[1]) This means the Federal *Länder* Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia as well as East Berlin. Although “East Berlin” (together with “West Berlin” today’s Land Berlin) is not a new Federal Land in the constitutional meaning, eastern Berlin is included with the new Federal *Länder* for the continuation of the emission development records of the former German Democratic Republic.

1.2 The German climate protection programme and greenhouse gas reduction target

The Federal Government was early in developing a comprehensive national climate protection strategy. The Federal Government's climate protection programme contains measures for reducing emissions of CO_2 and other greenhouse gases (CH_4, N_2O, CF_4, C_2F_6, SF_6, the ozone precursors NOx, CO, NMVOC and the laughing-gas precursor NH_3), and it provides for continuation and expansion of CO_2 storage in forests and wood products. This programme is being developed and implemented step by step.

By resolution of 13 June 1990, the Federal Government established the “CO_2 reduction” Interministerial Working Group, which is charged with identifying the potential for reduction of greenhouse gas emissions (especially CO_2) and with proposing measures to tap this potential. In the framework of this “CO_2 reduction” Interministerial Working Group, and under the chairmanship of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, working parties were established for the following topic areas: energy supply (chaired by: Federal Ministry for Economics), transport (chaired by: Federal Ministry of Transport), buildings and structures (chaired by: Federal Ministry for Regional Planning, Building and Urban Development), new technologies (chaired by: Federal Ministry of Education, Science, Research and Technology) and agriculture and silviculture (chaired by: Federal Ministry of Food, Agriculture and Forestry).

The Federal Government is aiming to reduce CO_2 emissions by 25% by the year 2005 (based on the reference year, 1990).

Reduction and limitation of other climate-relevant emissions – such as emissions of methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF_6) – have also been included in the national climate protection strategy.

To date, the “CO_2 reduction” Interministerial Working Group has submitted three reports on climate protection strategy in Germany to the Federal Cabinet: in November 1990, December 1991 and September 1994. The Working Group is continuing its work, and it has been commissioned by the Federal Cabinet to submit its next report in May 1997 and its 5th report in 1999. The fourth report is to contain targets and emissions reduction measures for the greenhouse gases CH_4, N_2O, CF_4, C_2F_6, the ozone precursors NOx, CO, NMVOC and the laughing-gas precursor NH_3; it is also expected to describe progress made in reducing CO_2 emissions and to present further refinements of the Federal Government's climate protection strategy.

Overall economic and finance-policy limitations must be taken into account in this context.

1.3 Framework data/the situation in Germany following reunification

General framework data:

Since 27 October 1994, protection of the natural basis for life (environmental protection) has been enshrined as a state aim in the Basic Law of the Federal Republic of Germany (constitution) (Article 20 a Basic Law). Consequently, the state is charged, also as a result of its responsibility for future generations, with protecting the natural basis for life, within the framework of the constitutional order, by means of its legislative organs; it is also charged with protecting this basis, within a framework of law and justice, by means of its executive and judicial organs.

The Federal Republic of Germany is a federal state. Its Basic Law divides tasks and competencies between the Federation/Federal Government and the *Länder*.

From 1987 to 1995, Germany's population increased by 4 million; from 1990 to 1995 it grew by 2.4 million. In the old Federal *Länder*, the population has been growing; in the new Federal *Länder*, it has been shrinking.

Germany's primary energy requirements of 14,191 PJ in 1995 were met primarily with mineral oils (40%). Natural gas met about 20%, hard coal about 15% and lignite about 12% of the country's primary energy requirements. Some 10% of Germany's primary energy requirements were met with nuclear power. In 1995, renewable energies, especially hydropower, wind power, biomass, waste, sewage sludge etc., covered about 3% of these requirements.

Germany following reunification (old Federal *Länder*/new Federal *Länder*):

Germany's reduction of carbon dioxide emissions is due only in part to developments in the new Federal *Länder* following German reunification. In addition, the changes in the new Federal *Länder* have not been caused solely by economic problems; they are also due to major structural transformations in the direction of an energy supply with lower emissions.

For example, as part of structural changes in the new Federal *Länder*, consumption of lignite, which is particularly high in emissions, decreased by nearly two-thirds from

Tab. 1.3.1: Changes in energy consumption in Germany from 1990 to 1995, by fuels

	Old		New		Germany		Changes 1990/1995		
	Länder						Old	New	Germany
	1990	1995*)	1990	1995*)	1990	1995*)	*Länder*		
	PJ						%		
Hard coal	2169	1986	137	75	2306	2060	-8,5	-45,5	-10,7
Lignite	940	928	2261	804	3201	1732	-1,2	-64,5	-45,9
Mineral oils	4718	4927	520	763	5238	5690	4,4	46,8	8,6
Nat. gas, petr. gas	2012	2342	281	472	2293	2814	16,4	67,9	22,7
Nuclear	1383	1470	63	0	1446	1470	6,3	-100,0	1,6
Renewables, other	283	418	28	8	312	426	47,4	-71,5	36,6
Total	11505	12070	3290	2122	14795	14191	4,9	-35,5	-4,1
	Structure in %						Change in %-points		
Hard coal	18,9	16,5	4,2	3,5	15,6	14,5	-2,4	-0,6	-1,1
Lignite	8,2	7,7	68,7	37,9	21,6	12,2	-0,5	-30,8	-9,4
Mineral oils	41,0	40,8	15,8	36,0	35,4	40,1	-0,2	20,2	4,7
Nat. gas, petr. gas	17,5	19,4	8,5	22,2	15,5	19,8	1,9	13,7	4,3
Nuclear	12,0	12,2	1,9	0,0	9,8	10,4	0,2	-1,9	0,6
Renewables, other	2,5	3,5	0,9	0,4	2,1	3,0	1,0	-0,5	0,9
Total	100,0	100,0	100,0	100,0	100,0	100,0	0,0	0,0	0,0

*) 1995 prelim. estimate   Discrepancies in totals due to rounding-off   Source: AG Energiebilanzen

1990 to 1995. This fuel's role in total primary energy consumption fell from nearly 69% in 1990 to just under 38% in 1995. On the other hand, the percentages for natural gas and mineral oil have risen sharply. The nuclear power plants in the new Federal *Länder* were decommissioned immediately following reunification, as a result of safety concerns (cf. Table 1.3.1).

Old Federal *Länder*'s population grew from 63.3 million in 1990 to 66.3 million in 1995, i.e. it grew by about 5%. Although the specific CO_2 emissions per capita decreased by about 3% during this period, absolute CO_2 emissions increased by about 2% – in part, due to this population increase. Another reason for the increase in CO_2 emissions in the old Federal *Länder* is that production capacities were used to a greater extent there following reunification, in order to supply goods and services to the population in the new Federal *Länder*.

The main causes for the sharp reduction in CO_2 emissions in the new Federal *Länder* include economic restructuring, a population decrease of about 4% since 1990, some shifting of production to the old Federal *Länder*, the fact that many goods were obtained from the old Federal *Länder* and other industrial countries following German reunification, improvements in energy efficiency and decreases in consumption of lignite, which is high in CO_2 emissions.

Numerous measures have been taken in the new Federal *Länder* to ensure that the restructuring process initiated there in all energy sectors proceeds systematically and is lasting. As a result, the real gross domestic product in the new Federal *Länder* grew by 8.5% in 1994 and by 5.6% in 1995, while CO_2 emissions continued to decrease.

The restructuring process in all economic and energy-use sectors in the new Federal *Länder* is a process of modernising production and consumption structures to the western European level. Energy prices were greatly undervalued in the former GDR. The former GDR's obsolete, heavily lignite-dependent energy sector, and its outdated industrial and commercial production structures, have had to be phased out; and new structures, fuel diversification and enhanced energy efficiency, on both the supply and demand sides, have been phased in – with major economic and financial support from the old Federal *Länder*. This process, which is still continuing, has been accompanied by increased shipments of goods from the old Federal *Länder* to the new Federal *Länder*.

The CO_2-emissions reductions in the new Federal *Länder* have been achieved through major economic and financial expenditures, financed largely by the old Federal *Länder*. While there has been private investment, public financial transfers to the new Federal *Länder* have played a central role in this connection. The net transfers of public funds to the new Federal *Länder* have been as follows in recent years: in 1991, 106 billion DM; 1992, 115 billion DM; 1993, 129 billion DM; 1994, 125 billion DM; 1995, 140 billion DM; and 1996, 140 billion DM. A considerable share of these financial transfers has gone toward economic mod-

Tab. 1.3.2: Changes in primary energy consumption and CO_2 emissions per unit of gross domestic product[1)], adjusted for inflation (in 1991 prices), and changes in CO_2 intensity of primary energy consumption in Germany from 1990 to 1995

	1990	1991	1992	1993	1994	1995
	Primary energy consumption per GDP unit (GJ/DM)					
Western Germany	4,56	4,53	4,42	4,54	4,42	4,39
Eastern Germany	12,93	12,02	10,05	9,12	8,19	7,78
Germany	5,33	5,07	4,85	4,92	4,75	4,69
Eastern to Western Germany in %	283	265	227	201	185	177
	Carbon dioxide emissions per GDP unit (t CO_2/Mio DM)					
Western Germany	281	281	270	275	267	263
Eastern Germany	1200	1125	899	801	699	632
Germany	364	342	318	318	305	296
Eastern to Western Germany in %	427	401	333	291	261	241
	Carb. dioxide intensity of prim. energy consumption (t CO_2/TJ)					
Western Germany	61,6	62,0	61,0	60,6	60,5	59,8
Eastern Germany	92,8	93,6	89,4	87,9	85,4	81,2
Germany	68,5	67,4	65,5	64,8	64,3	63,0
Eastern to Western Germany in %	151	151	147	145	141	136

[1)] GDP in 1991 prices.
Sources: Fed. Office for Statistics; UBA; AG Energiebilanzen

ernisation, including implementation of measures for CO_2 reduction.

In 1991 and 1992 DM 829.9 million of Federal budget funds were spent on environmental protection measures and DM 149.3 million on the renovation of long-distance heating installations within the framework of the joint project on revitalising the new Federal *Länder*.

Efficiency of energy use was considerably improved in the new Federal *Länder* between 1990 and 1995. One manifestation of this improvement is that primary energy consumption and CO_2 emissions per capita are now even lower in the new Federal *Länder* than in the old Federal *Länder*. And there is potential for further efficiency increases.

It can be assumed that some CO_2 emissions were "shifted" into the old Federal *Länder* as a result of German reunification. A total of 90% of such shifts was compensated for by efforts made in the old Federal *Länder* to reduce CO_2 emissions. This effect has received little notice to date. It should also be remembered, in this context, that a large percentage of the new Federal *Länder*'s goods have been supplied by the old Federal *Länder* and other countries.

Without doubt, one significant reason for the emissions reduction in the new Federal *Länder* has been that the process of economic transformation has enhanced the efficiency of nearly all aspects of production. The most significant reductions have been achieved through substitution of obsolete procedures and products, especially in chemical process manufacturing.

Consequently, this system transformation has fulfilled an important prerequisite for a more efficient – and thus cleaner – energy supply. This basis has been enhanced by a number of specially targeted – and also environmentally motivated - measures, such as:

– Support for district heating systems fed by combined heat and power stations,

– Support for economic modernisation,

– Support for energy-oriented renovation and modernisation of buildings,

– Support for restructuring of heating systems,

– Implementation of ordinances in keeping with the Federal Immission Control Act and similar legislation.

Overall, the economic efficiency of energy use in the new Federal *Länder* was considerably increased between 1990 and 1995. Nonetheless, the new Federal *Länder* still lag behind the old Federal *Länder* in this area: For example, in 1995 overall economic energy intensity was nearly 80% greater in the new Federal *Länder* than in the old Federal *Länder*; overall economic carbon dioxide intensity was nearly 140% higher. These figures reveal further major potential for efficiency enhancements – potential which, if made use of, could enable even strong economic growth in the new Federal *Länder* in the coming years to occur without increasing energy consumption and reversing the trend for CO_2 emissions (cf. Tab. 1.3.2).

1.4 Inventories of anthropogenic emissions of greenhouse gases and of carbon storage

Emissions levels have been determined with the standard sectoral method, which also serves as a basis for the IPCC Guidelines. This method takes both energy-related emissions and non-energy emissions (processes) into account.

Tab. 1.4.1 lists emissions of directly acting and indirectly acting greenhouse gases.

Table 1.4.2 shows the development of specific emissions of CO_2, CH_4 and N_2O per capita.

Table 1.4.3 shows how economic growth and CO_2 emissions have been decoupled. The ratio of energy-related CO_2 emissions to gross domestic product (GDP) decreased by about 19% in Germany from 1990 to 1995. This shows that the process of increasing efficiency of energy use and of converting to low-carbon fuels, a process which began in the 1970s, is continuing.

Table 1.4.4 shows emissions of greenhouse gases in Germany, pursuant to the IPCC Summary Tables, for 1990. Table 1.4.5 presents a summary of emissions of greenhouse gases in Germany, including CO_2 equivalents, for 1994.

Tab. 1.4.1: Emissions of directly and indirectly acting greenhouse gases (Gg) in Germany (figures for HFC, CF_4, C_2F_6 and SF_6 in Mg)

	1987	1990	1991	1992	1993*)	1994*)	1995*)	1996*)
Directly acting greenhouse gases:								
CO_2	1 073 924	1014155	975248	926565	918300	904500	894500	910000
CH_4	5750	5682	5250	5194	5013	4849	4788	NA
N_2O	241	226	220	226	218	219	210	NA
HFC	200[3)]	200	200	302	1165	1942	2214	NA
CF_4	370[3)]	355	308	278	260	214	218	NA
C_2F_6	45[3)]	42	38	36	35	31	27	NA
SF_6	160[3)]	163	182	204	226	242	251	NA
CO_2-equivalents[1)]	1278000[2)]	1212477	1162739	1115165	1102313	1085655	1071034	NA
Indirectly acting greenhouse gases:								
NO_X (as NO_2)	3177	2640	2509	2357	2274	2211	NA	NA
NMVOC	3220	3155	2748	2505	2289	2135	NA	NA
CO	11936	10743	9046	7926	7379	6738	NA	NA
Aerosol-forming:								
SO_2	7347	5326	4172	3436	3153	2995	NA	NA

*) tentative data
NA: No data available
1) GWP figures: 2nd IPCC report 1995, 100-year time horizon (cf. Tab. 4.6.7)
2) including estimates for HFC, CF_4, C_2F_6 and SF_6
3) estimates

Tab. 1.4.2: Development of CO_2, CH_4 and N_2O emissions per capita and year in Germany, from 1970 to 1995

Greenhouse gas	1970	1975	1980	1985	1987	1990	1991	1992	1993*)	1994*)	1995*)
CO_2 (t/per cap.)	13,4	13,2	14,2	13,9	13,8	12,8	12,2	11,5	11,3	11,1	10,9
CH_4 (kg/per cap.)	82,3	77,4	78,2	76,2	77,0	71,6	65,6	64,4	61,8	59,5	58,5
N_2O (kg/per cap.)	2,6	2,6	2,9	3,1	3,1	2,8	2,8	2,8	2,7	2,7	2,6

*) tentative data
Source: Federal Environmental Agency (UBA), Statistical Yearbook

Tab. 1.4.3: CO_2 emissions in relation to gross domestic product (GDP) in Germany (in 1991 prices)

Year	CO_2 emissions[1)] (Gg)	GDP (in billions of DM)	CO_2 emissions in relation to GDP (in kg/1,000 DM)
1990	1014000	2787[3)]	364
1991	975000	2854	342
1992	927000	2916	318
1993	918000[2)]	2884	318
1994	905000[2)]	2966	305
1995	895000[2)]	3023	296

1) information pursuant to IPCC guidelines (not including high-seas bunkering and international air traffic)
2) tentative data
3) Source: German Institute for Economic Research (DIW), Policy scenarios for climate protection
Source: Federal Environmental Agency (UBA), Federal Statistical Office

Tab. 1.4.4: Emissions of greenhouse gases pursuant to IPCC Summary Tables – 1990, figures in Gg

Source and Sinks of Greenhouse gases	CO_2 Emissions	CO_2 Storage	CH_4	N_2O	NO_x as NO_2	CO	NMVOC not incl. CFC and halons
Total emissions/storage	**1014155**	**30000[4)]**	**5682**	**226**	**2640**	**10743**	**3155**
1 Energy-related emissions	**986640**		**1768**	**37**	**2606**	**10059**	**1902**
A Combustion-related	**986640**		**205**	**37**	**2606**	**10032**	**1619**
1 Energy and transformation industries	439427		13	15	658	197	11
2 Industry	169741		14	4	277	848	14
3 Transport	158647		66	11	1310	6529	1418
4 Residential, commercal and institutional[1)]	198190		109	6	170	2241	113
5 Other (incl. military)[2)]	20635		3	1	191	217	63
6 Combustion of biomass	NR		NA	NA	NA	NA	NA
B Production, processing and distribution of fuels	**NA**		**1563**	**0**	**0**	**27**	**283**
1 Solid fuels	NR		1230	NR	NR	NR	6
2 Oil and gas	NA		333	0	0	27	277
2 Industrial processes	**27.515**		**0**	**83**	**34**	**684**	**93**
3 Solvent and other product use	NR		**NO**	**6**	**NR**	**NR**	**1160**
4 Agriculture	NR		**2044**	**96**	**NA**	**NA**	**NA**
A Fermentation	NR		1430	NR	NR	NR	NR
B Animal waste	NR		614	11	NR	NR	NR
D Agricultural solis	NR		NR	85	NR	NR	NR
F Combustion of agricultural waste	NR		NA	NA	NA	NA	NA
5 Land-use changes and forestry		**30000[4)]**	NR	NR	NR	NR	NR
A Changes in forests		30000	NR	NR	NR	NR	NR
B Conversion of forest and grassland into farmland	NR		NR	NR	NR	NR	NR
C Set-asides of agricultural land		NE	NR	NR	NR	NR	NR
6 Waste management	**NA**		**1870**	**4**	**NA**	**NA**	**NA**
A Landfills	NR		1777	NR	NR	NR	NR
B Wastewater treatment	NR		93	4	NR	NR	NR
C Waste incineration	NE		NA	NA	NA	NA	NA
International transports[3)]	19569		0	NA	206	96	26

[1)] Not including transports in agriculture and silviculture and not including fisheries
[2)] Including transports in agriculture and silviculture but not including fisheries
[3)] Not included in total emissions
[4)] Rough estimate
NR Not relevant
NA No data available

Tab. 1.4.5: Emissions of greenhouse gases pursuant to IPCC Summary Tables – 1994 *Preliminary figures*

Emissions group		Emissions absolute in Gg	Emissions CO_2-equivalent[1] in Gg	Percent of total emissions in %
1 Energy-related emissions	CO_2	879300	879300	
	CH_4	1289	27069	
	N_2O	42	13020	
Total			**919389**	**84,7**
2 Industy (non-energy)	CO_2	25200	25200	
	CH_4	0	0	
	N_2O	81	25110	
	HFC	1,942	3980	
	SF_6	0,242	5790	
	CF_4	0,214	1386	
	C_2F_6	0,031	280	
Total			**61746**	**5,7**
3 Solvent and other product use	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	6	1860	
Total			**1860**	**0,2**
4 Agriculture	CO_2	NR	NR	
	CH_4	1660	34860	
	N_2O	86	26660	
Total			**61520**	**5,7**
5 Land-use changes and forestry	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	NR	NR	
Total			**NR**	**0,0**
6 Waste management	CO_2	NA	NA	
	CH_4	1900	39900	
	N_2O	4	1240	
Total			**41140**	**3,8**
Total emissions			**1085655**	**100,0**
Of this	CO_2	904500	904500	83,3
	CH_4	4849	101829	9,4
	N_2O	219	67890	6,3
	HFC	1,942	3980	0,4
	SF_6	0,242	5790	0,5
	CF_4	0,213	1386	0,1
	C_2F_6	0,031	280	0,0

[1] Source for greenhouse gas potential: IPCC: The Science of Climate Change, Prepared by Working Group I, Technical Summary for circulation at SBSTA/AGBM, Feb./March 1996

NR Not relevant
NA No data available

1.5 Policies and measures

Since 1990, the Federal Government has been implementing a comprehensive package of measures within the framework of its climate protection strategy. It is doing this with a broad range of tools including regulatory measures, economic instruments and other supporting measures (such as research, education and training, provision of information and advising).

Many of these measures were described in Germany's First National Report pursuant to the Framework Convention on Climate Change. Since that report appeared, the number of measures has grown to over 130. For the period since September 1994, the following measures are worthy of particular mention – in addition to special efforts in behalf of modernisation in the new Federal *Länder* (cf. also Chapter 1.3):

- German industry's declaration on climate protection (updated version from 27 March 1996),
- The German automobile industry's commitment of 1995 to reduce fuel consumption,
- Other incentive programmes in behalf of energy-saving and intensified use of renewable energies and
- The amendment of the Ordinance on Small Firing Installations (1. Ordinance for the Implementation of the Federal Immission Control Act).

The policies and measures relative to CO_2, CH_4, N_2O, NOx, NMVOC, PFC and SF_6 are summarised in short form in Tables 1.5.1 – 1.5.7, arranged by sectors. Table 1.5.8 shows other planned measures and instruments in behalf of climate protection. In order to facilitate comparison, the measures' numbers from Germany's First National Report pursuant to the Framework Convention on Climate Change have been retained, and numbering of additional measures builds on this system. Measures to reduce greenhouse gases controlled by the Montreal Protocol are not included here.

Abbreviations in Tables 1.5.1 through 1.5.8:

Type of measure:

E	economic instrument
R	regulation, law, guideline
V	voluntary agreement
I	information
ET	education and training
D	research and development

Sectors:

Carbon dioxide (CO_2)

C	Cross-sectoral
E	Energy and transformation industries
T	Transport
IE	Industry (energy-related)
IN	Industry (non-energy)
R	Residential, commercial and institutional
F	Fugitive fuel emissions
A	Agriculture
L	Land-use change and forestry

Methane (CH_4)

W	Waste management (including sewage treatment)
A	Agriculture (non-energy)
F	Fugitive fuel emissions
IE	Industry (energy-related)
IN	Industry (non-energy)
L	Land-use change and forestry

Nitrous oxide (N_2O)

IE	Industry (energy-related)
IN	Industry (non-energy)
A	Agriculture (non-energy)
T	Transport
E	Energy and transformation industries
L	Land-use change and forestry

Other greenhouse gases and precursors (NOx), (NMVOC), (PFC), (SF_6)

T	Transport
E	Energy and transformation industries
IE	Industry (energy-related)
IN	Industry (non-energy)
R	Residential, commercial and institutional
L	Land-use change and forestry
S	Solvent and other product use
W	Waste management (including sewage treatment)

Tab. 1.5.1: Short summary of policies and measures: CO_2

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1)] in Gg 2000/ 2005
(53) Model projects entitled “Generation of heat and power from renewable raw materials”	E, D	A	project in progress	
(55) Joint task “Improvement of agricultural structure and coastal protection”	E	A	project in progress	
(56) Bonuses for land set-asides	E	A	project in progress	
(63) Agency for Renewable Raw Materials	E	A	began its work in October 1993	
(120) Concept of the Federal Government for research, development and demonstration projects, from 1996 to 2000, in the area of “renewable raw materials”	E	A	programme in progress	
(121) Guidelines for support of research and development projects in the agricultural sector, aimed at environmental protection (FER-BML)	D	A	programme in progress	
(133) Support of renewable energies in the agricultural sector	E	A	programme in progress	
(2) Support for local and regional energy supply and climate protection concepts	E	C	concluded	
(6, 112) Support for renewable energies	E	C	programme in progress	143/ 143
(7) ERP environmental and energy-saving programme	E	C	programme in progress	
(8) Support for advising of companies	E, I	C	programme in progress	
(9) Support for the Forum für Zukunftsenergien e.V..	E, I	C	active since 1989	
(10) Information on use of renewable energies	I	C	continually updated and new editions published as appropiate	
(11) Information on saving energy and on efficient energy use	I	C	published	
(130) KfW Reconstruction Loan Corporation infrastructure programme	E	C	programme in progress	
(40) Specialised programme on environmental research and technology	E	C	programme in progress	
(47) Research and development concerning use of solar technology	E, D	C	work in progress	
(48) Research and development concerning secondary energy systems integrated with renewable-energy systems	E, D	C	work has begun	
(49) Research and development concerning efficient energy use	E, D	C	programme in progress	

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1] in Gg 2000/ 2005
(118) 4th energy research programme	E, D	C	programme in progress	
(65) Ordinance on packaging	R	C	came into force in 1991	
(69) Improvement of training and continuing training of architects, engineers, technicians and craftsmen	ET, I	C	programme in progress	
(71) Investment programme for reducing environmental pollution	E	C	programme in progress	
(72) Environmental programme of the KfW Reconstruction Bank	E	C	programme in progress	
(73) Environmental programme of Deutsche Ausgleichsbank	E	C	programme in progress	
(74) Environmental protection guarantee programme: liability exemption in connection with loans under the Deutsche Ausgleichbank environmental programme for support of manufacturers of preventive environmental protection technology	E	C	programme in progress	
(75) Federal-*Länder* joint task "Improvement of the regional economic structure"	E	C	programme in progress	
(79) Orientation advising on environmental protection for small and medium-sized companies in the new Federal *Länder*	E, I	C	programme ended on 31 October 1994	
(80) Municipal advising on environmental protection for communities in the new Federal *Länder*	E, I	C	concluded in October 1996	
(81) Community loan programme for the new Federal Länder	E	C	programme terminated in 1992	
(83) Technical information concerning efficient energy use and use of renewable energies	I	C	implemented	
(84) Studies on optimising the CO_2 reduction programme	D	C	ongoing updates	
(86) Research on specific regulatory instruments	D	C	concluded	
(87) System analysis within the IKARUS project	D	C	project in progress	
(88) The "Blauer Engel" German environmental mark	I, E	C	implemented	
(103) Special preference in the building code for use of renewable energies	R	C	came into force on 1 January 1997	
(105) Improvement of the framework for vocational training and further training	ET, R	C		
(109) Planning of the parliament and government district in Berlin with regard to environmental protection requirements, especially climate protection requirements	R	C	project in progress	
(122) Technical information on "In-company energy management"	I	C	concluded	

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1] in Gg 2000/ 2005
(123) Joint-Implementation co-ordination office	R	C	implemented	
(124) Support for third-party financing/ contracting approaches	I	C	concluded	
(125) AIJ research	D	C	project in progress	
(126) AIJ projects	E	C	project in progress	
(127) European environmental mark	I, E	C	implemented	
(129) Aufbau Ost Investment support act (IfG)	E	C		
(110) German industry's declaration on climate protection	V	C	project in progress	18200/ 32500
(134) Guidelines on “Municipal climate protection”	I	C	project in progress	
(116) The Environmental Audit Act	R	C		
(140) Research project on “Policy scenarios for climate protection”	D	C	project in progress	
(142) Report on “Economic assessment of CO_2-reduction strategies”	D	C	concluded	
(3) Act on the Sale of Electricity to the Grid	E	E	in force since 1 January 1991	4863/ 6484
(5) Federal/*Länder* district-heating-modernisation programme for the new Federal *Länder*	E	E	concluded	
(12) 4th Ordinance on the Execution of the Federal Immission Control Act (4. BImSchV)	R	E	in force	
(13) Tax breaks for combined heat and power generation	E, R	E	in force	
(118) Application/implementation of the Federal Immission Control Act in the new Federal Länder (GFAVO, TA Luft)	R	E	in force, implementation in progress	
(41) Research into, and technical refinement of, power-station and firing technologies, especially those for environmentally compatible use of coa	E, D	E, IE		
(42) Research and development concerning gas and steam turbine power stations	E, D	E,IE		
(43) Research and development concerning use of renewable energies	E	E	support continues	23/ 23
(45) Support for testing of wind power systems: “250 MW Wind”	E	E, R	programme in progress	562/ 562
(50) Nuclear energy research/ reactor-safety research	D	E		
(51) Nuclear-fusion research	E, D	E		

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1)] in Gg 2000/ 2005
(54) Geothermal energy	E, D	E, R	programme in progress	35/ 35
(89) Amendment of the Energy Management Act (EnWG)	R	IE	in preparation	
(144) Reduction of subsidies for domestic hard coal	E	E	project in progress	
(59) Conservation of existing forests	R, E, I	L	implemented by the Federal Forest Act of 1975 and by the "Save the Forest" action programme	30 000/ 30 000
(60) Support for new afforestation	E	L	Council Regulation (EEC) 2080/92 has been transposed through the frame-work plan for the joint task "Improve-ment of the agricultural structure and of coastal protection" (GAK) and through *Länder* programmes	600/ 1 000/
(61) Silvicultural measures	E, I	L	Silvicultural directives of the *Län-der;* support for silvicultural measures in the GAK (see above)	
(1) Federal table of charges for electricity	R	R	in force	
(4) Elimination of the excise duty on lamps	E	R	duty eliminated	
(113) Information campaign on "climate protection"	I	R	concluded	
(29) Amendment of the Heat Insulation Ordinance (WSchV)	R	R	in force on 1 January 1995	3 500/ 7 000
(30) Amendment of the Heating Installation Ordinance	R	R, C	in force on 1 June 1994	4 800/ 9 700
(31) Advising concerning efficient energy use in residential buildings – on-site advising	E, I	R	programme in progress	100/ 100
(32) Support area act of 24 June 1991, pursuant to the 1991 Tax Amendment Act and the Act on securing the futures of sites *(Standortsicherungsgesetz)* of 13 September 1993	E	R	programme in progress	
(33) Housing modernisation programme of the KfW Reconstruction Loan Corporation	E	R	programme in progress	6 200/ 6 200
(111) KfW Reconstruction Loan Corporation programme for reducing CO_2 emissions in the buildings in the old Federal Länder	E	R	programme in progress	1 900/ 1 900
(117) "50,000 Roofs" solar initiative of the Deutsche Ausgleichsbank (DtA), from the DtA's environmental programme	E	R	programme in progress	30/ 80
(34) Joint programme "Economic recovery in the new Federal *Länder*" *(Aufschwung Ost)*	E	R	concluded	1 400/ 1 400
(35) Subsidies for construction of public (low-rent) housing	E	R	support continues	300/ 700
(36) Experimental housing construction and urban development *(Experimenteller Wohnungs- und Städtebau – ExWoSt);* the research area "Reducing pollution in urban development"	D	R	programme in progress	

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1] in Gg 2000/ 2005
(37) Act on investment facilitation and on land for housing construction (Investitionserleichterungs- and Wohnbaulandgesetz)	R	R	in force	
(38) Reduction of barriers to investment in housing construction in the territory of the former GDR, for cases in which ownership questions have not been settled	R, E	R	implemented	
(39) Information for building owners, architects, planners, engineers, craftsmen	I	R	continuing, regulary updated	
(44) Programme for promotion of photovoltaic systems	E	R	concluded	3/ 3
(46) “Solarthermie 2000” programme for promoting solar-heating systems	E	R	programme in progress	1/ 2
(77) Advising concerning efficient energy use, provided by the Arbeitsgemeinschaft der Verbraucherverbände (AgV; Consumer associations' working group), on commission to the Federal Ministry of Economics	I	R	programme in progress	
(85) Amendment of the Fee Table for Architects and Engineers (HOAI)	E, R	R	The amendment in in force	
(101) 2nd Ordinance for Amendment of the Ordinance on Small Firing Installations (1. BImSchV – 1st Ordinance for the Implementation of the Federal Immission Control Act)	R	R	The amendment has been in force since 1 November 1996	700/ 1400
(106) Support for provision of information regarding third-party financing	I	R	partly implemented	400/ 1000
(108) Law on labelling with regard to energy consumption	R, I	R	legislative process in progress	
(130) Act on Assistance for Old Debts of 23 June 1993	E	R	implemented	
(115) Subsidies for owners of “low-energy” houses	E	R	in force	400/ 400
(142) The “Solar-optimised construction” programme of the Federal Ministry of Education, Science, Research and Technology (BMBF)	D	R	programme in progress	
(14) Amendment of the mineral-oil tax	E	T	implemented	3500/ 5000
(131) Mineral-oil-tax reduction for gas-powered vehicles	E	T	in force	
(15) Emissions-oriented taxation for heavy utility vehicles	E	T	in force since 1 April 1994	
(92) Emissions-oriented tax for automobiles	E	T	in force as of 1 July 1997	
(16) 1992 Federal Traffic Infrastructure Plan	E	T	approved	

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1] in Gg 2000/ 2005
(17) Increasing use of local public transportation	E	T	ongoing support	3000/ 3400
(19) Research programme on city traffic (FOPS)	D	T	programme in progress	500/ 1000
(20) Improving continuity of traffic flow	D	T	programme in progress	600/ 1200
(21) Information on energy-saving and environmentally compatible driving habits	I	T	programme in progress	
(22) Research projects and information regarding urban traffic planning and cleaner city traffic	D	T	concluded	
(138) The German automobile industry's declaration on a voluntary commitment to reduce fuel consumption	V	T		
(23) Railway structural reform	R	T	in force	
(24) Freight centres	E	T	ongoing support	500/ 1000
(26) Research programme on "Pollution in aviation"	D	T	programme in progress	
(27) Transport research	D	T	programme in progress	
(62) Tax exemption for pure rape methyl ester (RME)	E	T	in force	
(93) Road-use tolls	E	T	in force since 1 January 1995	
(94) CO_2-emissions reductions in new automobiles	E, R	T		3000/ 7000
(95) German Railways' development concept for combined road/rail transports	E	T	currently being implemented	300/ 1000
(96) Use of modern information technology for reducing and regulating traffic (telematics)	D	T	project in progress	
(98) Amendment of the Common Rules of Procedure *(Gemeinsame Geschäftsordnung)* of federal ministries	R	T	in force	
(99) Introduction of traffic-impact assesments *(Verkehrsauswirkungsprüfung)*	R	T	implemented	
(100) Shifting of international transit traffic from roads to railways and waterways	R, I	T	project in progress	100/ 500
(141) Mobility research	D	T	project in progress	

[1] where quantified

Tab. 1.5.2: Short summary of policies and measures : CH_4

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1] in Gg 2000/ 2005
(52) Research into thermal treatment of waste	E, D	W	project in progress	
(66) Technical Instructions on Waste from Human Settlements	R	W	came into force on 1 June 1993	650/ 1300
(67) Technical Instructions on Waste Management, part 1	R	W	came completely into force on 1 April 1991	18/ 18
(68) Closed Substance Cycle and Waste Management Act	R	W	in force	
(57) Improvement of animal digestive efficiency as part of animal husbandry, in order to reduce methane emissions	R, E	A	in force and being implemented	
(143) Use of pit gas hard-coal mining	V	E	project in progress	580/ 730

[1] where quantified

Tab. 1.5.3: Short summary of policies and measures : N_2O

Measure name	Type of Measure	Sector	Implementation status	Expected effekt[1] in Gg 2000/ 2005
(58) Support for extensive methods of agriculture	E	A	project in progress	
(64) Fertiliser Ordinance	R	A	The Ordinance was issued in February 1996 and has been completely in force since 1 July 1996	
(139) Technical measures for adipic acid production	V	IN	project in progress	

[1] where quantified

Tab. 1.5.4: Short summary of policies and measures: NOx

Measure name	Type of Measure	Sector	Implementation status	Expected effect[1] in Gg 2000/ 2005
(118) Application/implementation of the Federal Immission Control Act in the new Federal *Länder* (GFAVO, TA air)	R	E	in force, implementation continues	
(15) Emissions-based motor-vehicle tax (heavy utility vehicles)	E	T	in force since 1 April 1994	
(92) Emissions-based motor-vehicle tax (automobiles)	E	T	in force as of 1 July 1997	

[1] where quantified

Tab. 1.5.5: Short summary of policies and measures: NMVOC

Measure name	Type of Measure	Sector	Implementation status	Expected effekt[1] in Gg 2000/ 2005
(18) Gas-balance System Ordinance	R	T	in force	

[1] where quantified

Tab. 1.5.6: Short summary of policies and measures: PFC

Measure name	Type of Measure	Sector	Implementation status	Expected effekt[1] in Gg 2000/ 2005
(136) Declaration of the German primary aluminium industry	V	IN	project in progress	

[1] where quantified

Tab. 1.5.7: Short summary of policies and measures: SF_6

Measure name	Type of Measure	Sector	Implementation status	Expected effekt[1] in Gg 2000/ 2005
(135) Declaration of manufacturers and users of SF_6 in switching systems and equipment	V	E, IN, IE	project in progress	

[1] where quantified

Tab. 1.5.8: Short summary of other planned measures and instruments for climate protection

Measure name	Type of Measure	Sector	Implementation status	Expected effekt[1] in Gg 2000/ 2005
(114) New amendment of the Heat Insulation Ordinance by the end of the decade	R	R	planned	
(91) Increase in the EU's minimum tax rates for mineral oil	E	T	planned	
(97) Taxation of aircraft fuels	E	T	planned	
(102) Instruments for increasing energy efficiency of existing buildings	E, I	R	planned	
(104) Standardisation of licensing procedures for installations that use renewable energies	R	C	planned	
(107) Introduction of an at least EU-wide CO_2/energy tax that does not affect total revenue or competition	E	C	planned	
(132) Enhancing consideration of renewable energies in the building code	R	C	planned	
(128) New regional planning principle with regard to transport	R	T	planned	

[1] where quantified

Apart from these federal measures, other parties in Germany have initiated climate protection measures of their own. The *Länder* and local authorities figure prominently among these groups.

Länder measures in behalf of climate protection:

Many *Länder* are assuming special responsibility for climate protection. For example, on 31 March 1995 the *Länder* approved a resolution in the Bundesrat that underscored the need for development and implementation of measures to achieve the reduction target established for Germany. Pursuant to the resolution, the *Länder* support the Federal Government's objectives. The different situations in the various *Länder* should be noted in this context. CO_2 emissions differ as a result of differences in population, energy sources used, infrastructure etc. The following figures highlight the significance of the *Länder* in this context: the state *(Land)* of North Rhine-Westphalia (with a population of about 18 million, making it the most populous of all the *Länder*) has annual CO_2 emissions of about 200,000 Gg, or about the same as the annual CO_2 emissions of Spain or The Netherlands. Another example is the state of Berlin (population about 3.5 million), which annually emits about 25,000 Gg CO_2, or roughly half as much CO_2 as Denmark emits in a year. Tab. 1.5.9 provides an overview of the populations and CO_2 emissions of Germany's 16 *Länder* in 1990.

Tab. 1.5.9: Populations and CO_2 emissions of the *Länder* – Germany 1990

	Land area in km^2	Land population in 1 000s	Final energy-consumption (FEC) in TJ	Share of total FEC in western/eastern Germany in %	CO_2 emissions in Mt
Berlin East	403	1 276	60 556	3,9	12
Brandenburg	29 056	2 578	295 009	19,0	58
Mecklenburg West Pomerania	23 559	1 924	151 872	9,8	30
Saxony	18 341	4 764	415 252	26,7	81
Saxony Anhalt	20 607	2 874	393 463	25,3	77
Thuringia	16 251	2 611	238 450	15,3	47
Total for the new Federal *Länder*	**108 217**	**16 027**	**1 554 602**		**305**
Baden-Württemberg	35 751	9 822	751 193	12,5	89
Bavaria	70 554	11 449	957 873	16,0	113
Berlin West	486	2 158	108 754	1,8	13
Bremen	404	682	112 045	1,9	13
Hamburg	755	1 652	144 254	2,4	17
Hesse	21 114	5 763	625 350	10,4	74
Lower Saxony	47 351	7 387	779 593	13,0	92
North Rhine Westphalia	34 070	17 350	1 801 137	30,0	213
Rhineland-Palatinate	19 849	3 764	330 438	5,5	39
Saarland	2 570	1 073	153 064	2,5	18
Schleswig-Holstein	15 731	2 626	241 731	4,0	29
Total for the old Federal *Länder*	**248 635**	**63 726**	**6 005 432**		**709**
Germany	**356 852**	**79 753**	**7 560 034**		**1 014**

The carbon dioxide emissions of the Federal *Länder* were estimated on the basis of each Land's share of the total FEC.
In cases in which results of detailed calculations are available for individual Federal *Länder*, these results are significantly more precise.
Sources: Figures on final energy consumption from the energy summaries of the Federal *Länder* for 1990
CO_2 emissions for the old Federal *Länder* and the new Federal *Länder* from calculations of the Federal Environmental Agency (UBA)
Population and area data from the 1992 Statistical Yearbook

Measures of local authorities in behalf of climate protection:

The local level – cities and communities – holds considerable potential for action to reduce emissions of CO_2 and other greenhouse gases.

The areas in which local authorities contribute to climate protection are as diverse as local authorities' functions. Local authorities have numerous possibilities for direct action, such as saving energy in their buildings, pursuing aims of climate protection in their procurements or choosing vehicles with low fuel consumption for their fleets. In addition, local authorities can contribute substantially to climate protection in their planning and in their tasks in behalf of the public interest. Relevant areas in this context include especially the municipal power supply, local public transportation and energy efficiency in municipal waste treatment and wastewater disposal. In municipal centres for advice on the environment and energy use, for example, local citizens can be inspired to save energy, opt for environmentally compatible types of mobility and reduce waste production. By means of participatory instruments such as round tables or climate protection forums, new local players (associations, various branches of industry and commerce, young people etc.) can be persuaded to become involved in joint activities (cf. Table 5.4.3.1).

After 1990, many cities and local authorities in Germany began to develop and implement municipal climate protection concepts (often on the basis of existing energy supply concepts). To date, far more than 100 such concepts have been prepared.

In March 1996, the association of municipal companies (Verband kommunaler Unternehmen – VKU) issued a voluntary commitment in behalf of climate protection: by the year 2005, it plans to reduce CO_2 emissions by 34 million tonnes. Such a reduction would amount to more than 25 %, based on the level in 1990, the reference year.

In addition, the local authorities are increasingly organising themselves on the international and European levels by joining the relevant institutions.

Due to the major importance of the municipal sector for the implementation of national and international climate protection policy, the Federal Government is supporting a range of activities aimed at reducing CO_2 emissions on the local level.

1.6 Emissions scenarios and projections through 2000, 2005, 2010 and 2020, and assessing the effects of measures

Any prediction depends closely on the trends that have been identified to make it; the picture painted by any given scenario depends on the premises chosen for that scenario. This means: at any given time, several different consistent, non-contradictory descriptions of the future are possible; each depends on the assumptions made regarding the further development of the economic, demographic and political framework, and depending on perceptions of interrelationships relevant to energy consumption.

The results of the selected predictions and scenarios must be assessed in this light. The Federal Government has not adopted any conclusion of these studies as its own position, but it does take these conclusions into account in designing its policy.

The recently published studies "Policy scenarios for climate protection" *(Politik-Szenarien für den Klimaschutz; 1997)* and "Overall economic assessment of CO_2-reduction strategies" *(Gesamtwirtschaftliche Beurteilung von CO_2-Minderungsstrategien; 1996)* have been selected from the range of existing studies. In the project "Policy scenarios for climate protection", carried out by the Jülich Research Centre (FZJ), the German Institute for Economic Research (DIW), the Fraunhofer Institute for System Technology and Innovation Research (FhG-ISI) and the Öko-Institut (Öko), the attempt was made to develop a "without-measures scenario" and a "with-measures scenario" for greenhouse gas emissions, carefully applying the scenario categories of the IPCC Guidelines. The project "Overall economic assessment of CO_2-reduction strategies", carried out by the Rhine-Westphalian Institute for Economic Research (RWI), Essen, and the ifo Institute for Economic Research, Munich, attempted to assess the total economic consequences of a CO_2-reduction policy.

These two studies are complementary in that the first study reaches conclusions regarding trends for all greenhouse gases and precursors in Germany and recommends measures, while the second focuses more strongly than the "policy scenarios" on the overall economic consequences of policy oriented exclusively to reduction of CO_2 emissions.

The studies "Policy scenarios for climate protection"/ "Overall economic assessment of CO_2-reduction strategies" are based on the following premises:

– The "without-measures scenario"/reference scenario assumes that no climate protection policy measures are taken. Efficiency improvements are the main factor that counters increases in CO_2 emissions.

– In the "with-measures scenario"/"IWG-measures scenario", approved measures of climate protection policy/CO_2-reduction measures are taken into account to the greatest possible extent.

Policy scenarios for climate protection (Jülich Research Centre, German Institute for Economic Research (DIW), ISI, ÖKO; 1997)

a) In the **"without-measures scenario",** CO_2 emissions change little between the years 1990 and 2005; in the year 2005, they would be only 30 million t CO_2, or about 3 %, lower than in the reference year (cf. Table 1.6.1).

Tab. 1.6.1: Development of CO_2 emissions in Germany by the year 2005 in the "without-measures scenario" (with increases in energy efficiency)

Sectors	Act. values		Scenario values				
	1990	1995[1]	2000[2]	2005[2]	90/95	95/05	90/05
	CO_2-emissions in mills. of t				Changes in %		
Industry	169,7	126,8	122,5	122,5	-25,3	-3,4	-27,8
Institutional [3]	75,7	51,9	70,5	73,0	-31,5	40,7	-3,6
Residential	128,4	135,2	135,5	138,5	5,3	2,5	7,9
Transport [4]	184,9	196,1	231,0	236,0	6,0	20,4	27,6
Total final energy sectors	558,8	509,9	559,3	570,0	-8,7	11,8	2,0
Power stations	353,6	317,5	331,4	345,5	-10,2	8,8	-2,3
District heating	42,9	31,7	29,7	26,9	-26,0	-15,1	-37,2
Other energy sector[5]	43,0	24,0	21,0	19,0	-44,1	-20,9	-55,8
Total energy sector	439,4	373,2	382,2	391,4	-15,1	4,9	-10,9
Total	998,2	883,1	941,5	961,4	-11,5	8,9	3,7
Also: renewable energies	–	–	7,9	12,8	–	–	–
Total energy-related emissions	998,2	883,1	949,3	974,2	-11,5	10,3	-2,4
Ind. (non-energy) emissions	27,5	25,2	26,1	25,5	-8,4	1,0	-7,5
Total emissions	1025,7	908,3	975,4	999,7	-11,4	10,1	-2,5
Minus internat. air transport[5]	11,6	13,9	15,0	15,9	19,8	14,3	36,9
Emissions wio. internat. air transport	1014,2	894,5	960,4	983,8	-11,8	10,0	-3,0

[1] Prelim, figures calculated using energy summary data.
[2] Mean values, where ranges were listed for the individual sectors.
[3] Including military installations, but not including fuels.
[4] Including international air transports and emissions from mobile facilities in residential, industry and military.
[5] Emissions by analogy to PROGNOS.
Source: UFO plan project "Policy scenarios for climate protection"

No detailed calculations of CO_2 emissions in 2010 and 2020 have been carried out. Assessment of the impact of the considered measures produces the following picture:

Extrapolation of the trends shows that without measures, CO_2 emissions of about 1,025 million t would be expected in the year 2010; about 1,130 million t would be expected in the year 2020.

From a sectoral perspective, it must be emphasised that industry is likely to achieve strong emissions reductions in the period from 1990 to 2005 – as it did in developing district heating. This expectation primarily reflects developments in the first half of the 1990s in the new Federal *Länder*.

On the other hand, large increases in CO_2 emissions are expected in the transport sector; in this scenario, emissions in the year 2005 would be at least 50 million t, or 28%, larger than in 1990. An increasing emissions trend is expected for the residential sector, while emissions in the institutional sector would remain about the same.

b) When the **"with-measures scenario"** is used as a basis, CO_2 emissions – as a result, in particular, of federal climate protection policy measures – are about 147 million t or some 14.5% lower in the year 2005 than in 1990; in comparison with 1995 levels, the reduction by the year 2005 would still be 27 million t or about 3% (cf. Table 1.6.2).

Above-average emissions reductions would occur, throughout the entire period under consideration, mainly in industry and in district heating. In addition, the climate protection policy measures taken in recent years also lead to considerable reductions in the institutional and residential sectors and in power stations. An increase of CO_2 emissions would be expected only in the transport sector, but the increase would be considerable. In this scenario, transport-related CO_2 emissions would be about twice as high as those from all industry by the year 2005.

According to sector-specific trend predictions (as in the with-measures scenario in the supplement to the First National Report of April 1996), CO_2 emissions (Table 6.4.1.1) in a with-measures scenario would decrease slightly overall by 2010 and 2020 (2010: 854,000 Gg, 2020: 847,000 Gg). In sector-specific terms, this would be due to slight emissions increases in the industry and transformation sectors and to slight emissions decreases in the transport, residential and institutional sectors.

The effects of the individual measures on reduction of greenhouse gas emissions were also estimated in the framework of this "with-measures scenario". As part of this analysis, overlapping and synergies were taken into account in order to avoid any double-counting. The summable estimates of the effects of measures are listed in Tables 1.5.1 and 1.5.2 and in Chapter 5 (cf.. Tab. 5.2.1 to 5.2.7).

The "Overall economic assessment of CO_2-reduction strategies" scenario (RWI/ifo-study)

The results of the RWI/Ifo study "Overall economic assessment of CO_2-reduction strategies" (cf. Table 6.3.1.2.2) supplement and support the scenarios described above.

a) In the reference or basis scenario, i.e. the scenario in which no additional targeted measures are taken to reduce CO_2 emissions, CO_2 emissions in the year 2005 are 83 million t lower than in 1990. This result is seen to be caused especially by increases in energy efficiency, decreases in CO_2 emissions in the new Federal *Länder* and contrarian trends in the transport sector. Growth of the gross domestic product is assumed at nearly 2% per year beginning in 1996.

b) In the so-called IWG (IMA) scenario, the measures approved by the Federal Government on the basis of the 2nd CO_2 report of the "CO_2 reduction" Interministerial Working Group (IWG) are evaluated. In addition, the analysis covers the quantifiable measures of the 3rd CO_2 report of 1994 and German industry's 1995/1996 voluntary commitments on CO_2.

In sum, the reference and IMA scenarios show a CO_2 reduction of about 170 million t by the year 2005; this would be equivalent to about 17% of the Federal Government's goal of a 25% reduction in CO_2 emissions (based on the 1990 level). Assuming that the population is the same size as it was in 1992, this would mean a CO_2 reduction of 22%.

Economically, somewhat weaker average growth (on a yearly average), and somewhat slower increases in the workforce, are expected in comparison with the reference scenario.

Tab. 1.6.2: Development of CO_2 emissions in Germany by the year 2005 in the "with-measures scenario"

Sectors	Act. values		Scenario values				
	1990	1995[1]	2000[2]	2005[2]	90/95	95/05	90/05
	CO_2 emissions in Mill. of t				Changes in %		
Industry	169,7	126,8	116,9	107,1	-25,3	-15,5	-36,9
Institutional[3]	75,7	51,9	61,6	56,5	-31,5	8,9	-25,4
Residential	128,4	135,2	115,9	110,5	5,3	-18,2	-13,9
Transport[4]	184,9	196,1	223,0	224,0	6,0	14,3	21,1
Total final energy sectors	558,8	509,9	517,4	498,2	-8,7	-2,3	-10,8
Power stations	353,6	317,5	316,7	318,9	-10,2	0,4	-9,8
District heating	42,9	31,7	30,0	27,5	-26,0	-13,4	-35,9
Other energy sector [5]	43,0	24,0	21,0	19,0	-44,1	-20,9	-55,8
Total energy sector	439,4	373,2	367,8	365,3	-15,1	-2,1	-16,9
Total	998,2	883,1	885,2	863,5	-11,5	-2,2	-13,5
Also: renewable energies	–	–	-2,3	-5,6	–	–	–
Total energy-related emissions	998,2	883,1	882,9	857,9	-11,5	-2,9	-14,1
Ind. (non-energy) emissions	27,5	25,2	26,0	25,3	-8,4	0,4	-8,1
Total emissions	1025,7	908,3	908,9	883,2	-11,4	-2,8	-13,9
Minus internat. air transport[5]	11,6	13,9	15,0	15,9	19,8	14,3	36,9
Emissions wio. internat. air transport	1014,2	894,5	893,9	867,3	-11,8	-3,0	-14,5

1) Prelim, data calculated using energy summary data.
2) Mean values, where ranges have been listed for the individual sectors.
3) Including military installations, but not including fuels.
4) Including international air transports and emissions of mobile units in institutional, industry and military.
5) Emissions by analogy to PROGNOS.
Source: UFO plan project "Policy scenarios for climate protection"

1.7 Expected consequences of climate changes and assessment of sensitivity

In recent years in Germany, research into the impacts of climate change has concentrated on climate-sensitive regions (coastal areas, mountains) and on ecologically and economically sensitive areas (agriculture and silviculture, hydrology of groundwater and inland waters). During their growing periods, natural and agricultural plants need an even distribution of precipitation. Seasonal shifts of precipitation, or unusually intense or long dry periods, could cause significant changes in plant cover in affected regions of Germany. Lacks of precipitation during main vegetation periods could reduce harvests and cause ecological damage in forests and in wetlands.

1.8 Measures for adaptation

In the climate discussion, the term "adaptation" is used to describe adjustment of ecological and socio-economic systems – as a result of processes, measures and structural changes – to current or projected climate changes.

Anthropogenic climate changes would create considerable additional stress on the many ecologically and socio-economic systems that are already under stress due to substance discharges, growing use of resources and non-sustainable management.

In Germany, development of adaptation strategies and measures began in the area of coastal protection. For example, in the framework of the integrated project "Climate change and the coast", climate changes' complex impacts on coastal areas were examined, primarily in case studies, and sensitive sectors were identified. Other federally financed projects in the next two to three years will consider the consequences of expected climate changes for agricultural production, including agricultural structures and the agricultural market in central and western Europe, and for forests and European silviculture. On the basis of these findings, strategies will be developed for preventing possible negative consequences of climate changes – or at least diminishing such consequences.

Global climate change could have considerable, regionally differing consequences on forests. The extent of such impacts cannot yet be sufficiently precisely predicted. The forest species and forest structures/composition that would permit stable and productive forests in the future will be different from those of today. The difficulty is complicated in that tree-species compositions in some current forests must already be considered unsuitable, under today's environmental conditions, for the areas in which the relevant forests are located. Profound changes in ranges of tree species must be expected; in natural forest communities, shifts of species ranges, changes in floral composition and losses of species must be expected, as a result of changes in conditions governing competition.

1.9 Financial support and technology transfer

The Federal Government promotes compliance with the principles set forth by the Rio Declaration, and it orients its bilateral and multilateral development co-operation to the aim of implementing Agenda 21.

The emphasis of climate-oriented development policy measures is on projects that improve economic vitality – through cost reductions resulting from lower consumption of energy and raw materials – and that minimise environmental stresses and, especially, their climate-threatening consequences, by reducing emissions and waste (no-regrets options or win-win measures).

Bilateral co-operation:

In consultations with the governments of developing countries, the Federal Government has developed a broad spectrum of measures that contribute to prevention of climate changes and to adaptation to climate changes. These problem-solving strategies have been developed especially in the sectors of energy, transport, industry, agriculture and silviculture – sectors which, pursuant to Article 4.1 c of the Framework Convention on Climate Change, are of special significance in combating climate changes. In addition, support is being provided, in the framework of development aid, for land-use planning in coastal areas and in regions at the edges of deserts, and for a number of projects aimed at avoidance, recycling and proper disposal of waste.

Multilateral co-operation:

The Global Environment Facility (GEF) is a financing mechanism that supplements existing instruments of bilateral and multilateral development co-operation in a useful way. Assumption of additional costs of measures with global benefits gives parties (countries) to internationally binding conventions for combating global environmental dangers (Montreal Protocol on the Protection of the Ozone Layer, the Framework Convention on Climate Change, the Convention on Biodiversity) a means of effectively fulfilling joint, but differentiated responsibilities. For this reason, the Federal Government is seeking to have the GEF enshrined as a permanent financing mechanism for the aforementioned conventions.

To date, the GEF has effectively supported developing countries in developing local capacities for fulfilling their obligations from the conventions. The first projects in which additional costs are being financed are now being implemented. The Federal Republic of Germany has contributed some 390 million DM (about 242 million US$) of the total commitment of over 2 billion US$ for 1994 to 1997. In the third round of negotiations on replenishing the GEF, the Federal Government is seeking sufficient funding that will permit the GEF to fulfil its tasks.

The Federal Government is also supporting selected developing countries with "Immediate-aid measures for implementation of the Framework Convention on Climate Change".

In 1992, in order to support the CEE countries in building democratic structures and creating market economies, the Federal Government initiated the "Transform" consulting programme, which also provides advice on environmental issues. A number of climate protection projects have been carried out within the Transform programme. In addition, the Federal Government has provided direct support, in the form of investment subsidies, for selected environmental protection projects in central and eastern Europe that will bring about reductions in cross-border environmental pollution.

Programmes for technology transfer

A number of technology transfer programmes in the framework of bilateral co-operation are applicable in this context, especially including

– The establishment [i.e. of company locations] and technology programme of the Kreditanstalt für Wiederaufbau (KfW) Reconstruction Loan Corporation

– The Integrated Advising Service for private industry developing countries and

– The German Appropriate Technology Exchange (GATE) programme of the German Society for Technical Co-operation *(Deutsche Gesellschaft für Technische Zusammenarbeit GmbH [GTZ])*.

Pilot phase for "Activities Implemented Jointly"

The Federal Government is participating intensively in the pilot phase for "Activities Implemented Jointly", which was approved at the First Conference of the Parties in 1995 in Berlin. The German pilot projects are being carried out and financed exclusively by the private sector. They are subject to the five criteria adopted by the 1st Conference of the Parties, as well as to three additional criteria from the German AIJ programme.

1.10 Research and systematic monitoring

In Germany, research on the topics of climate change, global change and sustainability is supported primarily by the Federal Ministry of Education, Science, Research and Technology (BMBF) and the German Research Foundation (DFG). Some research institutions and projects are also funded by other ministries such as the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU; along with the Federal Environmental Agency – UBA), Federal Ministry of Transport (BMV; along with German Weather Service) and others. The Federal *Länder* also support research and research institutions (in part, in co-operation with the Federal Government) that deal with this topic. In 1994, the Federal Government's R&D expenditures for environmental and climate research amounted to 1,030 million DM, of which 435 million DM went to ecological research, 345 million DM went toward support of innovative environmental protection technologies and 249 million DM was earmarked for climate and atmosphere research. The Federal Ministry of Education, Science, Research and Technology is a member in the steering committee of the "International Group of Funding Agencies for Global Change Research" (IGFA). The IGFA is an alliance of national support organisations from 25 countries.

Emphases of climate-relevant research in Germany:

– Climate systems (basic research, atmosphere research, ocean and polar research),

– Climate models and predictions,

– Estimates regarding sensitivity to climate changes and to the consequences of climate changes (ecosystem research, climate-impact research and research on global change),

– Prevention of climate changes and adaptation to climate changes and their consequences (environmental protection technologies, energy research and energy technology, mobility research),

– Systematic monitoring (monitoring systems, earth monitoring, data management, information management).

1.11 Education, training and public awareness

In the first half of the 1990s, the topic of "climate protection" has been a focus of environmental education, reflecting the general public discussion on global climate changes. This discussion was initiated by the publications of the German Parliament's Enquete Commission on "Preventive Measures to Protect the Earth's Atmosphere". In 1989, the former Federal Ministry for Education and Science commissioned a group of experts to submit proposals for measures, based on the Enquete Commission's findings, for all sectors of training and education. These recommendations were published in 1990. They have led to a number of projects in which pedagogical concepts have been developed and tested, especially in the areas of school education and further training.

In addition, the Federal Government and the *Länder* governments, non-governmental organisations, the media, local authorities, consumer associations and advice centres carry out a wide range of activities aimed at providing information and building awareness about climate protection.

2. Introduction

The present report on climate protection in Germany is the Federal Government's second report to the Conference of the Parties pursuant to Article 12 of the Framework Convention on Climate Change. It is based on Germany's first national report pursuant to the Framework Convention on Climate Change, which was submitted in September 1994. The report updates earlier information and presents it in a format that complies with the guidelines for the preparation of national reports adopted by the 2nd Conference of the Parties (Resolution 9\CP.2); in addition, the chapter on projections of greenhouse gas emissions has been considerably expanded, and data is now also included for sulphur hexafluoride (SF_6), perfluorocarbons and hydrofluorocarbons (PFC and HFC) and sulphur dioxide (SO_2).

The term "old Federal *Länder*" refers to the territory of the Federal Republic of Germany until 3 October 1990 (Federal Republic of Germany's former territory including West Berlin); the term "new Federal *Länder*" refers to the territory of the former German Democratic Republic (including the eastern part of Berlin). A new section of the report discusses the causes of emissions trends since reunification on 3 October 1990. Germany's first national report broke down virtually all national data into data for the old Federal *Länder* and data for the new Federal *Länder*; the present report seldom uses this approach. The framework data has been significantly abridged; in particular, much of the data that changed little since Germany's first national report was presented has been omitted from the present report.

2.1 Framework Convention on Climate Change

The Framework Convention on Climate Change was signed in Rio in June 1992. It came into force on 21 March 1994, and it has been ratified by 165 countries to date, including the European Union (status as of March 1997). The 1st Conference of the Parties (CoP) to the Framework Convention on Climate Change took place in Berlin from 28 March to 7 April 1995. The most important result of the Berlin climate conference was the "Berlin Mandate", which establishes a framework for further negotiations regarding greater commitments by industrialised countries to limit and return greenhouse gas emissions. The Berlin Mandate is based on the following consensus reached at the 1st CoP: that the commitment made by the industrialized countries, in the framework of the Convention, to reduce greenhouse gas emissions to 1990 levels by the year 2000 is inadequate in light of the Convention's overall objective; this commitment must be strengthend, if the global greenhouse effect is to be effectively combated and the objective of the Framework Convention on Climate Change achieved. The Berlin Mandate contains two central specifications – the development of policies and measures and the establishment of quantified emission limitation and reduction objectives for greenhouse gases, with respect to certain time horizons such as the years 2005, 2010 and 2020. The 1st CoP established an ad hoc working group on the Berlin Mandate (AGBM) and commissioned this group to prepare a protocol, or another legal instrument, for adoption at the 3rd CoP. The 3rd CoP will take place in Kyoto, Japan from 1 to 12 December 1997.

The primary aim of the 2nd CoP, which took place in Geneva from 8 to 19 July 1996, was to prepare an interim summary regarding implementation of the Berlin Mandate and to give new political impetus to negotiations on the climate protocol. This aim was achieved when a ministerial declaration supported by over 140 Parties (countries) was adopted. The Geneva Declaration contains specific provisions that concretise and move beyond the Berlin Mandate. For example, the Berlin Mandate's two central specifications have been supplemented in that legally binding quantified targets for emissions reductions and significant overall reductions are to be defined, and policies and measures in now-specified areas (energy, transport, industry, agriculture and silviculture, waste management, economic instruments) are now to be established.

The Ministerial Declaration of the 2nd Conference of the Parties reaffirms the obligations of industrial and developing countries pursuant to the Framework Convention on Climate Change, and it notes that many Annex I parties, i.e. industrialized countries, will have to make additional efforts if they are to fulfil existing Convention obligations to return their greenhouse gas emissions to 1990 levels by the year 2000. The Ministerial Declaration also recognises the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) as being the most comprehensive and authoritative scientific assessment to date with regard to the science of climate changes, their consequences and the means currently available to combat climate changes, and it affirms that this status report is to be the basis for further protocol negotiations.

At the 2nd CoP, the Climate Secretariat presented a summary and synthesis of the first national reports of industrial countries, based on a detailed review of these reports.

2.2 The Second Assessment Report of the Intergovernmental Panel on Climate Change (Second IPCC Report)

The Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) was approved in December 1995. This scientific report makes a strong case for the need to act.

The following section describes this report's significant conclusions.

[1]) This means the Federal *Länder* Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia as well as East Berlin. Although "East Berlin" (together with "West Berlin" today's Land Berlin) is not a new Federal Land in the constitutional meaning, eastern Berlin is included with the new Federal *Länder* for the continuation of the emission development records of the former German Democratic Republic.

IPCC Working Group I, which has studied the topic “The Science of Climate Change”, has concluded that the balance of findings to date suggests a discernible human influence on global climate. This conclusion is new and was not contained in the First IPCC report of 1990. Human activities have caused a marked increase of concentrations of greenhouse gases in the atmosphere. The mean global air temperature has increased by 0.3 °–0.6 °Celsius since the end of the 19th century, and the average global sea level has risen by 10–25 cm in the last 100 years. According to the Second IPCC report, model calculations show that if no countermeasures are taken, the mean global air temperature can be expected to rise by about 2 °Celsius (best estimate within a “low” to “high"” range of 1 ° to 3.5 °Celsius), and the average global sea level can be expected to rise by about 50 cm (between 15 and 95 cm) by the year 2100 (the reference year is 1990). The First IPCC report projected a mean temperature increase of 3°C, within a range of 1.5 ° and 4.5 °, and a sea-level rise of 65 cm (between 33 and 110 cm).

The following projections of the Second IPCC report differ from corresponding projections in the First IPCC report (each projection is to the year 2100; the reference year is 1990):

– The most likely figure for the temperature increase is 2°C (the First IPCC report: 3 °C).

– The Second IPCC report gives 1 °C as the “low” estimate for the temperature increase (The First IPCC report used a figure of at least 1.5 °C).

– The “high” figure for the temperature increase is now 3.5 °C (rather than 4.5 °C as in the First IPCC report).

The figures listed in the Second IPCC report are considered significantly more reliable than those in the First IPCC report, even though the Second IPCC report's figures for temperature changes suggest a considerably more mild assessment of the dangers that will present themselves by the end of the next century. Nonetheless, there is no room for complacency, since

– global temperatures will continue to rise after the end of the next century; this will magnify the danger, if no mitigation measures are taken and

– the additional measures for global climate protection that have been approved and are conceivable to date will not suffice to solve global climate problem – even in light of the figures of the second IPCC report.

The primary reasons for the discrepancies between the two IPCC reports are that the scenarios and model calculations described in the second report use lower emissions estimates (especially for CO_2 and CFC); that the second report takes the cooling effects of sulphate aerosols into account; and that a better understanding of the carbon cycle (absorption of CO_2 by the oceans, cloud/water vapour effects, etc.) is now available and has been incorporated into the model calculations. The cooling effect of sulphate aerosols, which originate from both anthropogenic and natural sources (for example, volcano eruptions), could temporarily mitigate the atmospheric warming caused by anthropogenic greenhouse gases emissions.

Little changes have been made in the climate change projections for given changes in radiative forcing. The climate change description is now more realistic, and the reliability of projections has been significantly increased. The calculated temperature increase is now lower than that of earlier calculations. To stabilise atmospheric concentrations of greenhouse gases at a level less than double the pre-industrial level, global greenhouse gas emissions would ultimately have to be reduced to less than 50% of their current level.

IPCC Working Group II (Scientific-technical analysis of impacts, adaptation and mitigation of climate change) has concluded that if no countermeasures are taken, the expected climate changes will have negative impacts on ecological, social and economic systems, including food and water supplies, as well as impacts on human health. In some cases, the impacts could be irreversible. Developing countries and small island countries are likely to be more strongly affected by climate changes. Considerable reductions of net greenhouse gas emissions are technically possible and economically sensible, if a number of political measures are taken in the technology sector that will accelerate the development, spread and transfer of the relevant technology. In addition, most countries have good possibilities to take “no-regret measures” to reduce net greenhouse gas emissions.

Numerous studies have shown that in the next two to three decades, and in many parts of the world, energy efficiency could be increased by 10–30% over current levels, at little or no net costs, by means of energy-saving technology and improved management. The IPCC report also contains information about efficiency improvements that would reduce net emissions.

IPCC Working Group III focused on the topic “Economic and social dimensions of climate changes”. This Working Group has concluded that in the long term climate changes would cause damages to the global economy on the order of several percent of the world's gross domestic product (1% of the world's gross domestic product corresponds to 250 billion US dollars *[Statistisches Jahrbuch des Auslands 1996]*). Working Group III also concludes that some climate protection measures could be carried out more successfully and cost-effectively by a number of countries working together.

The Second Assessment Report of the IPCC (3 volumes) is available through bookstores (Cambridge University Press, 1996). A summary for political decision-makers, which is also a synthesis report, is available in German from “Pro Clima – Forum für Klima und Global Change”, Schweizerische Akademie der Naturwissenschaften, Bärenplatz 2, CH – 3011 Bern.

3. Framework data

The national framework data for this 2nd National Report for Germany has been somewhat simpler to compile than that for the 1st National Report; in the period under review, the framework data for the new Federal *Länder* has become largely comparable with that for the old Federal *Länder*.

Most of the framework data is for the period 1990 to 1995. While the First National Report listed separate figures for the old and new Federal *Länder*, the present report uses separate data only in especially justified exceptional cases.

3.1 The state framework

3.1.1 Environmental protection as a state objective

Since 27 October 1994, protection of the natural basis for life (environmental protection) has been enshrined as a state objective in the Basic Law (constitution) of the Federal Republic of Germany (Article 20 a GG). Consequently, the state is responsible for protecting the natural basis for life, through the state's legislative, executive and judicial organs, within the framework of the constitutional order and in keeping with principles of law and justice. This responsibility is also part of the state's responsibility for future generations.

Tab. 3.1.2.1: Structural data for the Federal *Länder* (states) – comparison for 1990

	Land area in km^2	Land population in 1000s of inhabitants	Final energy consumption (FEC) in TJ	FEC contribution to consumption of old/new Federal *Länder* in %	CO_2-emissions in millions of t
Berlin East	403	1276	60556	3,9	12
Brandenburg	29056	2578	295009	19,0	58
Mecklenburg-West Pomerania	23559	1924	151872	9,8	30
Saxony	18341	4764	415252	26,7	81
Saxony Anhalt	20607	2874	393463	25,3	77
Thuringia	16251	2611	238450	15,3	47
Total New Federal *Länder*	**108217**	**16027**	**1554602**		**305**
Baden-Württemberg	35751	9822	751193	12,5	89
Bavaria	70554	11449	957873	16,0	113
Berlin West	486	2158	108754	1,8	13
Bremen	404	682	112045	1,9	13
Hamburg	755	1.652	144254	2,4	17
Hesse	21114	5763	625350	10,4	74
Lower Saxony	47351	7387	779593	13,0	92
North Rhine-Westphalia	34070	17350	1801137	30,0	213
Rhineland-Palatinate	19849	3764	330438	5,5	39
Saarland	2570	1073	153064	2,5	18
Schleswig-Holstein	15731	2626	241731	4,0	29
Total Old Federal *Länder*	**248635**	**63726**	**6005432**		**709**
Germany	**356852**	**79753**	**7560034**		**1014**

The carbon dioxide emissions of the Federal *Länder* have been estimated on the basis of each *Land's* (state's) contribution to the FEC.
In cases in which results of detailed calculations are available for individual Federal *Länder,* such results are significantly more accurate.

Sources: Final energy consumption data from the energy balances of the Federal *Länder* for 1990
CO_2 emissions for old and new Federal Länder from calculations of the Federal Environmental Agency (UBA)
Population and territorial statistics from the 1992 statistical yearbook

3.1.2 State structure

The Federal Republic of Germany is a federal state. The Basic Law distributes tasks and competencies between the Federal Government and the *Länder*. The *Länder* have the authority to structure their administrations autonomously; the *Länder* differ in their administrative structures. In general, each Land divides itself into Land administrative districts (Regierungsbezirke), rural districts (Landkreise), communities (Gemeinden) and non-district cities (kreisfreie Städte). The communities have the right, within the legal framework, to regulate all their own local affairs under their own responsibility.

Tables 3.1.2.1 and 3.1.2.2 provide an overview of the *Länder* structures and the municipal divisions in Germany.

3.1.3 Legislation

In the Federal Republic of Germany, legislative competencies are divided between the Federal authorities and the *Länder*. The Federal authorities have exclusive jurisdiction, from the Basic Law, for certain areas (for example, foreign affairs, defence and currency). In addition, the Federal Government has the right to issue so-called "competing" legislation that can override the *Länder* in certain areas (for example, waste management, air quality control and noise control) and the right to issue framework legislation for certain areas (for example, nature conservation, landscape management and water resources management). This division of jurisdiction makes the Federal Government largely responsible for environmental legislation. Where the Basic Law gives the Federal authorities no legislative jurisdiction, the *Länder* have such jurisdiction.

On the federal level, bills (proposed legislation) can be introduced by members of the German Bundestag (parliament), by the Bundesrat (*Länder* chamber) or by the Federal Government.

After the Bundesrat (in connection with initiatives of the Government) or the Federal Government (in connection with Bundesrat initiatives) has responded officially, a bill is sent to the Bundestag, within certain deadlines, for deliberation. Bills introduced by parliamentary factions or parliamentary groups are placed directly on the agenda of the German Bundestag's plenary session.

Proposed legislation is treated in the Bundestag in three different "readings" *(Lesungen)*. After a first general discussion concerning the necessity and the aims of the bill, the bill is sent to the responsible committees for specialised discussion. On the basis of the reports of these committees, a second reading then takes place (discussion concerning proposed amendments); in the third reading, the bill is put to a vote.

If the bill is rejected by the Bundestag, it is considered to have failed (although it can be re-introduced later).

If the Bundestag passes the bill, it must then also be passed by the Bundesrat, if it touches on *Länder interests. The* Bundesrat can refer both bills touching on *Länder* interests *(Zustimmungsgesetze)* and bills in which the Bundesrat has the right of opposition *(Einspruchsgesetze)* to a Mediation Committee *(Vermittlungsausschuß)*, which is composed of members of the Bundestag and of the Bundesrat. The Bundestag and the Federal Government can apply to this committee with regard to bills touching on *Länder* interests.

Once a bill has been passed, it is countersigned by the Federal Chancellor and the appropriate Federal Ministers and then sent to the Federal President for approval. Once the Federal President has signed it, the legislation is considered "signed into law". After it has been promulgated in the Federal Law Gazette, the law comes into force at the time specified within the law itself or on the fourteenth day after the day on which the relevant issue of the Federal Law Gazette appeared.

To protect the basic rights and freedoms guaranteed by the Basic Law, the Federal Constitutional Court can review the law, upon application and in the framework of a judicial review or a constitutional complaint, for constitutionality.

The Federal Government or a Federal ministry can be empowered by law to issue ordinances and administrative provisions regulating further details regarding the execution of the law in question, within the framework of the empowerment. In addition, the Federal Government may issue general administrative provisions. Ordinances are subject to the consent of the Bundesrat, if so specified by the basis for the empowerment, or if a law is to be executed by the *Länder*, through representative administration, and no other provision is made in the empowering law. Administrative provisions are always subject to the Bundesrat's consent in cases of representative administration. This is the norm in the environmental sector.

Tab. 3.1.2.2: Germany's administrative divisions

Federal *Länder*	*Land* administrative districts	Districts			Communities
		Total	of these: non-district cities	of these rural districts	
16	32	439	116	323	14627

Source: 1996 Statistical Yearbook

3.1.4 Execution of legal provisions

Federal laws, ordinances and administrative provisions are normally executed by the *Länder* under their own responsibility; this also applies to the environmental sector. Some areas are reserved for federal administration, and in some areas the *Länder* execute federal laws on behalf of the federal authorities (for example, laws concerning safety of nuclear installations and radiation protection); these latter areas are subject to federal supervision.

Länder laws are executed by the *Länder* themselves.

3.2 Population

From 1987 to 1995, Germany's population grew by 4.1 million inhabitants; from 1990 to 1995, it grew by 2.4 million. In the old Federal *Länder,* the population increased, while it decreased in the new Federal *Länder* (cf. Table 3.2.1).

The increase in the old Federal *Länder*, especially that occurring since the end of the 1980s, is due to new arrivals from the new Federal *Länder* and other countries.

Germany's population is expected to continue increasing slightly until the year 2000 and to level off by the year 2005 or 2010; at this point, it is expected to decrease slightly or considerably (by 1 to 4 million, depending on what assumptions are used regarding birth rates and numbers of new arrivals) by the year 2020.

In its age structure, Germany's population is somewhat skewed toward older ages; this is the result of increasing life expectancies and a low birth rate.

Germany's population density varies considerably by region. The country has both densely settled urban and industrial regions, especially in its western parts, with densities of over 1200 inhabitants per km². It also has rural areas, especially in is eastern and northern regions, with less than 100 inhabitants per km².

Tab. 3.2.1: Population development in Germany from 1987 to 1995 (annual average population in millions)

Year	old Federal *Länder*	new Federal *Länder*	Total
1987	61,1	16,6	77,7
1988	61,5	16,7	78,1
1989	62,1	16,6	78,7
1990	63,3	16,1[1)]	79,4
1991	64,1	15,9	80,0
1992	64,9	15,7	80,6
1993	65,5	15,6	81,2
1994	66,0	15,5	81,5
1995	66,3	15,5	81,8

[1)] The population on 3 October 1990 has been used as the annual average
Source: Statistical Yearbook 1996; 1996 memorandums of the Federal Office for Statistics

3.3 Geography/land use

3.3.1 Area and land use

The Federal Republic of Germany has an area of 356,957 km² = 35,696 million hectares.

Table 3.3.1.1 shows land use in 1993. The main trend in land use is that the area used for settlement and transport is continually increasing, while that used for agriculture is decreasing (land consumption).

Tab. 3.3.1.1: Land use in Germany in 1993

Type of use	km²	%
agriculture	195433	54,7
industry	2428	0,7
water	7798	2,2
buildings + open areas	20657	5,8
forest	104326	29,2
recreational areas	2307	0,6
transport infrastructure	16327	4,6
other	7694	2,2
Total	356957	100

Source: 1996 Statistical Yearbook

3.3.2 Agriculture

3.3.2.1 Land use by agriculture

In 1993, Germany's agricultural sector used a total of 195,433 km², of which 118,050 km² was farmland. Organic farming was practised on a small, but increasing portion of the total agricultural area. According to the Working group for organic farming (Arbeitsgemeinschaft für ökologischen Landbau – AGÖL), in 1995 1.09% of all farms (≙ 1.81% of all agricultural land) were organically farmed.

3.3.2.2 Fertilisers and livestock

Fertiliser use (cf. Table 3.3.2.2.1) and livestock (cf. Table 3.3.2.2.2) are the most significant agriculture-sector sources of emissions of the climate-relevant gases CH_4 and N_2O.

Among fertilisers, it is primarily the nitrogen fertilisers which are climate-relevant; they release a small portion of their nitrogen content (on the average, about 1.25%) as the greenhouse gas nitrous oxide (laughing gas – N_2O). In the first half of the 1990s, sales of nitrogen from commercial fertilisers declined considerably from their levels in the second half of the 1980s. On a long-term average, sales decreased by about one-fourth; now, sales seem to have stabilised at the 1994/95 and 1995/96 level. Further optimisation of fertiliser use is expected in the coming years, as a result of the implementation of the Fertiliser Ordinance. On the other hand, medium-term trends in sales of commercial fertilisers are influenced by the economic framework and by agricultural and environmental policy – for example, by the amount of land which is set aside and by the way in which extensification programmes are designed.

Tab. 3.3.2.2.1: Domestic sales of fertilisers in Germany (in 1000 t of nutrients)

Year	nitrogen (N)	phosphate (P_2O_5)	potassium (K_2O)	lime (CaO)
1990/91	1885,3	672,2	1031,7	2407,6
1993/94	1612,2	415,4	644,7	1560,3
1994/95	1787,4	450,7	667,5	1831,6
1995/96	1769,2	399,9	649,0	1886,5

Source: Federal Ministry of Food, Agriculture and Forestry (BML)

Livestock has a twofold impact on emissions of greenhouse gases.

Methane (CH_4) is produced when cellulose fibres are broken down in the stomachs of ruminants, and it is produced through microbial decomposition of animal excrement. Emissions produced by the latter process depend on both the type of animal excrement in question and on the way in which it is stored and spread. Part of the methane produced by the latter process is used to produce energy in biogas systems.

Tab. 3.3.2.2.3: Livestock in 1000s of livestock units (LU)

Year	1990	1992	1994	1995
LU	18084	15400	15156	15063

Source: Federal Ministry of Food, Agriculture and Forestry (BML)

In addition, N_2O can form from animal excrement under certain conditions

Since 1990, numbers of livestock in Germany have decreased by about 17%; this is due especially to the changes in the new Federal *Länder*. Methane emissions from livestock decreased by about 19%. The decrease in numbers of livestock was also due to changes in eating habits, to continuing increases in yields from livestock herds and overall structural development. Of all types of livestock raised for food, only the numbers of poultry are tending to increase (5% increase from 1992 to 1994). Additional shrinking of cattle herds is expected to occur as a result of the BSE issue, but no quantitative predictions can yet be made in this connection.

3.3.3 Silviculture

Seen geobotanically, Germany's forests are located in the temperate zone, and naturally consist primarily of decidu-

Tab. 3.3.2.2.2: Livestock in Germany (in 1000s; numbers counted in December)

Type of animal	1990	1992	1994	1995
calves, younger than 1/2 year old	3012	2841	2477	2470
young cattle, 1/2–1 year old	3701	2991	2861	2771
cattle, 1–2 years old	4731	3791	3670	3652
cattle over 2 years old, female	7827	6791	6804	6848
cattle over 2 years old, male	218	153	150	149
cattle, total	19488	16207	15962	15890
pigs	30819	26514	24698	23737
sheep	3239	2386	2340	2437
horses	491	531	599	599[1)]
poultry	113879	104014	109878	109878[1)]

[1)] Data from previous year, since no census was taken in 1995
Source: Federal Ministry of Food, Agriculture and Forestry (BML)

Tab. 3.3.3.1: Percentages of total forest area for the various tree-species groups in Germany

spruce	pine	other conifers	beech	oak	other deciduous trees
32,5 %	27,7 %	5,9 %	14,0 %	8,6 %	11,3 %

Source: BML: old Federal *Länder:* Federal Forest Inventory 1986–90;
new Federal *Länder:* "Der Wald in the neuen Bundesländern"
("The Wald in the new Federal *Länder*")

ous broad-leaved trees. About 10.7 million hectares of Germany, or about 30 % of the country's total area, are forested. Over the last 10 years, Germany's forest area has increased by 5 000 hectares annually. Further increases of 5 000 hectares per year are expected in the coming decade.

3.4 Climate

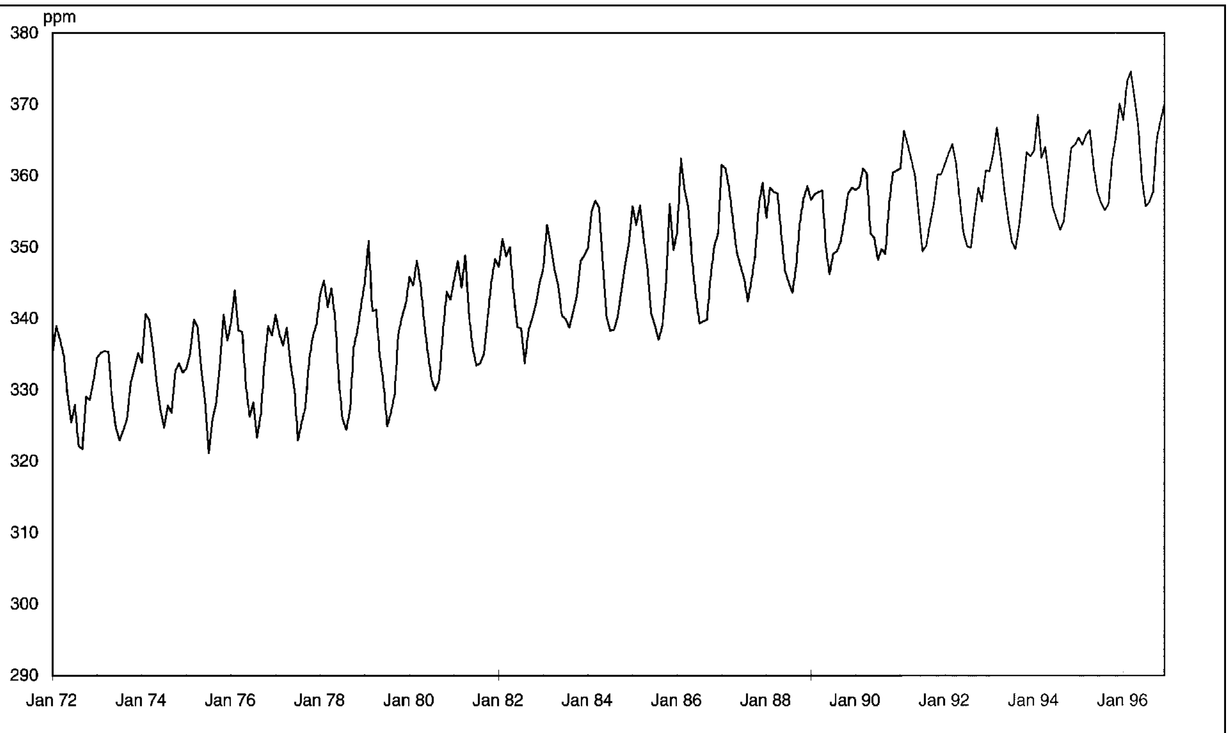
Germany's climate is determined by the country's location in the temperate zone, where the weather changes frequently. The climate is modified by altitude and by distance from the sea, however. The prevailing winds are westerly, and there is precipitation in all seasons.

The north German lowlands have annual rainfall of 500 to 700 mm. The central mountain ranges have 700 to over 1 500 mm, and the Alps have up to over 2 000 mm. On the coast and in the interior lowlands, over 10 mm of rain (per day) falls on 10–20 days. The central mountains receive at least this amount of rainfall on 20 to 30 days, and the high mountains (Zugspitze) receive at least 10 mm on 50 to 70 days.

Between the north-western part of the country and its eastern and south-eastern regions, the climate makes a gradual transition from more oceanic to more continental climate, i. e. the temperature swings between summer and winter and between day and night gradually increase. Germany's temperature averages +9 °C throughout the year. The average temperatures in January, the coldest month of the year, range from +1.5 °C to –1.5°C in the lowlands; in the mountains, depending on altitude, they reach –6.0 °C and lower. The average July temperatures (July is the warmest month of the year) range from +17 °C to +18 °C in the north German lowlands; in the upper Rhine graben (Germany's warmest region) they reach +20 °C. In the lowest areas of the interior, strong winds (over 8 Beaufort) occur on only 1 to 6 days of the year. On the coast and the coastal islands and in the central mountains, they occur on 10 to 20 days of the year; in the Alps, strong winds occur on an average of 50 days.

The "degree day" indicator is widely used by the energy sector to determine heating requirements. Only days with an average temperature below 15 °C count in the degree day total. The degree day number is a sum of daily differences between the average temperature and 15 °C. The

Fig. 3.4.1: CO_2 concentration, Schauinsland measuring station



Source : Federal Environmental Agency

long-term yearly average for Germany is 4000 (for one year). The winter half of the year (October to March) by itself registers a figure of 3000.

For the past 25 years, the Federal Environmental Agency's (UBA's) measurement network has measured trends in concentrations of the greenhouse gas CO_2 at stations in rural areas (cf. Fig. 3.4.1). Since the early 1990s, the Schauinsland measuring station has also measured concentrations of CH_4 and N_2O, which are also climate-relevant gases. In 1995, the annual average concentrations for the three gases were 362 ppm (CO_2), 1865 ppb (CH_4) and ~ 320 ppb (N_2O).

3.5 Economy

3.5.1 Overall economic indexes

The gross domestic product (GDP) is the monetary result of the production process, i.e. the total value of all goods and services produced within a country's geographic boundaries, by both nationals and foreigners, minus the value of the goods consumed as part of the production process.

The gross domestic product is figured as the total gross value added (GVA) of all economic sectors, minus the theoretical cost of relevant banking services, plus non-deductible turnover tax and import duties. The GVA is the net result of production. As a rule, it is calculated as the difference between the gross production values and the advance payments of the various economic sectors. The GDP is the more suitable figure for establishing a relationship to the environmental stresses resulting from economic processes, since it describes the total economic activity of a country's economy (cf. Fig. 3.5.1.1).

The gross national product (GNP) is an indicator of income, while the gross value added is a figure used to characterise the various economic sectors.

Table 3.5.1.1 shows the development of GVA for various aggregated economic sectors in DM, taking into account the relevant exchange rate in US$. The data for 1990 to 1995 is listed in 1991 prices. In 1995, the GVA (unadjusted) for Germany totalled 2941.1 billion DM. This works out to 36,265 DM/per capita. In the new Federal *Länder*, GDP was not determined prior to reunification. For this reason, no federal statistics are available to determine it for 1990.

Tab. 3.5.1.1: Gross value added (GVA) from 1990 to 1995, by sectors, in 1991 prices (in billions)

Sector	1990		1991		1992		1993		1994		1995		%-share for each sector
	DM	US$*	DM	US$*	DM	US$*	DM	US$*	DM	US$*	DM	US$*	in GVA 1995
agriculture and silviculture, fisheries	36,4[1)]	24,4	41,0	27,0	48,1	29,8	45,3	26,2	43,7	28,2	45,3	31,6	1,5 %
Manu-facturing	968,4[1)]	648,2	1077,1	710,5	1065,2	660,0	1004,1	581,7	1037,1	669,7	1046,1	729,6	35,6 %
Trade and transport	355,8[1)]	238,1	415,8	274,3	424,9	263,3	422,2	244,6	425,0	274,4	432,1	301,3	14,7 %
Services	749,2[1)]	501,4	842,6	555,8	889,9	551,4	926,1	536,5	965,5	623,4	1008,3	703,2	34,3 %
State and private budgets	328,5[1)]	219,9	387,2	255,4	395,6	245,1	401,0	232,3	404,4	261,1	409,3	285,4	13,9 %
Total GVA	2438,3[1)]	1632,0	2763,7	1823,0	2823,7	1749,6	2798,7	1621,3	2875,7	1856,8	2941,1	2051,1	100 %
$ exchange rate		0,6693		0,6596		0,6196		0,5793		0,6457		0,6974	

[1)] only old Federal *Länder;* data for the new Federal *Länder* not available
[*)] Dollars in accordance with the relevant exchange rates (please note that exchange rates fluctuate widely)

Source: Federal Statistical Office, Fachserie 18, Reihe 1.1 (1995)

Tab. 3.5.1.2: Development of GDP and of primary energy consumption in Germany

	1990	1991	1992	1993	1994	1995
GDP (in billions of DM)	2787	2854	2916	2884	2966	3023
Primary energy consumption (PJ)	14795	14467	14150	14179	14076	14191

Source: Federal Statistical Office, GDP 1990: German Institute for Economic Research (DIW),
Energy balances working group *(Arbeitsgemeinschaft Energiebilanzen)*

Fig. 3.5.1.1: Development of GDP and of primary energy consumption in Germany

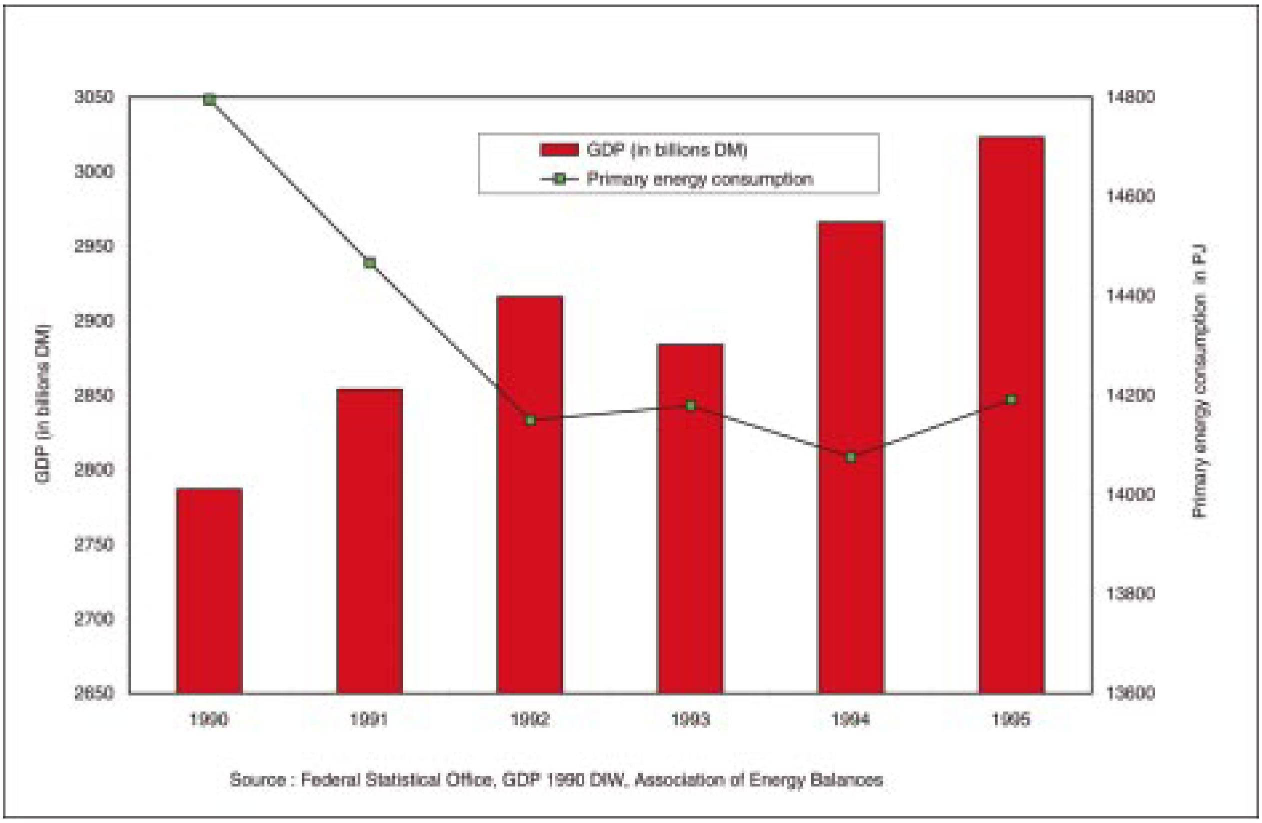
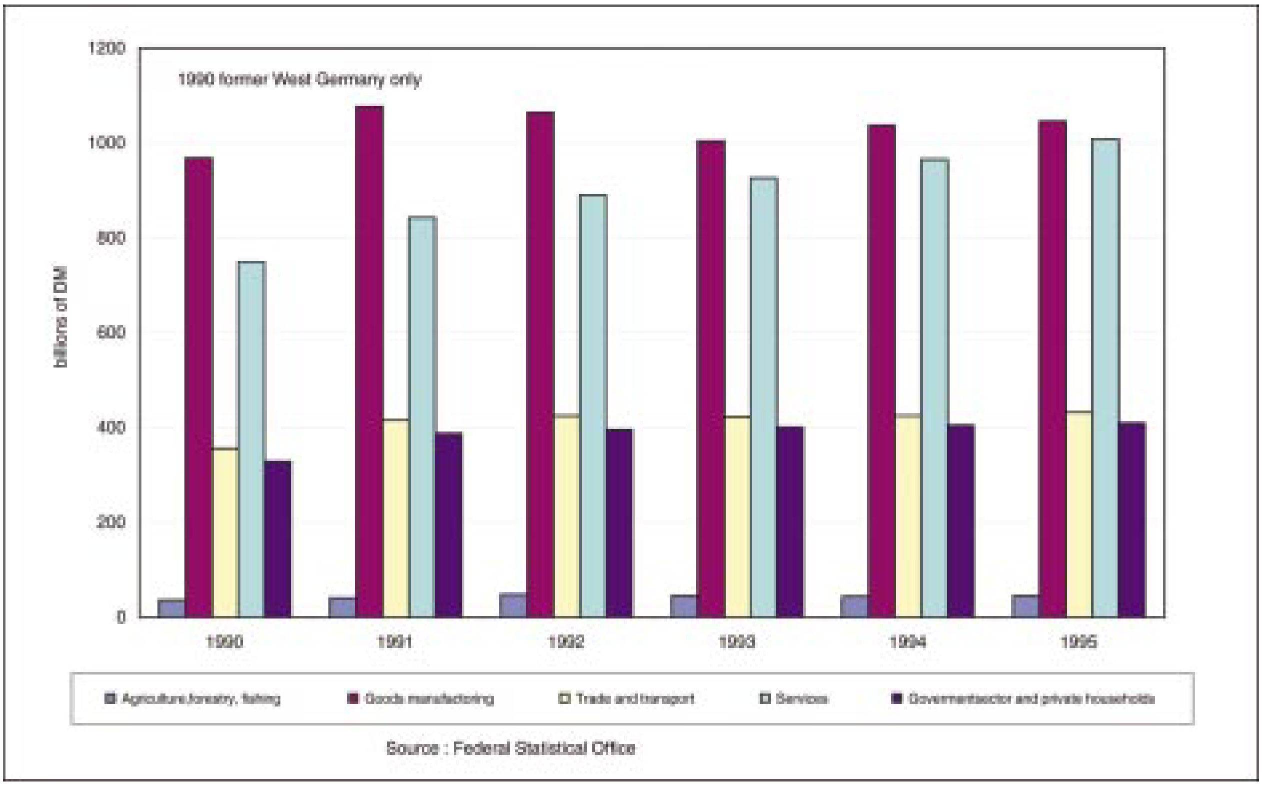


Fig. 3.5.1.2: Gross value added from 1990 to 1995, by sectors, in 1991 prices (in billions of DM)



Germany's average GDP growth from 1991 to 1995 was about 1.5% per year .

3.5.2 Per-capita gross domestic product

Table 3.5.2.1 shows the development of real GDP per capita for Germany from 1990 to 1995. The data for 1991 to 1995 has been taken from the 1996 Statistical Yearbook. Because East and West Germany had different economic systems, it has not been possible to determine a total GDP for Germany in 1990. For this reason, an estimate of the German Institute for Economic Research has been used for that year. Throughout the period under consideration, the per-capita

Tab. 3.5.2.1: Development of real gross domestic product per capita from 1991–1995, in 1991 prices (in DM)

	1990	1991	1992	1993	1994	1995
Germany	35101[1]	35675	36179	35517	36393	36956

[1] Calculation from a research project of the German Institute for Economic Research (DIW): "Policy scenarios for climate protection"
Source: Federal Statistical Office

GDP increased by about 5%. In 1993, it hardly changed, and in 1994 and 1995 it increased sharply.

3.5.3 Employment by economic sectors

Table 3.5.3.1 shows the development of employment in Germany from 1990 to 1995, in the various economic sectors. It also shows the development of each sector's percentage share of total employment. The services sector was the only one to register a clear increase in numbers of employees; the numbers of people employed in other areas tended to decrease more (agriculture and silviculture, fisheries) or less (manufacturing, trade and transport) strongly. Overall, the number of people employed decreased from 1990 to 1995. Similar trends were also experienced by many other OECD countries.

3.6 Energy

3.6.1 Domestic fossil fuels

Germany's primary energy consumption, 27% of which is met by coal, about 40% by oil and about 20% by natural

Tab. 3.5.3.1: Employment by economic sectors in Germany, from 1990–1995 (in 1000s)

	1990	1991	1992	1993	1994	1995	%-share of employees in each sector in 1995
Agriculture and silviculture, fisheries	1776	1424	1212	1113	1063	1024	2,9
Manu-facturing	15253	14437	13588	12936	12545	12404	35,6
Trade and transport	6718	6788	6801	6730	6643	6537	18,7
Services	5978	6524	6852	7083	7328	7545	21,6
State and pivate budgets	7574	7337	7389	7351	7378	7367	21,1
Total employees	37299	36510	35842	35213	34957	34877	100

Source: Federal Statistical Office, Fachserie 18, Reihe 1.1 (1995); German Institute for Economic Research (DIW)

Tab. 3.6.1.1: Proven recoverable reserves an fossil fuels

		Coal proven recoverable reserves[1] billion t HCU	Coal %[3]	Coal continuity of supply[2] years	Oil proven recoverable reserves[1] million t	Oil %[3]	Oil continuity of supply[2] years	Natural gas proven recoverable reserves[1] billion m^3	Natural gas %[3]	Natural gas continuity of supply[2] years
Germany	1990	38	5,6	230	62,8	0,03	15	347,2	0,19	15
	1995	35	6,0	321	53	0,04	18	325	0,21	18
World	1990	677	100	223	135915	100	43	119288	100	64
	1995	586	100	190	146000	100	45	148000	100	67

[1] Recoverable within the current technical and economic framework
[2] Proven recoverable reserves divided by current production per year
[3] Percentage share of world reserves
Source: Federal Agency for Geosciences and Raw Materials *(Bundesanstalt für Geowissenschaften und Rohstoffe)*

Tab. 3.6.1.2: Production of fossil fuels in Germany

		Coal		Oil		Natural gas	
		million t HCU	%[2)]	million t	%[2)]	billion m³	%[2)]
Germany	1990	165,1	5,2	4,0	0,1	22,8	1,1
	1995	109,3[1)]	3,5	3,1	0,1	21,4	1,0
World	1990	3152	100	3005	100	2064,0	100
	1995	3107[1)]	100	3261	100	2224,3	100

1) Coal production in 1994
2) Percentage share of world reserves
Source: Federal Agency for Geosciences and Raw Materials

gas, is strongly dependent on fossil fuels. Germany's own reserves of fossil fuels are very small, however. Only 6% of the world's coal reserves, and considerably less than 1% of its oil and gas reserves, are located on German territory.

Proven recoverable reserves are known reserves that can be developed within the current technical and economic framework. The continuity of supply is based on current annual production.

Production of fossil fuels decreased considerably in Germany between 1990 and 1995. This is especially true of coal, production of which was reduced by about 40% between 1990 and 1995.

3.6.2 Provision of primary and final energy

Provision of primary energy is shown in the balance in Table 3.6.2.1; it corresponds to primary energy consumption. Germany's primary energy consumption, i.e. in both the old and the new Federal *Länder*, has been decreasing since 1987; nonetheless, in 1995 it was still about 10% higher than in 1970. In addition, consumption trends in the old Federal *Länder* differ considerably from those in the new Federal *Länder*.

In the old Federal *Länder*, primary energy consumption remained nearly constant from 1980 to 1990. Following an increase of about 4% between 1990 and 1991, primary energy consumption has stayed virtually the same, at the new level.

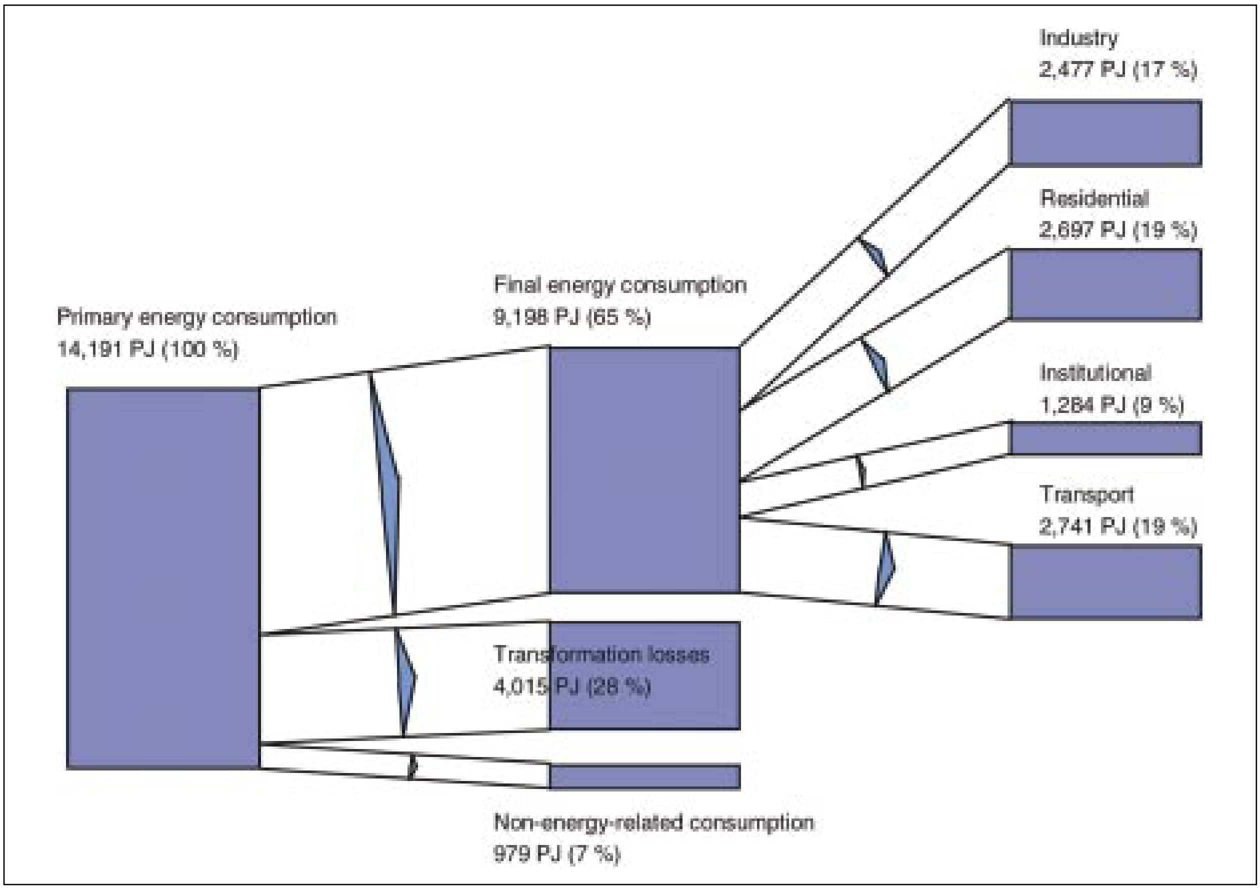
In the new Federal *Länder*, primary energy consumption increased until 1987, when a slight decrease began that continued until 1990, when consumption decreased sharply. The rate of decrease has slowed considerably since 1992. Overall, primary energy consumption in the new Federal *Länder* in 1995 was only slightly over half of its peak of 1987.

Tab. 3.6.2.1: Primary energy balance in Germany, 1970 to 1995, in PJ

	1970	1975	1980	1985	1987	1990	1991	1992	1993	1994[1)]	1995[1)]
Domestic extraction	7507	7100	7291	7488	7153	6319	5444	5115	4712	4464	4420
Import	7038	8111	9509	9075	9469	9682	10186	10398	10492		
Consumption of stores	78	167	95	226	106	295	243	76	205		
Export	1375	1192	1440	1432	1155	1324	1231	1092	1099		
Bunkering	174	142	142	147	147	105	89	75	93		
Replenishment of stores	154	560	311	174	129	72	86	273	38		
Primary energy cons.	12920	13484	15002	15036	15297	14795	14467	14150	14179	14076	14191

1) Tentative figures, AG Energiebilanzen (12.6.1996)
Source: Arbeitsgemeinschaft Energiebilanzen

Fig. 3.6.2.1: Primary energy consumption in Germany in 1995, with a breakdown

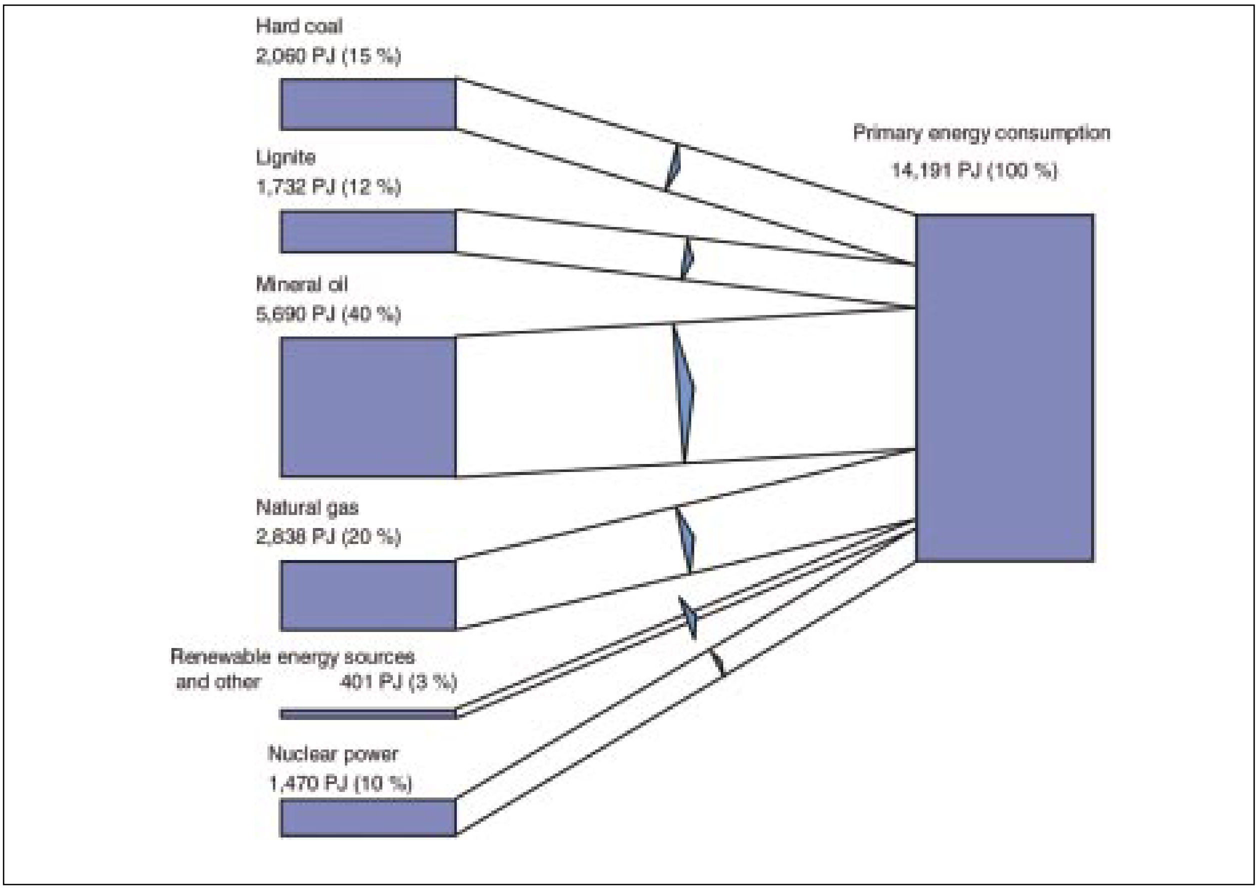


Primary energy consumption in Germany is shown in Table 3.6.2.2. The total consists of final energy consumption (about 65% in 1995) in the various consumption sectors, the transformation losses (about 28% in 1995) and a small percentage for non-energy-related consumption (about 7% in 1995).

From 1970 to 1995, trends differed in the various final consumption sectors in the old Federal *Länder*. Whereas energy consumption by road traffic nearly doubled, total industrial energy consumption decreased (about 18%). Residential energy consumption increased by about 26% between 1970 and 1995, while "institutional" energy consumption, i.e. services, retail and commercial, decreased by about 6%. In spite of efficiency increases in power stations and district heating stations, considerably increased total power consumption in the final consumption sectors increased absolute transformation losses in power stations and district heating stations until 1991. From this year until 1995, transformation losses in power stations and district heating stations decreased slightly. In other transformation sectors (for example, coking plants, refineries, briquetting plants), transformation losses decreased – especially those in the coal-tar industry and mineral-oil sector.

The trends in final consumption sectors in the new Federal *Länder* differ from those of the old Federal *Länder*. Whereas energy consumption in the road transports sector also nearly doubled between 1970 and 1990, industrial consumption increased by 9% until the mid-1980s. In 1990, primary energy consumption in the new Federal *Länder* began to decrease sharply – partly as a result of restructuring; by 1995, it had reached a level of 70% of consumption in 1970. In the residential sector, energy consumption also increased until the mid-1980s, by about 40%, but then it remained nearly the same until 1990. As in the industry sector, a sharp decrease began in the residential sector in 1991; consumption in 1995 was about 20% less than in 1990. Institutional consumption increased continually from 1970 to 1987, by a total of about 55%. The institutional sector then experienced a decrease in consumption similar to that seen in the industrial and residential sectors; by 1995, energy consumption in the institutional sector was 53% less than it was in 1990.

Fig. 3.6.2.2: Primary energy consumption in Germany, by fuels, in 1995



Most of Germany's 1995 primary energy requirements of 14,191 PJ were met by mineral oils (40 %). The shares for other fuels were roughly similar to each other;: natural gases met about 20 %, hard coal met about 15 %, and lignite met about 12 % of Germany’s primary energy requirements. Nuclear power covered about 10 % of the country's primary energy requirements. Renewable energies, especially hydropower, wind power, biomass, waste, sewage sludge etc., covered about 3 % of requirements.

In the old Federal *Länder*, use of nuclear power, natural gases and other energy sources increased considerably from 1970 to 1992. Consumption of mineral oils and lignite increased until 1980 and then decreased in the following decade. In 1991, mineral oil consumption increased considerably. The new, higher level of consumption continued until 1995, but it was still lower in that year than in the 1970s. Consumption of hard coal decreased considerably until the mid-1970s, to a level at which it has largely remained until the present.

In the new Federal *Länder*, lignite was the dominant fuel throughout the entire period under consideration. Until 1990, it covered about 70 % of primary energy requirements in that area. Since German unification, the balance has shifted somewhat in favour of mineral oils and natural gases. In 1995, lignite met a total of about 38 % of primary energy requirements in the new Federal *Länder*.

From 1970 to 1980, use of mineral oil increased. As a result of the oil-price crisis, and of economic policy and energy-policy measures taken in response to that crisis, mineral oil consumption developed similarly to other primary energy consumption: following an increase in the 1980s, it has now fallen below the level in 1970.

In the new Federal *Länder*, as in the old *Länder*, natural gas use has increased more since 1970 than use of any other primary energy source: from less than 1 % of total primary energy requirements in 1970 to 22 % in 1995. Hard coal met about 10 % of primary energy requirements in 1970; in 1995, the corresponding figure had decreased to about 3 %.

Overall, primary energy consumption in the new Federal *Länder* has decreased continually since 1987, and the decrease has been very sharp since 1990. Consumption in 1995 was about two-thirds that in 1970.

Tab. 3.6.2.2: Energy consumption balance for Germany (PJ)
Energy consumption balance for Germany for the period 1970 to 1996

	1970	1975	1980	1985	1987	1990	1991	1992	1993	1994[12]	1995[12]	1996[13]
Final consumption sectors:												
Industry [1]	3599	3527	3609	3312	3200	2977	2694	2560	2432	2468	2477	
Residential	2179	2186	2496	2642	2728	2382	2506	2394	2615	2531	2697	
Institutional [2]	1526	1669	1803	1862	1917	1703	1688	1457	1390	1329	1284	
Road transports [3]	1063	1317	1614	1657	1828	2067	2117	2198	2259			
Other transports	308	276	277	267	274	312	311	465	479	2700[10]	2741[10]	
non-energy consumption[4]	834	859	963	888	864	958	890	911	887	964	979	
Transformation:												
Power stations, distr. heating									4083[11]	4015[11]		
– transformation input [5]	3772	4451	5362	5919	6039	6002	5961	5937	5857			
– transformation output	1337	1671	2044	2327	2394	2428	2372	2339	2300			
other transformation [6]												
– transformation input	10152	8988	9325	8416	9972	7715	6816	6715	6694			
– transformation output	9177	8147	8366	7600	7131	6893	6144	6150	6133			
Primary energy consumption	12920	13484	15002	15036	15297	14795	14467	14150	14179	14076	14191	14505
Primary fuels:												
Hard coal	3142	2191	2497	2511	2420	2306	2330	2196	2139	2140	2060	2037
Lignite	3190	3178	3390	3687	3567	3201	2507	2176	1938	1864	1732	1685
Mineral oil	5653	5927	6059	5115	5297	5238	5547	5628	5746	5697	5690	5788
Natural gas [7]	563	1657	2190	2086	2287	2316	2433	2391	2532	2592	2838	3344
Renewable energies and other [8] [9]	305	293	303	285	364	288	263	262	341	358	401	123
Nuclear Power	67	240	563	1354	1363	1446	1387	1496	1439	1424	1470	1527

[1] Other mining and processing sectors
[2] Including military agencies but not their fuel consumption
[3] Including fuels from institutional and military
[4] For example, fuels as used raw materials in the chemical industry
[5] Including own consumption, line losses and statistical differences
[6] For example, refineries, colding plants, briquetting plants
[7] Natural gases, oil, pit gas sewage gas
[8] Hydropower, including foreign trade balance for electricity
[9] Firewood and waste wood, peat, waste, sewage sludge, other gases and waste heat for electricity and district heat
[10] Road transports and other transports
[11] Total transformation losses
[12] Tentative figures, AG Energiebilanzen (12.6.1996)
[13] First tentative estimate, DIW (13.2.1997)

Source: Energy balances working group (Arbeitsgemeinschaft Energiebilanzen), German Institute for Economic Research (DIW)/IFE, the federal Environmental Agency

3.6.3 Final energy consumption

Table 3.6.3.1 contains a balance of final energy consumption, with a breakdown of final energy consumption by energy services. The balance helps to identify potential for saving energy. Energy services can be described in terms of useable energy requirements. Useable energy is energy in a form in which it becomes available to the consumer, following its final energy transformation, to provide energy services, such as light, heat and mechanical energy.

The following breakdown, which considers the case of old Federal *Länder*, shows that about three-quarters of final energy consumption in the residential sector is used for heating. In the institutional sector, about half of final energy consumption is used to provide heat, while industry uses

Tab. 3.6.3.1: Energy consumption by sectors, and efficiency of energy use
Final energy consumption by sectors and energy use efficiently, old Federal *Länder*

	1987				1992			
	Final energy		Usable energy		Final energy		Usable energy	
	PJ	%	PJ	Efficiency	PJ	%	PJ	Efficiency
Transport total	**1869**	**100 %**	**339**	**18,1 %**	**2194**	**100 %**	**396**	**18,0 %**
– heat	4	0,2 %	3	65,0 %	2	0,1 %	1	70,0 %
– mechanical engery	1865	99,8 %	336	18,0 %	2189	99,8 %	394	18,0 %
– lights	*)		*)		3	0,1 %	0	7,5 %
Residential total	**2161**	**100 %**	**1310**	**60,6 %**	**2069**	**100 %**	**1357**	**65,6 %**
– process heat	322	14,9 %	129	40,0 %	340	16,4 %	160	47,0 %
– indoor heat	1692	78,3 %	1134	67,0 %	1568	75,8 %	1145	73,0 %
– mechanical energy	147	6,8 %	47	32,0 %	126	6,1 %	50	40,0 %
– lights	*)		*)		35	1,7 %	2	6,0 %
Institutional total	**1295**	**100 %**	**660**	**50,9 %**	**1276**	**100 %**	**754**	**59,1 %**
– process heat	290	22,4 %	102	35,0 %	299	23,4 %	132	44,0 %
– indoor heat	683	52,7 %	458	67,0 %	636	49,8 %	458	72,0 %
– mechanical energy	322	24,9 %	100	31,0 %	264	20,7 %	158	60,0 %
– lights	*)		*)		77	6,0 %	6	7,5 %
Industry total	**2199**	**100 %**	**1227**	**55,8 %**	**2212**	**100 %**	**1323**	**59,8 %**
– process heat	1526	69,4 %	870	57,0 %	1.521	68,8 %	882	58,0 %
– indoor heat	251	11,4 %	163	65,0 %	217	9,8 %	152	70,0 %
– mechanical energy	422	19,2 %	194	46,0 %	439	19,8 %	285	65,0 %
– lights	*)		*)		35	1,6 %	4	10,0 %
All sectors total	**7524**	**100 %**	**3535**	**47,0 %**	**7751**	**100 %**	**3829**	**49,4 %**
– process heat	2138	28,4 %	1100	51,5 %	2160	27,9 %	1174	54,3 %
– indoor heat	2630	35,0 %	1757	66,8 %	2423	31,3 %	1756	72,5 %
– mechanical energy	2756	36,6 %	678	24,6 %	3018	38,9 %	888	29,4 %
– lights	*)		*)		150	1,9 %	12	7,7 %

*) Included in the figures for mechanical energy
Sources: Arbeitsgemeinschaft Energiebilanzen, RWE-Anwendungstechnik

about 70% of its final energy to generate process heat. In the transport sector, almost 100% of consumed final energy is converted into mechanical energy.

A standard measure of energy use needed to meet useable energy requirements is final energy consumption per unit of useable energy requirements. This figure is used to describe efficiency of energy transformation in heating systems, household appliances, machines, heat generators and various modes of transportation. The comparison between 1987 and 1992 shows, for example, that indoor heating systems became considerably more efficient during that period. This was achieved through replacements of obsolete, inefficient and oversized heating systems with modern heating boilers. The efficiency of modern oil-fired and gas-fired heating boilers is now over 90%.

The efficiency achieved to date gives an indication of where further enhancements of energy efficiency – along with further emissions reductions – can be achieved (for example, use of insulation in the building sector). Such considerations must also take account of the economic framework, however.

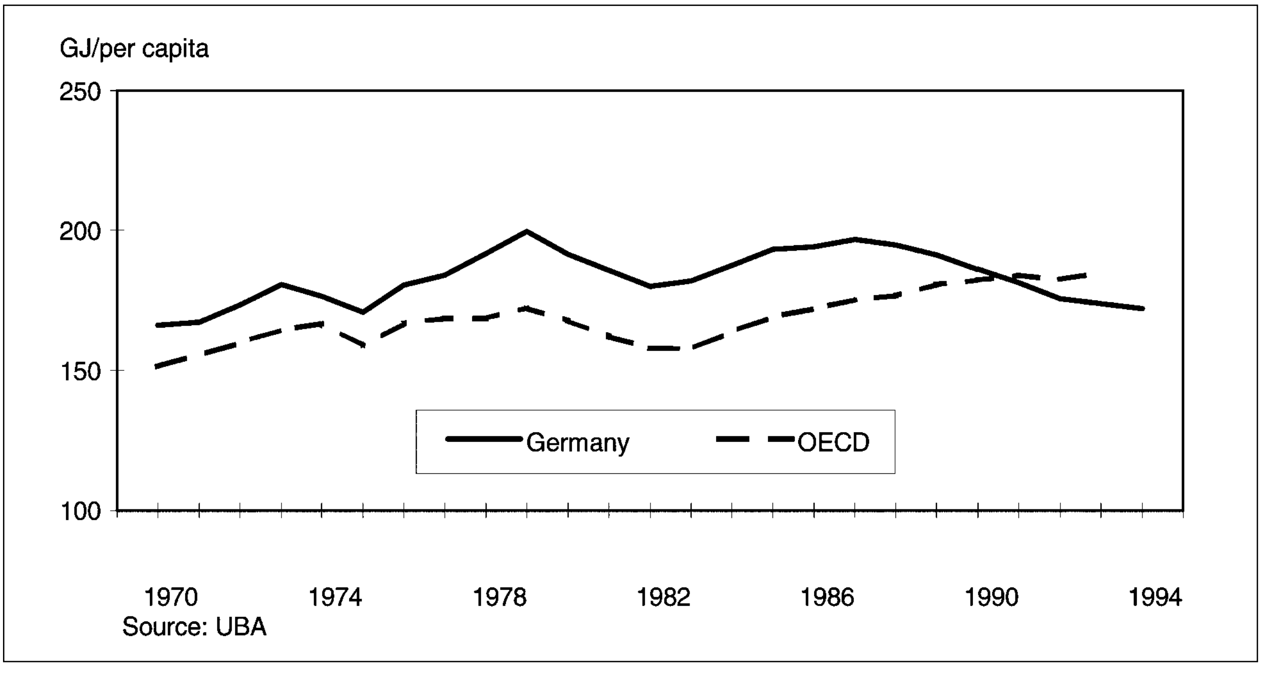
Less than half of total final energy consumed in the old Federal *Länder* was actually used; i.e. over half was lost to the environment as waste heat.

Efficiency increases in energy use not only reduce transformation losses between final energy and useable energy; they also reduce the pollution produced in upstream links in the energy provision chain – energy production, fuel transports, transformation into secondary forms of energy (for example, electricity).

3.6.4 Specific consumption indexes, per-capita energy consumption, energy prices

In 1979 and 1987, per-capita energy consumption in Germany reached its highest levels to date: nearly 200 GJ/per capita. By the mid 1980s, Germany's per-capita energy consumption was about 10% higher than the average per-capita energy consumption in the OECD. Whereas the trends in Germany and in the OECD, until the mid-1980s, were nearly the same, in 1988 per-capita energy consumption began decreasing in Germany and increasing in the OECD. Since 1991, Germany's per-capita energy consumption has been lower than the mean per-capita energy consumption in the OECD. The main cause of the downward trend has been decreasing energy consumption in the new Federal *Länder* – slightly decreasing in the late 1980s, and strongly decreasing as of 1990. In 1994, per-capita energy consumption in Germany again reached the level it had in the early 1970s. The downward trend has slowed considerably, however.

Fig. 3.6.4.1: Per-capita energy consumption from 1970 to 1994 (comparison Germany/OECD)



Tab. 3.6.4.1: Development of energy prices and different price indexes (old Federal *Länder;* all Germany beginning in 1993)

	Units	1973	1979	1980	1987	1988	1989	1990	1991	1992	1993	1994	1995*)
Crude oil [1]	$/b	2,81	29,19	36,01	18,34	14,89	18,19	23,67	19,98	19,62	17,00	15,87	17,04
Import prices:													
– crude oil	DM/t	82,20	278,47	455,61	250,66	205,87	257,01	278,60	252,70	226,38	209,00	193,46	186,03
– natural gas	Pf/kWh	0,44	1,36	2,01	1,45	1,41	1,32	1,49	1,71	1,39	1,13	1,39	1,32
– hard coal	DM/t	54,77	91,90	99,59	88,55	81,73	96,19	95,37	88,72	83,25	71,86	74,05	79,46
consumer prices: (incl. VAT)													
– light heating oil	DM/100l	22,60	54,79	62,01	37,70	32,40	43,60	48,80	51,60	47,60	48,4	45,10	42,90
– natural gas[2]	Pf/kWh	2,93	4,35	5,24	4,96	4,81	5,04	5,33	5,30	5,35	5,26	5,30	5,11
– broken coke	DM/50kg	13,44	22,80	25,87	31,20	30,80	30,50	30,50	30,95	31,40	32,25	32,60	32,95
– electricity[3]	Pf/kWh	11,70	14,69	15,46	20,84	21,29	21,40	21,45	21,33	22,29	22,88	23,49	23,70
Industry (not including VAT)													
– hard coal[4]	DM/t	93,00	174,17	199,33	262,00	266,02	270,78	274,10	276,40	291,08	293,25	295,00	295,00
– heavy heating oil[5]	DM/t	104,12	264,12	355,07	237,05	184,94	235,61	235,72	224,34	202,05	205,41	201,06	206,07
– natural gas[2]	Pf/kWh	0,79	1,91	2,45	2,37	2,14	2,33	2,79	2,80	2,64	2,50	2,50	2,49
– electricity[6]	Pf/kWh	7,54	10,15	11,07	15,24	15,12	15,07	14,06	14,25	15,00	15,45	15,13	14,96
Transport:													
– regular petrol[7]	Pf/l	69,0	98,4	116,5	95,6	92,2	109,9	113,9	127,5	134,3	134,8	151,1	150,2
– diesel fuel[8]	Pf/l	70,0	99,1	116,0	91,4	88,6	95,3	102,0	107,1	106,0	108,6	114,5	113,0
Price indexes													
– gross national product	1991=100	52,8	69,5	72,9	89,7	91,1	93,3	96,2	100,0	104,4	107,8	112,0	114,4
– cost of living	1985=100	59,9	78,5	82,8	100,1	101,4	104,2	107,0	110,7	115,1	119,9	112,8	114,8
– import	1991=100	57,4	84,0	96,9	96,0	97,1	101,5	99,2	100,0	97,6	96,1	96,9	97,3

[*]) tentative figures
[+]) old Federal *Länder*
Note: beginning in 1993, includes new Federal *Länder*
[1] b = barrel = about 159 l; until 1983 Arabian Light; as of 1984, Brent; since July 1987 Brent dated
[2] Average sales, converted from Pf/cbm to Pf/kWh using a factor of 9.7692 (not including VAT)
[3] Average sales, tariffed consumers (residential), not including compensatory taxes and VAT
[4] Fine coal (rich coal), Ruhr mining district
[5] Average price for purchase of 2001 t or more per month; beginning in 1993. for purchase of 15 t or more per month, and with sulphur content no greater than 1%
[6] Average sales, special customers, without compensatory taxes and VAT
[7] As of 1986, unleaded regular petrol, name brands with self-service
[8] Name brands with self-service
Source: Federal Statistical Office

3.6.5 Electricity generation

Table 3.6.5.2 provides an overview of production and use of electrical power in Germany. Table 3.6.5.3 shows total power generation in Germany, divided by input fuels. The 1995 breakdown for total power production in Germany was as follows:

Tab. 3.6.5.1: Energy sources used for Germany's total electric power production in 1995, by percentage contribution

coal:	55,0%
– hard coal:	27,4%
– lignite:	27,6%
nuclear power:	29,1%
natural gas:	7,0%
renewable energies and other fuels:	7,5%
heating oil:	1,4%
Total	100,0%

Tab. 3.6.5.2: Production and use of electricity in Germany from 1973 to 1995, in TWh

Old Federal *Länder;* as of 1991: Germany – in TWh –										
	1973	1980	1988	1989	1990	1991	1992	1993	1994	1995*)
Production										
Public power stations	218,3	298,3	367,3	378,2	385,1	459,1	460,9	452,7	455,5	460,5
Industrial owned systems	75,6	64,1	57,7	57,2	58,8	74,2	70,0	66,7	65,1	63,2
German Railways	5,1	6,4	6,2	5,5	5,6	6,1	6,2	6,3	6,2	6,2
Total domestic generation	299,0	368,8	431,2	440,9	449,5	539,4	537,1	525,7	526,8	529,9
contributions to this:										
hydropower	15,5	18,7	20,7	19,2	18,4	18,5	21,1	21,5	22,5	24,5
heat	271,7	306,4	265,4	272,3	283,9	373,5	357,2	350,7	353,1	351,3
nuclear power	11,8	43,7	145,1	149,4	147,2	147,4	158,8	153,5	151,2	154,1
import	18,0	19,2	22,7	21,5	25,4	30,4	28,4	33,6	35,9	39,4
Total production	317,0	388,0	453,9	462,4	474,9	569,8	565,5	559,3	562,7	569,3
Use										
Domestic consumption by consumer groups										
Iron industry	24,4	24,7	23,3	23,2	22,7	25,7	25,4	24,1	25,6	25,8
Chemical and mineral oil	52,2	53,5	59,3	59,8	58,5	65,1	64,9	62,3	63,3	63,5
Other industry	81,8	97,2	111,7	114,6	118,2	141,3	138,4	131,9	134,0	139,7
Transport	8,9	10,6	10,9	11,0	11,3	15,3	14,9	15,0	15,4	15,5
Public institutions	15,0	24,1	31,3	32,1	32,8	37,2	37,4	37,3	37,9	37,5
Agriculture	6,1	7,1	7,3	7,2	7,2	9,3	8,8	8,7	8,3	8,0
Residential	60,1	85,5	97,7	97,7	99,6	122,2	122,8	126,1	124,5	124,7
Trade and commercial	25,1	34,2	44,8	46,2	47,9	56,8	54,6	56,7	56,1	55,9
Sub-total	273,6	336,9	386,3	391,8	398,2	472,9	467,2	462,1	465,1	470,6
Consumption by producers and in pumping; loses	35,7	37,6	45,2	49,3	50,3	65,9	64,6	64,5	64,0	64,3
export	7,7	13,5	22,4	21,3	26,4	31,0	33,7	32,7	33,6	34,4
Total use	317,0	388,0	453,9	562,4	474,9	569,8	565,5	559,3	562,7	569,3

*) tentative figures

Source: Federal Ministry of Economics, 1996 energy date

Tab. 3.6.5.3: Total power production in Germany, by energy sources, in TWh

Total power production by energy sources – in TWh –										
	1973	1980	1988	1989	1990	1991	1992	1993	1994	1995*)
hard coal	101,6	112,5	130,7	130,3	140,5	149,8	141,9	146,2	144,6	145,1
lignite	77,5	93,5	80,1	82,8	82,6	158,4	154,5	147,5	146,1	146,3
heating oil	42,8	25,7	11,2	9,9	9,8	13,6	12,0	8,9	8,8	7,4
natural gas	35,6	61,0	29,3	34,7	35,9	36,3	33,0	32,8	36,1	37,3
nuclear power	11,8	43,7	145,1	149,4	147,2	147,4	158,8	153,5	151,2	154,1
renewable energies (hydropower and other sources)	29,7	31,8	34,8	33,8	33,5	33,9	36,9	36,8	40,0	39,7
Total	299,0	368,2	431,2	440,9	449,5	539,4	537,1	525,7	526,8	529,9

*) tentative figures
1) until 1990: old *Länder*, as of 1991: Germany
Source: Federal Ministry of Economics, 1996 energy data

3.7 Transport

3.7.1 Transport mileage

In the passenger transports category, automobile use and air travel have been increasing for some time, while use of railways and public buses has decreased (in percentage terms). In the goods transports category, total truck mileage has increased sharply, while rail mileage has decreased considerably during the period under consideration. Tables 3.7.1.1 and 3.7.1.2 summarise the trends during the last 15 years (cf. also Figs. 3.7.1.1 and 3.7.1.2).From 1980 to 1995, total transport mileage in Germany increased by nearly 30% in the motorised passenger transport sector and by 25% in the goods transport sector. Automobile traffic and truck traffic (goods transports) had disproportionately large shares of this growth: 40% and nearly 90%, respectively.

These figures show that the "modal split" in passenger transports is increasingly shifting toward the automobile

Tab. 3.7.1.1: Passenger transport mileage (1980–1995) (in billions of passenger-km) in Germany

Year	Railway		Public buses		Air travel		Automobile1)		Total transport mileage
	billions of passenger-km	%	billions of passenger-km	%	billions of passenger-km	%	billions of passenger-km	%	billions of passenger-km
1980	63,0	8,5	103,8	14,1	11,2	1,5	560,4	75,9	738,4
1985	66,0	8,7	90,6	12,0	13,0	1,7	586,0	77,5	756,6
1990	62,6	6,9	89,1	9,9	18,7	2,1	731,4	81,0	902,6
1991	57,0	6,3	82,6	9,1	18,0	2,0	753,7	82,7	911,3
1992	57,2	6,1	80,4	8,6	20,3	2,2	772,3	83,0	930,2
1993	58,7	6,2	79,6	8,5	21,9	2,3	780,1	83,0	940,3
1994*)	61,2	6,6	78,3	8,5	23,6	2,6	761,8	82,4	924,9
1995*)	63,2	6,7	76,9	8,2	25,4	2,7	773,8	82,4	939,3

*) Data from ifo Wirtschaftskonjunktur 1996 (1996 economic data); ifo-Institut, February 96
1) Incl. taxis and rental cars
Source: Transport statistics *(Verkehr in Zahlen)* 1991/1995; ed. Federal Ministry of Transport (BMV)

Tab. 3.7.1.2: Goods transport mileage (1980-1995) in Germany (in billions of t-km)

Year	Railway		Trucks (billions of t-km)				Inland waterways		Long-distance piplines		Air transports[1)]		Total mileage
	billions of t-km	%	Short distance	%	Long distance	%	billions of t-km	%	billions of t-km	%	billions of t-km	%	Total in billions of t-km
1980	121,3	35,7	56,8	16,7	88,6	26,1	53,6	15,8	19,3	5,7	0,3	0,1	339,9
1985	122,7	36,5	49,9	14,9	97,4	29,0	50,6	15,1	15,0	4,5	0,3	0,1	335,9
1990	103,3	28,7	56,2	15,6	126,6	35,2	56,7	15,8	16,6	4,6	0,4	0,1	359,8
1991	80,7	22,7	58,4	16,4	144,3	40,6	56,0	15,8	15,3	4,3	0,4	0,1	355,1
1992	67,3	19,4	62,9	17,4	156,1	43,1	57,2	15,8	15,4	4,3	0,4	0,1	359,3
1993	65,2	18,7	65,2	18,6	146,4	41,7	57,6	16,4	16,0	4,6	0,5	0,1	350,9
1994*	71,0	19,3	72,8	19,8	146,7	39,8	61,8	16,8	16,8	4,3	0,5	0,1	369,6
1995*	69,1	18,3	75,7	20,0	153,4	40,5	64,0	17,0	16,1	4,1	0,5	0,1	378,8

(until 1990, statistics separated by old and new Federal *Länder*)
[*)] Data from ifo Wirtschaftskonjunktur 1996 (1996 economic data); ifo-Institut, February 96
[1)] Through 1991, no data for the territory of the new Federal *Länder*
t-km = tonne-kilometre

Source: Transport statistics *(Verkehr in Zahlen)* 1991/1995; ed. Federal Ministry of Transport (BMV)

Fig. 3.7.1.1: Passenger transport mileage, 1980–1995 (in billions of passenger-km) in Germany

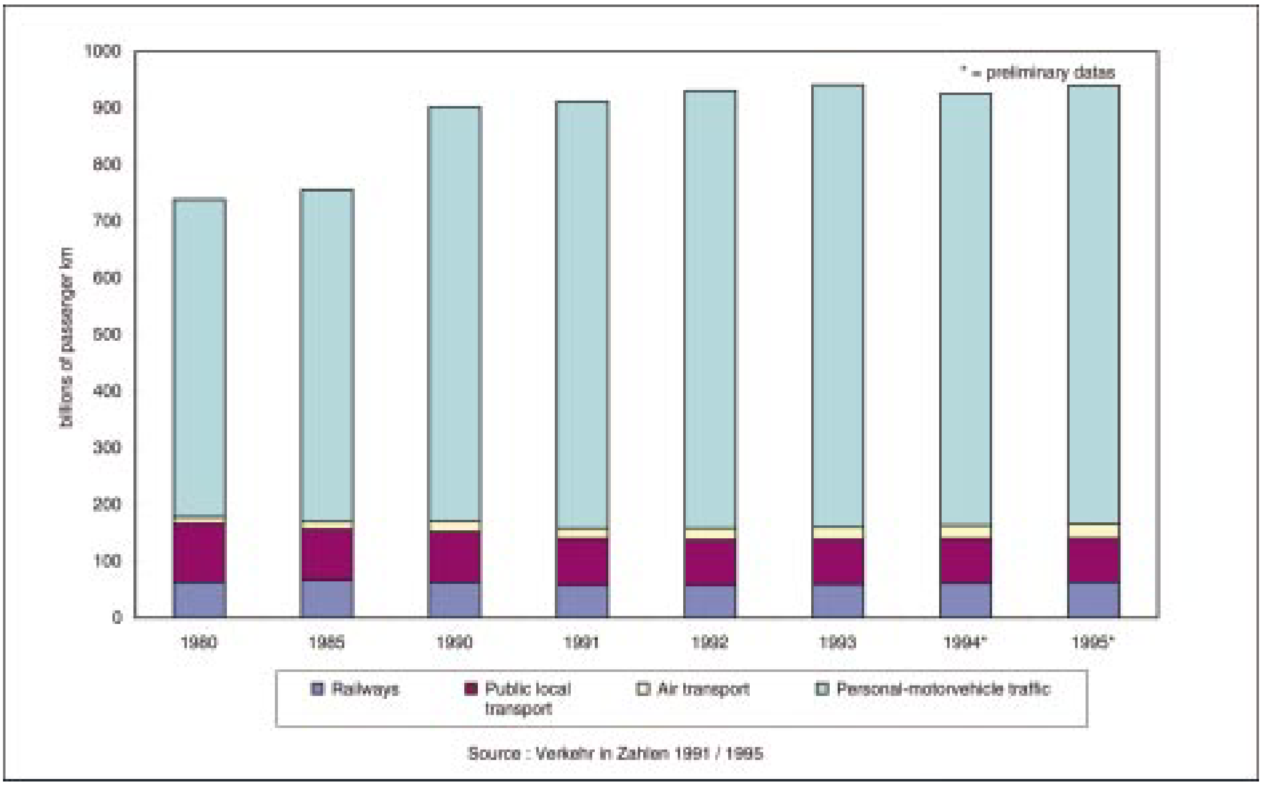
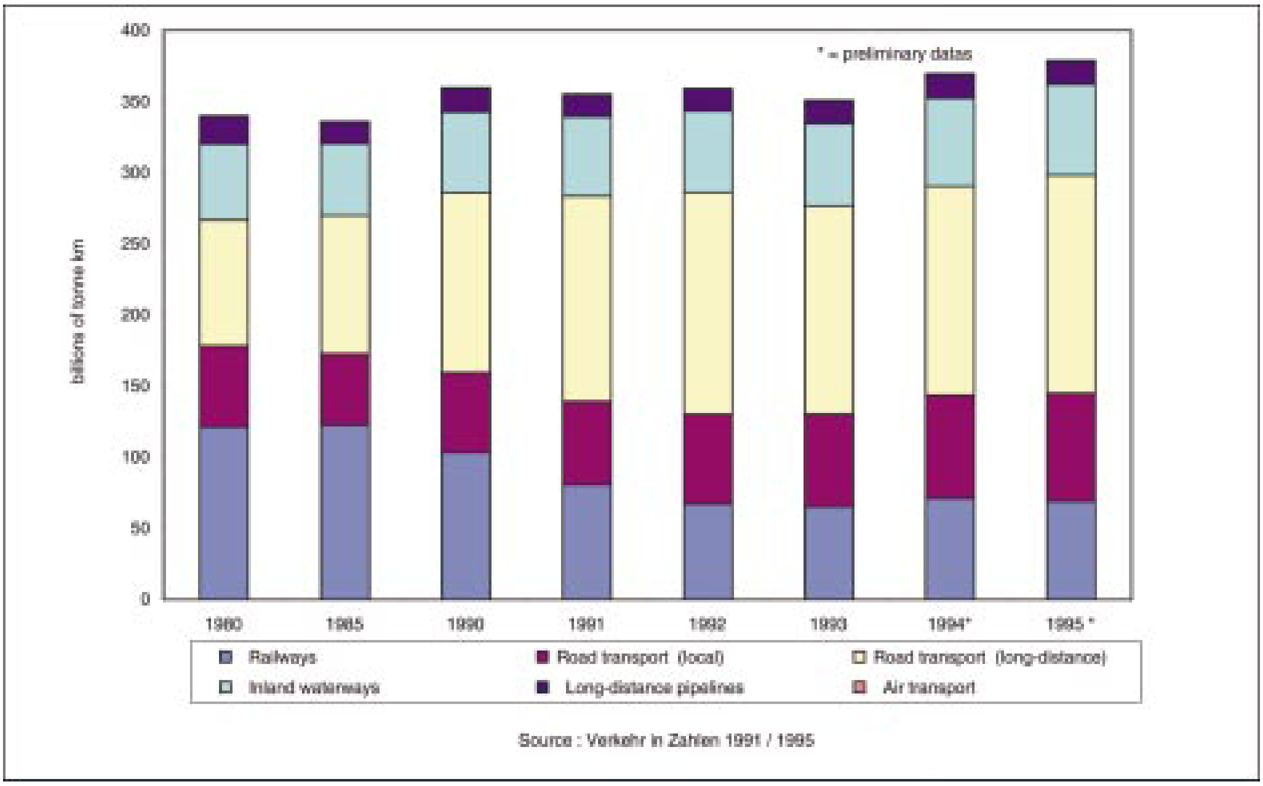


Fig. 3.7.1.2: Goods transport mileage 1980–1995 (in billions of t-km) in Germany



and away from trains and public buses. This trend has been interrupted only during the last two years, presumably as a result of the mineral oil tax increase of 1993. An analogous development has been occurring in goods transports. Long-distance trucking has considerably expanded its share of the total goods transport market, primarily at the expense of the railways. The social and economic changes in the new Federal Länder have intensified this process.

3.7.2 Total numbers of motor vehicles

Table 3.7.2.1 shows the growth in numbers of motor vehicles in the territories of the old and new Federal *Länder*. In the period under consideration, from 1980 to 1995, the total number of automobiles grew by over 55%. The fastest growth in this fleet since 1989 has occurred in the new Federal *Länder*. In 1989 only 235 vehicles were registered for every 1000 inhabitants; the corresponding figure in 1995 was 436 vehicles. With this growth, the new Federal *Länder* have reached 87% of the level in the old Federal *Länder* (501 automobiles/1000 inhabitants).

3.7.3 Predictions for the transport sector

The European Single Market, German unification and the opening-up of eastern European markets will all drive further growth in transports. Germany has become Europe's transport hub. Current predictions (ifo Wirtschaftskonjunktur 1996, ifo-Institut, February 1996 2000–2010: "Overall economic consequences of price-policy measures for CO_2 reduction in transport", commissioned by the Federal Ministry of Transport (BMV), ifo-Institut, October 1995), taking 1995 as a basis, indicate that total mileage for both passenger transports and goods transports will increase by

Tab. 3.7.2.1: Growth for the motor-vehicle fleet, including low-emissions automobiles

Year (as of 1 July)	Automobiles and vans etc. total	of these no. of low-emissions vehicles[1)		Trucks and semi towing vehicles	Motorbikes and motorcycles	Other motor vehicles
	in millions	in millions	in %	in millions	in millions	in millions
1980	25,9			1,5	4,2	2,0
1985	29,1			1,5	4,2	2,1
1990	35,5			1,8	3,7	2,6
1991	36,9			1,7	3,7	2,7
1992	37,9	17,8	47,0	1,9	4,0	2,6
1993	38,8	25,3	65,2	2,3	3,9	2,4
1994	39,8	28,0	70,5	2,2	3,8	2,6
1995	40,4	30,5	75,5	2,3	4,0	2,5
1996[2)]	41,0	33,0	80,6	2,4	4,2	2,5

(until 1990, statistics separated by old and new Federal *Länder*)
[1)] Vehicles pursuant to directives 94/12/EC, 91/441/EEC and Annexes XXIII (US norm) and XXV (EC norm); diesel and caburettor fuels
[2)] tentative data
Source: Verkehr in Zahlen (transport statistics) 1991/1995; ed. Federal Ministry for Transport;
Federal Office for Motor Traffic for 1994–1996

Tab. 3.7.3.1: Development of passenger transports in Germany, from 1990 to 2010 (in billions of passenger-km, includes prediction)

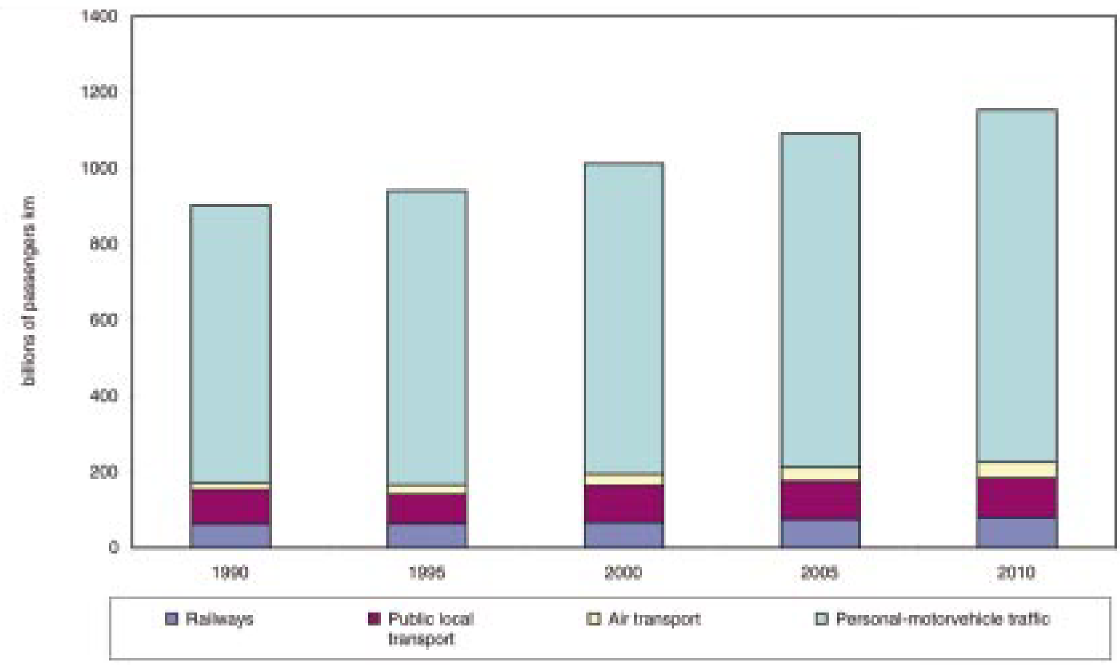
Year	Railway billions p.-km	Railway %	Public busses billions p.-km	Public busses %	Air travel billions p.-km	Air travel %	Automobile[1)2)] traffic billions p.-km	Automobile traffic %	Total transports billions p.-km
1990	62,6	6,9	89,9	10,0	18,7	2,1	731,4	81,0	902,6
1995	63,6	6,7	77,4	8,2	25,4	2,7	773,8	82,4	940,2
2000	67,7	6,7	97,0	9,6	30,2	3,0	817,1	80,7	1012,0
2005	74,6	6,8	101,2	9,3	35,9	3,3	878,7	80,6	1090,4
2010	80,3	7,0	103,7	9,0	41,3	3,6	927,5	80,5	1152,8

[1)] Includes taxis and rental cars
[2)] The ifo Institute's prediction data does not include the updated total transports data for the period until 1995
Sources: 1990: Verkehr in Zahlen (transport statistics) 1991/1995; ed. Federal Ministry of Transport (BMV)
1995: ifo Wirtschaftskonjunktur 1996 (economic data), ifo-Institut, February 1996
2000–2010: "Overall economic consequences of price-policy measures for CO_2 reduction in transports", commissioned by the BMV, ifo-Institut, October 1995

nearly 30 % by the year 2010. Tables 3.7.3.1 and 3.7.3.2 show the details of these trends (cf. also Figs. 3.7.3.1 and 3.7.3.2).

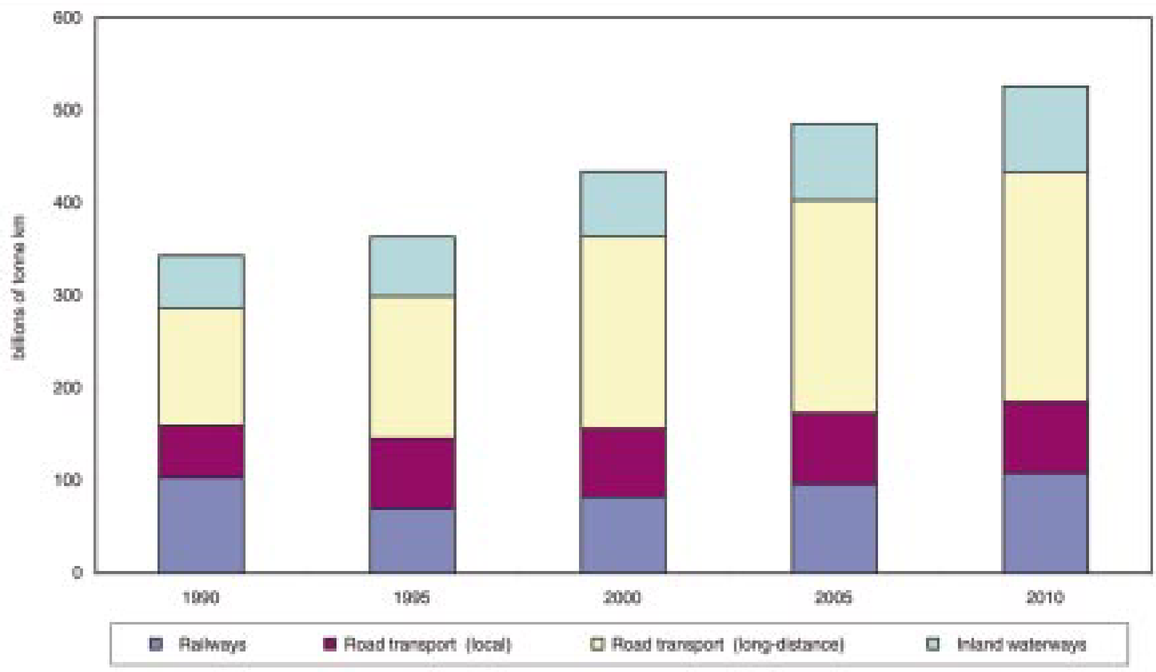
According to these predictions, growth in passenger transports will be driven largely by further growth in pleasure trips, although business travel will also make a significant

Fig. 3.7.3.1: Development of passenger transports in Germany from 1990–2010 (in billions of passenger-km; includes prediction)



Sources: 1990: Verkehr in Zahlen 1991 / 1995, BMV
1995: ifo Wirtschaftskonjunktur 1996, ifo-Institut Feb.1996
2000-2010: "Gesamtwirtschaftliche Auswirkungen preispolitischer Maßnahmen zur CO2-Reduktion im Verkehr", ifo Institut, Oct. 1995

Fig. 3.7.3.2: Development of goods transports in Germany from 1990 to 2010 (in billions of tonne- km; includes prediction)



Source : 1990: Verkehr in Zahlen 1991 / 1995, BMV
1995: ifo Wirtschaftskonjunktur 1996, ifo-Institut Feb.1996
2000-2010: "Gesamtwirtschaftliche Auswirkungen preispolitischer Maßnahmen zur CO2-Reduktion im Verkehr", ifo Institut, Oct. 1995

Tab. 3.7.3.2: Development of goods transports from 1990 to 2010 in Germany (in billions of tonne-km; includes prediction)

Year	Railway		Truck transports (billions of t-km)				Inland waterways		Total trans-ports
	billions of t-km	%	short-distance	%	long-distance	%	billions of t-km	%	billions of t-km
1990	103,3	30,1	56,2	16,4	126,6	36,9	56,7	16,5	342,8
1995	69,8	19,1	75,7	20,9	153,4	42,3	64,5	17,8	363,4
2000	82,0	18,9	74,3	17,1	207,1	47,7	70,4	16,2	433,8
2005	96,2	19,8	76,9	15,8	229,6	47,3	82,6	17,0	486,3
2010	107,7	20,5	77,6	14,8	247,8	47,1	92,9	17,7	526,0

Sources: 1990: Verkehr in Zahlen (transport statistics) 1991/1995; ed. Federal Ministry of Transport (BMV)
1995: ifo Wirtschaftskonjunktur 1996 (economic data), ifo-Institut, February 1996
2000–2010: “Overall economic consequences of price-policy measures for CO_2 reduction in transports”, commissioned by the BMV, ifo-Institut, October 1995

contribution. The main factors driving growth in goods transports will be further internationalisation of markets and continuing separation of production processes. Europe’s development as an economic region is the currently dominating trend in this connection.

The studies indicate that in the next 15 years – as in the past 15 – automobile traffic and truck traffic will play a central role in transport-sector growth. These two modes of transportation will account for nearly 80% of growth in passenger and goods transports. No changes in the “modal split” can be expected, since automobile and truck traffic are already dominant.

3.8 Housing

From 1990 to 1994, the average residence size and the average per-capita living space increased slightly (Table 3.8.1). These increases represent a continuation of trends described in Germany’s First National Report: increasing numbers of single-person households, fewer children per household, an increasing divorce rate, a tendency for children to move away from home sooner and a larger difference between the life expectancies of men and women. Since there continues to be a shortage of housing in the new Federal *Länder*, the trends in residence size and per-capita living space can be expected to continue.

Tab. 3.8.1: Available housing in Germany

	1990	1994
Living space in m^2		
– residence size	81,9	82,5
– per-capita living space	34,8	36,0
Number of rooms		
– per residence	4,3	4,3
– per capita	1,8	1,9
Residences with (in %):		
– 1 room	2,2	2,3
– 2 rooms	6,5	6,5
– 3 rooms	22,3	22,3
– 4 rooms	30,9	30,7
– 5 rooms	18,9	19,0
– 6 and more rooms	19,2	19,3

Source: 1996 Statistical Yearbook

3.9 Germany after unification (old Federal *Länder* / new Federal *Länder*)

3.9.1. The current situation

The Federal Government is pursuing the objective of reducing CO_2 emissions in Germany by 25%, on the basis of the 1990 emissions level, by the year 2005. In the old Federal *Länder*, the population grew from 63.254 million in 1990 to 66.265 million in 1995, i.e. it grew by about 5%. Although the specific per-capita CO_2 emissions decreased by about 3%, absolute CO_2 emissions increased during this period by about 2%, in part due to this population increase. Another reason for the increase in CO_2 emissions in the old Federal *Länder* is that production was increased in the old Federal *Länder* following unification in order to supply goods and services to the population of the new Federal *Länder*.

The significant causes of the sharp reduction in CO_2 emissions in the new Federal *Länder* include economic restructuring; a ca. 4% population decrease since 1990; some shifting of production to the old Federal *Länder*; imports of many goods, following German unification, especially from the old Federal *Länder* and from other industrialised countries; improvements in energy efficiency; and reductions in use of lignite, a CO_2-intensive fuel. In 1990, lignite met 68.5% of total primary energy requirements in the new Federal *Länder*; consumption was then reduced from 2260 PJ in 1990 to about 803 PJ in 1995, i.e. by about 2/3.

Many measures have been introduced in the new Federal *Länder* to ensure that the initiated restructuring in all energy sectors is thorough and lasting. The real gross domestic product in the new Federal *Länder* increased by 8.5% in 1994 and by 5.6% in 1995, while CO_2 emissions continued to decrease (cf. Chapter 4).

Tab. 3.9.1.1: Changes in CO_2 emissions in Germany, from 1990 to 1995, by sectors, and using the IPCC terminology and system (residential and institutional separated)

	1990	1995	Changes	
	CO_2 emissions		1990/1995	
	mill. t			%
	Old *Länder*			
Total emissions	708,8	722,1	13,4	1,9
1 Energy-related emissions	686,8	700,1	13,3	1,9
A Combustions-related	686,8	700,1	13,3	1,9
1 Energy and trans. industries	275,6	276,7	1,1	0,4
2 Industry	120,7	111,5	-9,2	-7,6
3 Transport	138,8	144,6	5,7	4,1
4 Residential, inst. comm.[1]	138,8	157,2	18,5	13,3
5 Other (incl. military) [2]	12,9	10,2	-2,7	-20,9
2 Industry (non-en.)	22,0	22,0	0,0	0
	New *Länder*			
Total emissions	305,4	172,3	-133,1	-43,6
1 Energy related emissions	299,8	169,1	-130,7	-43,6
A Combustion-related	299,8	169,1	-130,7	-43,6
1 Energy and trans. industries	163,9	96,5	-67,3	-41,1
2 Industry	49,0	15,3	-33,7	-68,7
3 Transport	19,8	26,2	6,4	32,1
4 Residential, inst. comm.[1]	59,4	28,8	-30,6	-51,5
5 Other (incl. military)[2]	7,7	2,3	-5,4	-70,7
2 Industry (non-en.)	5,6	3,2	-2,4	-42,5
	Germany			
Total emissions	1014,2	894,5	-119,7	-11,8
1 Combustion-related	986,6	869,3	-117,4	-11,9
A Combustion-related	986,6	869,3	-117,4	-11,9
1 Energy and trans. industries	439,4	373,2	-66,2	-15,1
2 Industry	169,7	126,8	-42,9	-25,3
3 Transport	158,7	170,7	12,0	7,6
4 Residential, inst. comm.[1]	198,2	186,1	-12,1	-6,1
5 Other (incl. military)[2]	20,6	12,5	-8,1	-39,5
2 Industry (non-en.)	27,5	25,2	-2,3	-8,4

[1] Including mobile sources in agriculture and silviculture
[2] Not including international transports
Sources: BMU; UBA; AG Energiebilanzen; DIW.

Tab. 3.9.1.2: Changes in energy consumption in Germany, from 1990 to 1995, by sectors

	Old *Länder*		New *Länder*		Germany		Changes 1990/1995 Old *Länder*	New *Länder*	Germany
	1990	1995*)	1990	1995*)	1990	1995*)			
	PJ						%		
Prim. energy consumption	11505	12070	3290	2122	14795	14191	4,9	-35,5	-4,1
Combust./losses in energy sector	3285	3377	1111	638	4396	4015	2,8	-42,6	-8,7
Non-energy use	790	841	168	138	958	979	6,5	-17,9	2,2
Final energy cons.	7429	7852	2012	1346	9441	9198	5,7	-33,1	-2,6
Other mining and manufacturing	2252	2181	725	296	2977	2477	-3,2	-59,2	-16,8
Transport	2091	2210	288	375	2.379	2585	5,7	30,3	8,7
Residential and institutional	3002	3420	944	672	3946	4092	13,9	-28,8	3,7
Residential	1861	2277	522	420	2383	2697	22,3	-19,5	13,2
Institutional	1141	1144	422	252	1563	1395	0,2	-40,3	-10,7
Military agencies	84	41	55	3	139	44	-51,0	-94,4	-68,2

*) 1995 tentative estimate
Discrepancies in totals due to rounding-off
Source: AG Energiebilanzen

The restructuring in all areas of the economy and of energy use in the new Federal *Länder* is a process of modernisation and adaptation of production and consumption structures to western European standards. In the former GDR, energy, a production factor, was highly undervalued. Consequently, obsolete structures in an energy sector that depended very heavily on lignite, and obsolete production structures, had to give way to new structures, a diversified fuel supply and improved energy efficiency on both the supply and demand sides. This process has required strong economic and financial support from the old Federal *Länder*. This process, which is still continuing, is being accompanied by increased movements of goods from the old Federal *Länder* to the new Federal *Länder*.

The CO_2 emissions reductions in the new Federal *Länder* have been achieved through large economic and financial input, especially from the old Federal *Länder*. In addition to private investments, public financial transfers to the new Federal *Länder* have been of central significance. The net transfer of public funding to the new Federal *Länder* was 106 billion DM in 1991; 115 billion DM in 1992; 129 billion DM in 1993; 125 billion DM in 1994; 140 billion DM in 1995; and 140 billion DM in 1996. A considerable share of these financial transfers has gone toward economic modernisation, including measures for CO_2 reduction. (for sources, cf. Table 3.9.4.1)

In 1991 and 1992, a total of 829.9 million DM in federal funds was spent on environmental protection, within the framework of the "Aufschwung Ost" joint task for recovery in the new Federal *Länder*; a total of 149.3 million DM was spent on modernisation of district heating systems.

From 1990 to 1995, transport CO_2 emissions in the Federal Republic of Germany increased by 7.6%. In the new Federal *Länder*, they increased disproportionately fast, from a comparably low level: by 32.3%.

Tab. 3.9.1.3: Relative changes in emissions, from 1990 and 1994 (for CO_2, to 1995) (for absolute emissions cf. Tab. 4.4.1–4.4.5)

Figures in %	Germany	Old *Länder*	New *Länder*
CO_2	- 12 %	+ 2 %	- 44 %
CH_4	- 15 %	- 17 %	- 7 %
N_2O	- 5 %	+ 2 %	- 25 %
H-FKW[1)]	+ 870 %	NA	NA
CF_4	- 40 %	NA	NA
C_2F_6	- 26 %	NA	NA
SF_6	+ 48 %	NA	NA
NO_x (as NO_2)	- 16 %	- 10 %	- 35 %
NMVOC	- 32 %	- 19 %	- 62 %
CO	- 37 %	- 26 %	- 63 %
SO_2	- 44 %	- 1 %	- 52 %
FCKW/Halone	- 71 %	- 85 %	- 66 %

NA: not available, since no data is available for the sub-areas
1) use beginning in 1994 as a substitute for CFC and H-CFC (cf. Chap. 4.4.5)
Source: Schwarz, W.: Aktuelle und künftige treibhauswirksame Emissionen fluorierter Verbindungen in Deutschland im Auftrag des Umweltbundesamtes, Berlin 1996

The main cause of these increases is growth in motor-vehicle traffic: rapidly increasing total mileage, the larger fleet of registered vehicles, supra-regional commuting between the old and the new Federal *Länder*, changes in local structures for living, shopping and working and significant increases in pleasure traffic as a result of greater travel opportunities and the decreasing importance of local public transportation.

In the new Federal *Länder*, total CO_2 emissions decreased. In 1995, they were 44% less than in 1990. On the other hand, CO_2 emissions in the old Federal *Länder* were slightly (almost 2%) higher in 1995 than in the reference year.

A similar picture emerges with regard to changes in sectoral energy consumption in the two parts of Germany: whereas primary energy consumption in the old Federal *Länder* was nearly fast 5% higher in 1995 than in 1990, it decreased by nearly 36% in the new Federal *Länder* over the same period.

3.9.2 Consequences of the economic changes and CO_2 emissions

In the two years after 1989, economic output in the new Federal *Länder* declined considerably. The 1991 gross domestic product there – as far as can be determined; the figures are only somewhat comparable – was about one-third lower than in 1989. In the manufacturing sector, gross value added decreased by 63% during the same period. As this was happening, energy consumption in the new Federal *Länder* also decreased in industry (-59%), in the energy and transformation sector (-43%) and in the institutional sector (-41%). These sectors were the commercial and industrial

Tab. 3.9.2.1: Changes in overall economic development in the old and new Federal *Länder*, from 1990 to 1995

	Changes over previos in %						
	1990	1991	1992	1993	1994	1995	1990/1995
	Old *Länder*						
Agriculture and silviculture	4,2	-6,5	21,4	-8,3	-1,9	2,0	4,2
Production	4,7	3,5	-1,9	-7,0	2,2	0,2	-3,4
Energy, mining	-0,2	6,8	-1,1	-2,4	-1,0	1,5	3,7
Manufacturing	5,5	3,7	-2,7	-8,0	2,3	0,5	-4,6
Construction	3,3	0,3	2,4	-3,8	3,2	-1,9	0,1
Commerce and tpt.	7,8	8,7	1,9	-1,5	0,1	1,6	10,9
Retail	7,9	11,3	0,2	-2,4	-0,9	0,4	8,3
Transport, news	7,6	4,5	4,8	-0,2	1,6	3,6	15,0
Services	7,2	6,4	5,0	4,1	4,0	4,2	25,9
Staate	1,6	1,7	2,1	0,8	0,5	0,3	5,6
Priv. budgets, priv. np. org.[1]	4,1	4,5	4,5	2,8	3,3	2,5	18,8
Gross domestic prod.	5,7	5,0	1,8	-1,8	2,4	1,6	9,1
	New *Länder*						
Agriculture and silviculture	-10,1	-33,5	-3,6	9,4	-13,6	12,12	-32,1
Production	-22,4	-32,0	9,7	9,0	14,8	5,8	-1,2
Energy, mining	-8,3	-15,0	-15,5	-3,3	-3,0	-8,0	-38,0
Manufacturing	-31,1	-46,8	6,1	12,2	13,7	8,2	-22,1
Construction	-2,1	-7,2	31,4	10,5	22,8	7,3	77,7
Commerce and tpt.	-19,8	-36,6	6,1	10,5	7,4	4,1	-16,8
Retail	-23,2	-41,9	16,8	7,5	1,4	3,4	-23,5
Transport, new	-10,5	-24,1	-13,1	17,9	20,7	5,5	-1,0
Services	-5,5	49,2	16,6	3,9	8,8	6,9	110,5
State	0,3	-3,5	-2,6	2,6	-2,9	3,3	-3,2
Priv. budgets, priv. np. org.[1]	-1,3	38,3	15,9	3,8	15,0	9,2	108,9
Gross domestic prod.	-16,2	-19,0	7,8	7,2	8,5	5,6	7,2

[1] Private households, private non-profit organisations
Sources: Federal Office for Statistics; DIW

sectors that were most affected by the necessary economic restructuring. Nonetheless, a sufficient energy supply was provided – all energy requirements were met. In contrast with approaches under the previous energy supply structure, for example, important measures were taken to reduce the demand of all energy users. In this manner, important progress in implementing a new approach to energy services. This progress was achieved equally with commercial, institutional and residential users.

Newly open markets in the new Federal *Länder* gave impetus to economic growth in the old Federal *Länder* in the early 1990s: the gross domestic product grew here by 5.7% in 1990 and by 5.0% in 1991 (each figure is with reference to the previous year).

After 1991, the new Federal *Länder* experienced marked economic growth, driven mainly by the construction industry and services. Manufacturing also exhibited significant growth rates; nonetheless, this sector's importance remained far smaller than it had been in the former GDR. In 1995, it accounted for just under 19% of total (unadjusted) gross value added; the comparable figure in 1989 had been one-third. It is worthy of note that manufacturing has considerably higher importance in the old Federal *Länder* (where its contribution to gross value added is about 27%) than in the new Federal *Länder*. Overall, the economic structure in the new Federal *Länder* has become less energy-intensive.

3.9.3 Structural framework for trends in CO_2 emissions

The reduction of carbon dioxide emissions in Germany was not due primarily to the special circumstances in the new Federal *Länder*. The changes in that region were caused not only by an economic downturn, but also by significant structural changes made to reduce emissions in energy use.

For example, as a result of the structural changes in the new Federal *Länder*, use of lignite, which is particularly emissions-intensive, decreased by nearly two-thirds from 1990 to 1995, and this fuel's percentage role in total primary energy consumption declined from nearly 69% in 1990 to just under 38% in 1995. On the other hand, use of natural gas and mineral oil increased sharply. The nuclear power plants in the new Federal *Länder* were decommissioned immediately after unification for safety reasons.

Tab. 3.9.3.1: Changes in energy consumption in Germany from 1990 to 1995, by energy sources

	Old		New		Germany		Changes 1990/1995		
	Länder						Old	New	Germany
	1990	1995*)	1990	1995*)	1990	1995*)	*Länder*		
	PJ						%		
Hard coal	2169	1986	137	75	2306	2060	-8,5	-45,5	-10,7
Lignite	940	928	2.261	804	3201	1732	-1,2	-64,5	-45,9
Mineral oil	4718	4927	520	763	5238	5690	4,4	46,8	8,6
Natural gas, petr. gas	2012	2342	281	472	2293	2814	16,4	67,9	22,7
Nuclear power	1383	1470	63	0	1446	1470	6,3	-100,0	1,6
Renewables, other	283	418	28	8	312	426	47,4	-71,5	36,6
Total	11505	12070	3290	2122	14795	14191	4,9	-35,5	-4,1
	Structure in %						Percentage change		
Hard coal	18,9	16,5	4,2	3,5	15,6	14,5	-2,4	-0,6	-1,1
Lignite	8,2	7,7	68,7	37,9	21,6	12,2	-0,5	-30,8	-9,4
Mineral oil	41,0	40,8	15,8	36,0	35,4	40,1	-0,2	20,2	4,7
Natural gas, petr. gas	17,5	19,4	8,5	22,2	15,5	19,8	1,9	13,7	4,3
Nuclear power	12,0	12,2	1,9	0,0	9,8	10,4	0,2	-1,9	0,6
Renewables, other	2,5	3,5	0,9	0,4	2,1	3,0	1,0	-0,5	0,9
Total	100,0	100,0	100,0	100,0	100,0	100,0	0,0	0,0	0,0

*) 1995 tentative estimate
Discrepancies in total due to rounding-off
Source: AG Energiebilanzen

Tab. 3.9.3.2: Changes in per-capita primary energy consumption and CO_2 emissions in Germany, 1990 to 1995

	1990	1991	1992	1993	1994	1995
	Per-capita primary energy consumption (MJ)					
Old *Länder*	182	187	184	183	181	182
New *Länder*	204	156	142	139	136	137
Germany	186	181	176	175	173	173
New to old *Länder* in %	112	83	77	76	75	75
	Per-capita carbon dioxide emissions (t)					
Old *Länder*	11,2	11,6	11,2	11,1	11,0	10,9
New *Länder*	19,0	14,6	12,7	12,2	11,6	11,1
Germany	12,8	12,2	11,5	11,3	11,1	10,9
New to old *Länder* in %	169	126	113	110	106	102

Source: Federal Office for Statistics; UBA; AG Energiebilanzen

In addition, energy efficiency in the new Federal *Länder* was considerably increased between 1990 and 1995. One result of this improvement is that per-capita primary energy consumption – as well as per-capita CO_2 emissions – in the new Federal *Länder* are now even lower than in the old Federal *Länder*.

And efficiency could be enhanced still further.

3.9.4 Evaluation of the different trends in CO_2 emissions in Germany

Evaluation of the regionally different trends in carbon dioxide emissions in the old and the new Federal *Länder* must take into account that the population trends in the two regions run counter to one another: Whereas the population in the old Federal *Länder* grew by nearly 2.9 million, or nearly 5% from 1990 to 1995, it decreased in the new Federal *Länder* during the same period by about 0.6 million, or by nearly 4%.

In addition, the per-capita gross domestic product in the new Federal *Länder* still remains considerably smaller than its counterpart in the old Federal *Länder*. There is still an enormous gap between production and goods consumption: in 1994, the gross domestic product covered only about 60% of the goods consumed 1994 (relationship established with the relevant prices). The economy in the new Federal *Länder* thus still depends strongly on resources transfer. The supply of goods to the population is still based to a considerable extent on transfers of income and assets that are used largely to finance consumption.

These transfers have achieved considerable reduction in CO_2 emissions, since the specific carbon dioxide emissions with respect to added value in the old Federal *Länder* are 58% less than those in the new Federal *Länder*.

It can be assumed that the process of German unification "shifted" CO_2 emissions into the old Federal *Länder*; 90% of this shift was compensated for by that region's efforts to reduce CO_2 emissions. This effect has received little notice to date.

It must also be noted in this connection that the supply of goods to the new Federal *Länder* has been "taken over" to a considerable degree by production in the old Federal *Länder* and abroad. One indication for this is that as follows: on the average, of all commercial products sold in unified Germany in 1994, only 5% came from production in the new Federal *Länder*, while 68% came from production in the old Federal *Länder* and 27% came from foreign production (cf. "Overall economic and entrepreneurial success in carrying out adaptations in the new Federal *Länder*" (Gesamtwirtschaftliche und unternehmerische Anpassungsfortschritte in Ostdeutschland). Fourteenth report. Weekly report of the German Institute for Economic Research (DIW), No. 27/96, p. 453). In this sense, therefore, production-related "shifting" of emissions occurred.

One significant cause of the emissions reduction in the new Federal *Länder* was certainly the greater efficiency, brought about by economic transformation, in use of nearly all production factors. The most important effects were achieved through substitution of obsolete procedures and products, especially in chemical process manufacturing. Carbide pro-

Tab. 3.9.4.1: Production, goods consumption and transfer of resources in the new Federal Länder, 1990–1994

	1990	1991	1992	1993	1994
	Billions of DM in relevant prices				
Gross domestic prod. (GDP)	223,9	206,0	262,2	303,0	334,8
Last domestic use	277,5	358,3	457,3	512,1	562,4
Private consumption and state cons.	223,8	267,3	328,4	357,8	381,3
Gross investments	53,7	91,0	128,9	154,3	181,1
Surplus[1)]	-53,6	-152,3	-194,7	-206,7	-221,8
Export	61,1	46,9	52,1	54,9	67,6
Import	114,7	199,2	246,8	261,6	289,4
Assets transfer [2)]	53,6	152,3	194,7	206,7	221,8
Eamed and assets income	1,3	8,0	10,8	9,4	8,3
Current transfers and assets transfers	43,6	114,6	131,9	134,6	124,5
Financing balance	8,7	29,7	52,1	62,7	89,1
News: GDP in % of last domestic use	80,7	57,5	57,4	59,2	59,5

[1)] Domestic concept; without earned and assets income
[2)] Balances with rest of the world
Sources: Federal Office for Statistics; DIW (from: DIW-Wochenbericht 27–28/95).

Tab. 3.9.4.2: Changes in primary energy consumption and CO_2 emissions per unit of gross domestic product[1)], adjusted for inflation (in 1991 prices), and CO_2 intensity of primary energy consumption in Germany, 1990 to 1995

	1990	1991	1992	1993	1994	1995
	Prim. energy cons. per GDP unit (GJ per DM)					
Old *Länder*	4,56	4,53	4,42	4,54	4,42	4,39
New *Länder*	12,93	12,02	10,05	9,12	8,19	7,78
Germany	5,33	5,07	4,85	4,92	4,75	4,69
New to old *Länder* in %	283	265	227	201	185	177
	Carb. diox. emissions per GDP unit (t CO_2/mill DM)					
Old *Länder*	281	281	270	275	267	263
New *Länder*	1 200	1 125	899	801	699	632
Germany	364	342	318	318	305	296
New to old *Länder* in %	427	401	333	291	261	241
	Carb. diox. intensity of primary energy cons. (t CO_2/TJ)					
Old *Länder*	61,6	62,0	61,0	60,6	60,5	59,8
New *Länder*	92,8	93,6	89,4	87,9	85,4	81,2
Germany	68,5	67,4	65,5	64,8	64,3	63,0
New to old *Länder* in %	151	151	147	145	141	136

[1)] Gross domestic product in 1991 prices.
Sources: Federal Office for Statistics; UBA; AG Energiebilanzen; DIW.

duction for manufacture of synthetic caoutchouc and solvents, and for manufacture of vinyl chloride, has been converted to oil-based production. The same process was carried out in the methanol industry. Supply of ethene and propene has made it possible to decommission most of the region's electrolysis plants. Other important energy-intensive raw materials are now being imported. Among these materials are aluminium, sulphuric acid, photographic and x-ray films and paper pulp.

In sum, the system transformation has provided an important basis for more efficient – and thus cleaner – energy use; this basis has been enhanced by a number of specifically targeted – and also environmentally oriented – political measures, such as:

– Support for district heating from combined heat and power generation,

– Support for economic modernisation,

– Modernisation of existing buildings, including improvements in energy efficiency,

– Support for modernisation of heating systems,

– Ordinances pursuant to the Federal Immission Control Act, etc.

In the sugar industry in 1995, for example, higher energy efficiency was achieved in the new Federal *Länder* than in plants in the old Federal *Länder*. Other areas, such as cement and potassium salt production, approached energy efficiency levels found in the old Federal *Länder*.

The changes in the above per-capita figures suffice to illustrate the efficiency increases. The improvements are also apparent in highly-aggregated overall economic indexes, however.

For example, from 1990 to 1995, overall economic energy intensity (primary energy consumption in relation to real gross domestic product) decreased by only 4 % in the old Federal *Länder*, while in the new Federal *Länder* it decreased by 40%. Total economic carbon dioxide intensity (carbon dioxide emissions in relation to real gross domestic product) has been almost cut in half in the new Federal *Länder* (in the old Federal *Länder*: -7%). Another indicator that has been considerably reduced in the new Federal *Länder* is the so-called carbon dioxide intensity of primary energy consumption (relationship between carbon dioxide emissions and primary energy consumption): from 1990 to 1995, it fell by nearly 13% (old Federal *Länder* : -3%); this improvement reflects the structural changes in the energy sector in favour of natural gas and oil.

Tab. 3.9.4.3: Carbon dioxide emissions in Germany, from 1990 to 1995, in accordance with the IPCC's categories (millions of tonnes)

	1990	1991	1992	1993[4]	1994[4]	1995[4]
Total emissions/storage	1014,2	975,2	926,6	918,3	904,5	894,5
1 Energy-related emissions	986,6	950,6	901,4	893,1	879,3	869,3
A Combustion-related	986,6	950,6	901,4	893,1	879,3	869,3
1 Energy/transformation	439,4	426,6	400,8	387,7	387,0	373,2
2 Industry	169,7	147,1	135,5	127,0	128,3	126,8
3 Transport	158,6	162,1	168,3	172,5	167,6	170,7
4 Residential, inst., commercial[1]	198,2	200,0	184,8	193,5	183,3	186,1
- Residential	128,4	130,7	123,1	133,5	126,9	135,2
- Institutional, commercial	69,8	69,3	61,7	60,0	56,5	50,9
5 Other (incl. military)[2]	20,6	14,9	12,0	12,5	13,1	12,5
6 Combustion of biomass	not relevant					
B Extraction/dist. of fuels	no data available					
2 Industry (non-en.)	27,5	24,6	25,2	25,2	25,2	25,2
International transports[3]	19,6	18,1	17,8	20,1	20,1	20,1
Maritime bunkering	8,0	6,7	5,6	7,2	7,2	7,2
International air transports	11,6	11,4	12,2	12,9	12,9	12,9

[1] Not incl. mobile sources in agriculture and silviculture, not incl. blue-water fisheries
[2] Incl. mobile sources in agriculture and silviculture
[3] Not included in total emissions; including blue-water fisheries
[4] Trentative figures
Sources: UBA; AG Energiebilanzen; DIW.

Overall, total economic efficiency of energy use in the new Federal *Länder* was considerably increased between 1990 and 1995. Nonetheless, the new Federal *Länder* still lag behind the old Federal *Länder* to a considerable degree: in 1995, the total economic energy intensity in the new Federal *Länder* was nearly 80 % higher than in the old Federal *Länder*; the total economic carbon dioxide intensity was nearly 140 % higher. These figures point to major further potential for efficiency enhancement; if this potential is made use of, even strong economic growth in the new Federal *Länder* in the coming years need not result in increasing energy consumption and re-increasing CO_2 emissions.

This assessment is supported by the findings of the most recent energy-consumption predictions of PROGNOS AG, according to which CO_2 emissions in the new Federal *Länder* (from 1992 until the year 2005) are likely to decrease even further (-4 %), even though total economic real output is expected to increase by a factor of 2.4 (i. e. by a total of 143 %, or annual average growth of about 7% from 1992 to 2005!). The first model calculations made in the framework of the IKARUS project have produced basically similar results.

Tab. 3.9.4.4: Carbon dioxide emissions in the old Federal *Länder,* from 1990 to 1995, in accordance with the IPCC's categories (in millions of tonnes)

	1990	1991	1992	1993[4]	1994[4]	1995[4]
Total emissions/storage	708,8	743,5	726,9	727,5	723,9	722,1
1 Energy-related emissions	686,8	721,1	705,0	705,5	701,9	700,1
A Combustion related	686,8	721,1	705,0	705,0	701,9	700,1
1 Energy transformation	275,6	290,0	280,8	275,9	281,2	276,7
2 Industry	120,7	120,3	116,1	110,2	113,1	111,5
3 Transport	138,9	141,9	145,3	147,8	142,1	144,6
4 Residential, inst., commercial[1]	138,8	159,5	154,2	161,9	154,6	157,2
– Residential	93,9	108,3	104,8	114,1	108,5	115,9
– Institutional, commercial	45,5	51,2	49,4	47,8	46,1	41,4
5 Other (incl. military)[2]	12,9	9,4	8,6	9,6	10,8	10,2
6 Combustion of biomass	not relevant					
B Extraction/dist. of fuels	no data available					
2 Industry (non-en).	22,0	22,4	22,0	22,0	22,0	22,0
International Transports[3]	17,7	17,5	17,3	19,3	19,3	19,3
Maritime bunkering	6,6	6,3	5,3	6,6	5,6	5,6
International air transports	11,1	11,1	12,1	12,7	12,7	12,7

[1] Not incl. mobile sources in agriculture and silviculture, not incl. blue-water fisheries
[2] Incl. mobile sources in agriculture and silviculture
[3] Not included in total emissions; including blue-water fisheries
[4] Tentative figures
Sources: UBA; AG Energiebilanzen; DIW

Tab. 3.9.4.5: Carbon dioxide emissions in the new Federal *Länder,* from 1990–1995, in accordance with the IPCC's categories (millions of tonnes)

	1990	1991	1992	1993[4]	1994[4]	1995[4]
Total emissions/storage	305,4	231,7	199,6	190,8	180,6	172,3
1 Energy-related emissions	299,8	229,5	196,4	187,6	177,4	169,1
A Combustion-related	299,8	229,5	196,4	187,6	177,4	169,1
1 Energy/transformation	163,9	136,6	120,0	111,8	105,7	96,5
2 Industry	49,0	26,7	19,4	16,7	15,2	15,3
3 Transport	19,8	20,2	23,0	24,7	25,5	26,2
4 Residential, inst., commercial[1]	59,4	40,5	30,5	31,6	28,8	28,8
– Residential	35,1	22,5	18,3	19,3	18,4	19,3
– Institutional, commercial	24,3	18,0	12,3	12,2	10,4	9,5
5 Other (incl. military)[2]	7,7	5,4	3,4	2,9	2,3	2,3
6 Combustion of biomass			not relevant			
B Extraction/dist. of fuels			no data available			
2 Industriy (non-en.)	5,6	2,2	3,2	3,2	3,2	3,2
International Transports[3]	1,9	0,6	0,5	0,8		
Maritime bunkering	1,4	0,4	0,3	0,6	0,6	0,6
International air transports	0,5	0,2	0,1	0,2	0,2	0,2

[1] Not incl. mobile sources in agriculture and silviculture, not incl. blue-water fisheries
[2] Incl. mobile sources in agriculture and silviculture
[3] Not included in total emissions; including blue-water fisheries
[4] Tentative figures
Sources: UBA; AG Energiebilanzen; DIW

4. Inventories of anthropogenic emissions of greenhouse gases and of carbon storage

4.1 Emissions categories

The emissions categories prescribed by the IPCC 95 Guidelines for national greenhouse gas inventories have been used for the present report. The purpose of these categories is to ensure that the emissions inventories provided by different countries all conform to a standard structure and are comparable.

These categories for national total emissions data do not include emissions caused by international activities (maritime commerce (bunkering), air transports). Nonetheless, data for these emissions has been included as added information in the inventory tables 4.4.2 to 4.4.7.

4.2 Presentation and determination

Emissions levels are determined with the standard sectoral method, which is also the basis for the IPCC Guidelines. In addition to energy-related emissions, it also includes emissions from industrial processes and other processes.

The characteristic feature of this method is its sectoral approach, in which different emissions source categories are treated separately. This approach makes it possible to take special aspects of different emissions-source groups, which vary widely in their emissions parameters, into account as is appropriate.

The data is summarised for the years 1990 to 1994 in the form of the overview tables prescribed by the IPCC ’95 Guidelines. A special research project has now made it possible, for the first time, to present detailed emissions data for HFC, CF_4, C_2F_6 and SF_6 for 1990 to 1995. For 1995, apart from the calculations on CO_2 emissions, only estimates concerning total emissions of direct greenhouse gases are available. In addition, only tentative data for total CO_2 emissions can be provided for 1996.

All of the emissions data as of 1993 is somewhat preliminary; relevant comprehensive reference data is still lacking.

The First National Report included very detailed explanations of the methods used to determine emissions levels. That information on determination of emissions data remains valid.

To date, only rough estimates can be given for emissions from combustion of biomass for energy production. The same holds for methane emissions from wastewater treatment and for emissions in the new Federal *Länder* from recycling of sewage sludge (landfills and deposition). Since the reference data for these categories is very uncertain, these emissions have not been included in the updates of the emissions inventories. Additional research is required in this area.

4.3 Accuracy of emissions data

Some of the emissions data is subject to considerable uncertainty. To some extent, this is due to a lack of information regarding the details of certain emissions-causing processes. But another, much more significant reason is a lack of data regarding the extent of certain emissions-relevant activities.

With the exception of the CO_2 data, emissions factors have been calculated on the basis of measurements made largely under defined conditions, although the number of such measurements, in many cases, must be termed inadequate. This applies especially to non-energy-related emissions. Additional research is being carried out in this area.

In general, data for combustion-related emissions is considerably more reliable than that for emissions from other processes, some of which begin with very complicated initial processes.

4.4 Emissions of greenhouse gases

The following section presents an overview, for the period from 1990 to 1995, of data for the directly acting greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (laughing gas, N_2O), hydrofluorocarbons (HFC), perfluorocarbons (CF_4, C_2F_6) and sulphur hexafluoride (SF_6). While ozone is also an important greenhouse gas, it is not emitted as such; instead, it is formed through photochemical reactions in the atmosphere, from indirectly acting greenhouse gases (precursors). For this reason, emissions of the precursors nitrogen oxides (NOx), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC) have been included in the overviews as emissions of indirectly acting greenhouse gases.

Data for chlorofluorocarbons (CFC), partially halogenated chlorofluorocarbons (H-CFC) and halons, pursuant to the provisions of the Framework Convention on Climate Change, need not be included this report, because these substances are controlled by the Montreal Protocol. Nonetheless, emissions data for these substances has been included, due to their significant role in the greenhouse effect.

Total emissions data for 1990 to 1995 (or 1996), for CO_2, HFC, CF_4, C_2F_6, SF_6, is listed in Table 4.4.1.

The emissions trends between 1990 and 1995 are shown in Tables 4.4.2–4.4.7, by sectors.

These tables show the emissions trends for the greenhouse gases described in greater detail in chapters 4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.7, 4.4.8 and 4.4.9.

Tab. 4.4.1: Emissions of directly and indirectly acting greenhouse gases (Gg) in Germany (data for HFC, CF_4, C_2F_6 and SF_6 in Mg)

	1987	1990	1991	1992	1993*)	1994*)	1995*)	1996*)
Directly acting greenhouse gases:								
CO_2	1073924	1014155	975248	926562	918300	904500	894500	910000
CH_4	5750	5682	5250	5194	5013	4849	4788	NA
N_2O	241	226	220	226	218	219	210	NA
HFC	200[3)]	200	200	302	1165	1942	2214	NA
CF_4	370[3)]	355	308	278	260	214	218	NA
C_2F_6	45[3)]	42	38	36	35	31	27	NA
SF_6	160[3)]	163	182	204	226	242	251	NA
CO_2 equivalents[1)]:	1278 000[2)]	1212477	1162739	1115165	1102313	1085655	1071034	NA
Indirectly acting greenhouse gases:								
NO_x (as NO_2)	3177	2640	2509	2357	2274	2211	NA	NA
NMVOC	3220	3155	2748	2505	2289	2135	NA	NA
CO	11936	10743	9046	7926	7379	6738	NA	NA
Aerosol precursors:								
SO_2	7347	5326	4172	3436	3153	2995	NA	NA

* tentative figures
NA: No data available
1) GWP figures: 2nd IPCC Report 1995, time horizon 100 years (cf. Tab. 4.6.7)
2) including estimate for HFC, CF_4, C^2F_6 and SF_6
3) Estimates
Source: AG Energiebilanzen, Federal Environmental Agency (UBA)

Tab. 4.4.2: Emissions of greenhouse gases in Germany pursuant to IPCC – 1990, data in Gg

Sources and sinks of greenhouse gases	CO_2 Emissions	CO_2 storage	CH_4	N_2O	NO_X as NO_2	CO	NMVOC not incl. CFC and halons
Total emissions/storage	**1014155**	**30000[4)]**	**5682**	**226**	**2640**	**10743**	**3155**
1 Energy-related emissions	**986640**		**1768**	**37**	**2606**	**10059**	**1902**
A Combustion-related	**986640**		**205**	**37**	**2606**	**10032**	**1619**
1 Energy and transformation industries	439427		13	15	658	197	11
2 Industry	169741		14	4	277	848	14
3 Transport	158647		66	11	1310	6529	1418
4 Residential, commercial and institutional[1)]	198190		109	6	170	2241	113
5 Other (incl. military)[2)]	20635		3	1	191	217	63
6 Combustion of biomass	NR		NA	NA	NA	NA	NA
B Production, processing and distribution of fuels	**NA**		**1563**	**0**	**0**	**27**	**283**
1 Solid fuels	NR		1230	NR	NR	NR	6
2 Oil and gas	NA		333	0	0	27	277
2 Industrial processes	**27515**		**0**	**83**	**34**	**684**	**93**
3 Solvent and other product use	**NR**		**NR**	**6**	**NR**	**NR**	**1160**
4 Agriculture	**NR**		**2044**	**96**	**NA**	**NA**	**NA**
A Fermentation	NR		1430	NR	NR	NR	NR
B Animal waste	NR		614	11	NR	NR	NR
D Agricultural soils	NR		NR	85	NR	NR	NR
F Combustion of agricultural waste	NR		NA	NA	NA	NA	NA
5 Land-use changes and forestry		**30000[4)]**	**NR**	**NR**	**NR**	**NR**	**NR**
A Changes in forests		30000	NR	NR	NR	NR	NR
B Conversion of forest and grassland into farmland	NR		NR	NR	NR	NR	NR
C Set-asides of agricultural land		NA	NR	NR	NR	NR	NR
6 Waste management	**NA**		**1870**	**4**	**NA**	**NA**	**NA**
A Landfills	NR		1777	NR	NR	NR	NR
B Wastewater treatment	NR		93	4	NR	NR	NR
C Waste incineration	NA		NA	NA	NA	NA	NA
International transports[3)]	19569		0	NA	206	96	26

1) Not including transports in agriculture, silviculture and fisheries
2) Including transports in agriculture, silviculture and fisheries
3) Not included in total emissions
4) Rough estimates
NR Not relevant
NA No data available

Tab. 4.4.3: Emissions of greenhouse gases in Germany pursuant to IPCC – 1991, data in Gg

Sources and sinks of greenhouse gases	CO_2 Emissions	CO_2 Storage	CH_4	N_2O	NO_X as NO_2	CO	NMVOC not incl. CFC and halons
Total emissions/storage	**975 248**	**30 000[4)]**	**5 250**	**220**	**2 509**	**9 046**	**2 748**
1 Energy-related emissions	**950 625**		**1 631**	**39**	**2 484**	**8 401**	**1 526**
A Combustion-related	**950 625**		**157**	**39**	**2 484**	**8 278**	**1 275**
1 Energy and transformation industries	426 597		11	14	633	187	11
2 Industry	147 060		10	5	238	753	11
3 Transport	162 107		52	14	1 287	5 635	1 118
4 Residential, commercial and institutional[1)]	200 004		80	5	157	1 633	81
5 Other (incl. military)[2)]	14 857		3	1	168	170	54
6 Combustion of biomass	NR		NA	NA	NA	NA	NA
B Production, processing and distribution of fuels	**NA**		**1 474**	**0**	**0**	**23**	**251**
1 Solid fuels	NR		1 122	NR	NR	NR	5
2 Oil and gas	NA		352	0	0	23	246
2 Industrial processes	**24 623**		**0**	**84**	**25**	**645**	**88**
3 Solvent and other product use	**NR**		**NR**	**6**	**NR**	**NR**	**1 134**
4 Agriculture	**NR**		**1 805**	**87**	**NA**	**NA**	**NA**
A Fermentation	NR		1 270	NR	NR	NR	NR
B Animal waste	NR		536	9	NR	NR	NR
D Agricultural soils	NR		NR	77	NR	NR	NR
F Combustion of agricultural waste	NR		NA	NA	NA	NA	NA
5 Land-use changes and forestry		**30 000[4)]**	**NR**	**NR**	**NR**	**NR**	**NR**
A Changes in forests		30 000	NR	NR	NR	NR	NR
B Conversion of forest and grassland into farmland	NR		NR	NR	NR	NR	NR
C Set-asides of agricultural land		NA	NR	NR	NR	NR	NR
6 Waste management	**NA**		**1 814**	**4**	**NA**	**NA**	**NA**
A Landfills	NR		1 707	NR	NR	NR	NR
B Wastewater treatment	NR		107	4	NR	NR	NR
C Waste incineration	NA		NA	NA	NA	NA	NA
International transports[3)]	18 099		0	NA	186	99	24

[1)] Not including transports in agriculture, silviculture and fisheries
[2)] Including transports in agriculture, silviculture and fisheries
[3)] Not included in total emissions
[4)] Rough estimates
NR Not relevant
NA No data available

Tab. 4.4.4: Emissions of greenhouse gases in Germany pursuant to IPCC - 1992, data in Gg

Sources and sinks of greenhouse gases	CO_2 Emissions	CO_2 Storage	CH_4	N_2O	NO_X as NO_2	CO	NMVOC not incl. CFC and halons
Total emissions/storage	**926562**	**30 000[4)]**	**5194**	**226**	**2357**	**7926**	**2505**
1 Energy-related emissions	**901383**		**1594**	**40**	**2336**	**7327**	**1325**
A Combustion-related	**901383**		**136**	**40**	**2336**	**7311**	**1100**
1 Energy and transformation industries	400775		10	15	529	176	10
2 Industry	135504		10	5	193	720	9
3 Transport	168297		50	16	1323	5019	968
4 Residential, commercial and institutional[1)]	184769		64	5	141	1242	64
5 Other (incl. military)[2)]	12038		3	0	150	154	49
6 Combustion of biomass	NR		NA	NA	NA	NA	NA
B Production, processing and distribution of fuels	**NA**		**1458**	**0**	**0**	**16**	**225**
1 Solid fuels	NR		1073	NR	NR	NR	4
2 Oil and gas	NA		385	0	0	16	221
2 Industrial processes	**25179**		**0**	**93**	**21**	**599**	**90**
3 Solvent and other product use	**NR**		**NR**	**6**	**NR**	**NR**	**1090**
4 Agriculture	**NR**		**1718**	**83**	**NA**	**NA**	**NA**
A Fermentation	NR		1202	NR	NR	NR	NR
B Animal waste	NR		516	9	NR	NR	NR
D Agricultural soils	NR		NR	74	NR	NR	NR
F Combustion of agricultural waste	NR		NA	NA	NA	NA	NA
5 Land-use changes and forestry		**30 000[4)]**	**NR**	**NR**	**NR**	**NR**	**NR**
A Changes in forests		30 000	NR	NR	NR	NR	NR
B Conversion of forest and grassland into farmland	NR		NR	NR	NR	NR	NR
C Set-asides of agricultural land		NA	NR	NR	NR	NR	NR
6 Waste management	**NA**		**1881**	**4**	**NA**	**NA**	**NA**
A Landfills	NR		1753	NR	NR	NR	NR
B Wastewater treatment	NR		128	4	NR	NR	NR
C Waste incineration	NA		NA	NA	NA	NA	NA
International transports[3)]	17818		0	NA	167	98	24

[1)] Not including transports in agriculture, silviculture and fisheries
[2)] Including transports in agriculture, silviculture and fisheries
[3)] Not included in total emissions
[4)] Rough estimates
NR Not relevant
NA No data available

Tab. 4.4.5: Emissions of greenhouse gases in Germany pursuant to IPCC - 1993, data in Gg

Sources and sinks of greenhouse gases	CO_2 Emissions	CO_2 Storage	CH_4	N_2O	NO_X as NO_2	CO	NMVOC not incl. CFC and halons
Total emissions/storage	**918300**	**30 000[4]**	**5013**	**218**	**2274**	**7379**	**2289**
1 Energy-related emissions	**893100**		**1430**	**41**	**2253**	**6782**	**1109**
A Combustion-related	**893100**		**130**	**41**	**2253**	**6768**	**946**
1 Energy and transformation industries	38170		10	14	499	168	10
2 Industry	127000		10	5	173	672	9
3 Transport	172500		45	18	1302	4522	814
4 Residential, commercial and institutional[1]	193500		63	5	140	1249	64
5 Other (incl. military)[2]	12500		2	0	137	157	49
6 Combustion of biomass	NR		NA	NA	NA	NA	NA
B Production, processing and distribution of fuels	**NA**		**1 300**	**0**	**0**	**14**	**163**
1 Solid fuels	NR		950	NR	NR	NR	4
2 Oil and gas	NA		350	0	0	14	159
2 Industrial processes	**25200**		**8**	**86**	**23**	**597**	**90**
3 Solvent and other product use	**NR**		**NO**	**6**	**NO**	**NO**	**1090**
4 Agriculture	**NR**		**1688**	**81**	**NA**	**NA**	**NA**
A Fermentation	NR		1178	NR	NR	NR	NR
B Animal waste	NR		510	9	NR	NR	NR
D Agricultural soils	NR		NR	72	NR	NR	NR
F Combustion of agricultural waste	NR		NA	NA	NA	NA	NA
5 Land-use changes and forestry		**30000[4]**	**NR**	**NR**	**NR**	**NR**	**NR**
A Changes in forests		30000	NR	NR	NR	NR	NR
B Conversion of forest and grassland into farmland	NR		NR	NR	NR	NR	NR
C Set-asides of agricultural land		NA	NR	NR	NR	NR	NR
6 Waste management	**NA**		**1895**	**4**	**NA**	**NA**	**NA**
A Landfills	NR		1780	NR	NR	NR	NR
B Wastewater treatment	NR		115	4	NR	NR	NR
C Waste incineration	NA		NA	NA	NA	NA	NA
International transports[3]	20100		0	NA	161	98	24

[1] Not including transports in agriculture, silviculture and fisheries
[2] Including transports in agriculture, silviculture and fisheries
[3] Not included in total emissions
[4] Rough estimates

NR Not relevant
NA No data available

Tab. 4.4.6: Emissions of greenhouse gases in Germany pursuant to IPCC – 1994, data in Gg

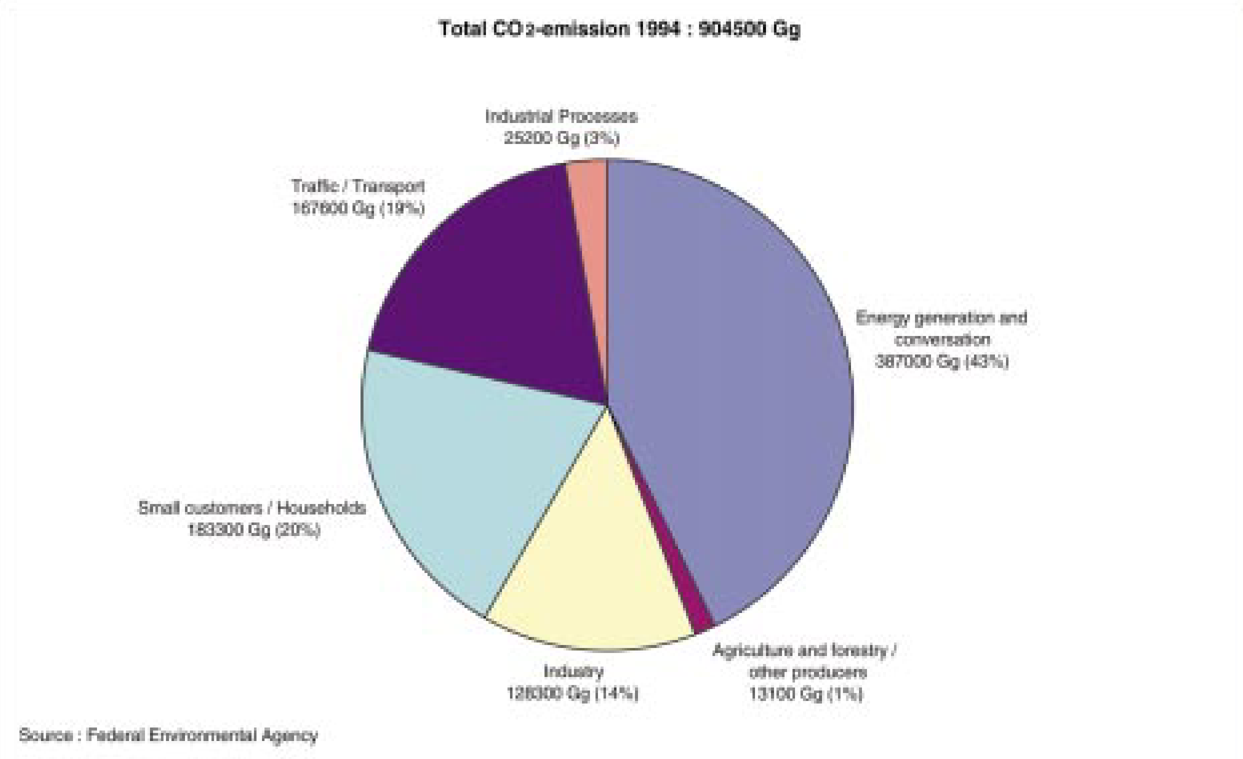
Sources and sinks of greenhouse gases	CO_2 Emissions	CO_2 Storage	CH_4	N_2O	NO_X as NO_2	CO	NMVOC not incl. CFC and halons
Total emissions/storage	**904500**	**30000[4)]**	**4 849**	**219**	**2211**	**6738**	**2135**
1 Energy-related emissions	**879300**		**1 289**	**42**	**2188**	**6143**	**955**
A Combustion-related	**879300**		**119**	**42**	**2188**	**6130**	**821**
1 Energy and transformation industries	387000		10	14	500	167	10
2 Industry	128300		10	5	173	675	9
3 Transport	167600		40	19	1249	4018	693
4 Residential, commercial and institutional[1)]	183300		57	5	130	1112	64
5 Other (incl. military)[2)]	13100		2	0	136	158	49
6 Combustion of biomass	NR		NA	NA	NA	NA	NA
B Production, processing and distribution of fuels	**NA**		**1170**	**0**	**0**	**13**	**134**
1 Solid fuels	NR		850	NR	NR	NR	4
2 Oil and gas	NA		320	0	0	13	130
2 Industrial processes	**25200**		**0**	**81**	**23**	**595**	**90**
3 Solvent and other product use	**NR**		**NR**	**6**	**NR**	**NR**	**1 090**
4 Agriculture	**NR**		**1 660**	**86**	**NA**	**NA**	**NA**
A Fermentation	NR		1 162	NR	NR	NR	NR
B Animal waste	NR		498	9	NR	NR	NR
D Agricultural soils	NR		NO	77	NR	NR	NR
F Combustion of agricultural waste	NR		NA	NA	NA	NA	NA
5 Land-use changes and forestry		**30000[4)]**	**NR**	**NR**	**NR**	**NR**	**NR**
A Changes in forests		30000	NR	NR	NR	NR	NR
B Conversion of forest and grassland into farmland	NR		NR	NR	NR	NR	NR
C Set-asides of agricultural land		NA	NR	NR	NR	NR	NR
6 Waste management	**NA**		**1 900**	**4**	**NA**	**NA**	**NA**
A Landfills	NR		1 780	NR	NR	NR	NR
B Wastewater treatment	NR		120	4	NR	NR	NR
C Waste incineration	NA		NA	NA	NA	NA	NA
International transports[3)]	20 100		0	NA	161	98	24

Tab. 4.4.7: Emissions of greenhouse gases in Germany pursuant to IPCC – 1995, data in Gg

Sources and sinks of greenhouse gases	CO_2 Emissions	CO_2 Storage	CH_4	N_2O	NO_X as NO_2	CO	NMVOC not incl. CFC and halons
Total emissions/storage	**894500**	**30000[4)]**	**4788**	**210**			
1 Energy-related emissions	**869300**						
A Combustion-related	**869300**						
1 Energy and transformation industries	373200						
2 Industry	126800						
3 Transport	170700						
4 Residential, commercial and institutional[1)]	186100						
5 Other (incl. military)[2)]	12500						
6 Combustion of biomass	NR						
B Production, processing and distribution of fuels	**NA**						
1 Solid fuels	NO						
2 Oil and gas	NA						
2 Industrial processes	**25 200**						
3 Solvent and other product use	**NR**						
4 Agriculture	**NR**						
A Fermentation	NR						
B Animal waste	NR						
D Agricultural soils	NR						
F Combustion of agricultural waste	NR						
5 Land-use changes and forestry		**30000[4)]**					
A Changes in forests		30000					
B Conversion of forest and grassland into farmland	NR						
C Set-asides of agricultural land		NA					
6 Waste management	**NA**						
A Landfills	NR						
B Wastewater treatment	NR						
C Waste incineration	NA						
International transports[3)]	20 100						

[1)] Not including transports in agriculture, silviculture and fisheries
[2)] Including transports in agriculture, silviculture and fisheries
[3)] Not included in total emissions
[4)] Rough estimates
NR Not relevant
NA No data available

Fig. 4.4.1.1: Sources of CO_2 emissions in Germany in 1994



4.4.1 Carbon dioxide (CO_2)

Development of emissions since 1970 was described in detail in the First National Report. The present report describes the development from 1987 to 1996, although the figures for 1993 to 1996 are still tentative. From 1990 to 1995, emissions decreased continually, by a total of about 12 %, from 1,014,000 Gg to 894,500 Gg. Due to the severity of the 1995/96 and 1996/97 winters, CO_2 emissions in 1996 increased by 15,500 Gg. All in all, emissions decreased by a total of 10.4 % between 1990 and 1996.

Whereas emissions fell sharply in the energy and transformation industries, and decreased slightly in the industrial, residential, institutional and commercial areas, emissions in the transport sector increased.

4.4.1.1 IPCC Reference Approach for CO_2

Both the sectoral method and the IPCC Guidelines' Reference Approach were used to calculate carbon dioxide emissions. The Reference Approach is used to determine the amounts of carbon released annually through fuel use in energy production. It considers total use of the various relevant fuels, without correlating fuel use with particular emissions-source groups. In addition, the Reference Approach focuses exclusively on energy-related CO_2 emissions.

The necessary reference data for domestic primary energy consumption by fuels and non-energy fuel use has been taken from the national energy balance. Precise analyses of

Tab. 4.4.1.1.1: Comparison of the results of the Reference Approach with those of the Federal Environmental Agency's sectoral calculations

Year	Total CO_2 emissions in Gg (only energy-related)		Discrepancy with respect to the sectoral calculation	
	Reference Approach	Sectoral calculation	in Gg	in %
1987	1 042 338	1 044 731	– 2 393	– 0,2
1990	983 528	986 640	– 3 112	– 0,3
1991	948 549	950 625	– 2 076	– 0,2
1992	904 325	901 383	2 942	0,3
1993	896 608	893 100[1)]	3 508	0,4

[1)] tentative figure
Source: Federal Environmental Agency (UBA)

fuels used are necessary to determine pertinent emissions factors.

In particular, detailed considerations are needed to assess emissions of the crude oil used in Germany, since the sectoral emissions calculations do not include this fuel.

For Germany, the Reference Approach was first applied to the period from 1990–1993, and to 1987 for comparison (cf. Annex E). The method cannot yet be applied to 1994 and 1995, since the national energy balances for those years are not yet available.

Because it has not yet been possible to determine the relevant emissions factors for Germany – as a result of the above-described difficulties – the "default" factors from the IPCC Guidelines have been used. The sole exception is the emissions factor for lignite. The default factor for that fuel seemed too low, and the factor has been set at 28.5 tC/TJ.

An additional problem is that it is difficult to obtain a detailed picture of hard coal use. The energy balance permitted only an overall consideration of hard coal; i.e. no breakdown into the various different types of hard coal was possible.

Table 4.4.1.1.1 compares the results of the sectoral emissions calculations with the results obtained with the Reference Approach. The results differ by no more than 4000 Gg carbon dioxide (corresponds to a discrepancy of less than 0.5 percent).

In evaluating the results, the Reference Approach's unavoidable approximations and simplifications must be taken into account. While the confirmation of the standard sectoral method is quite satisfactory, this confirmation still requires further reinforcement through systematic study of specific national characteristics.

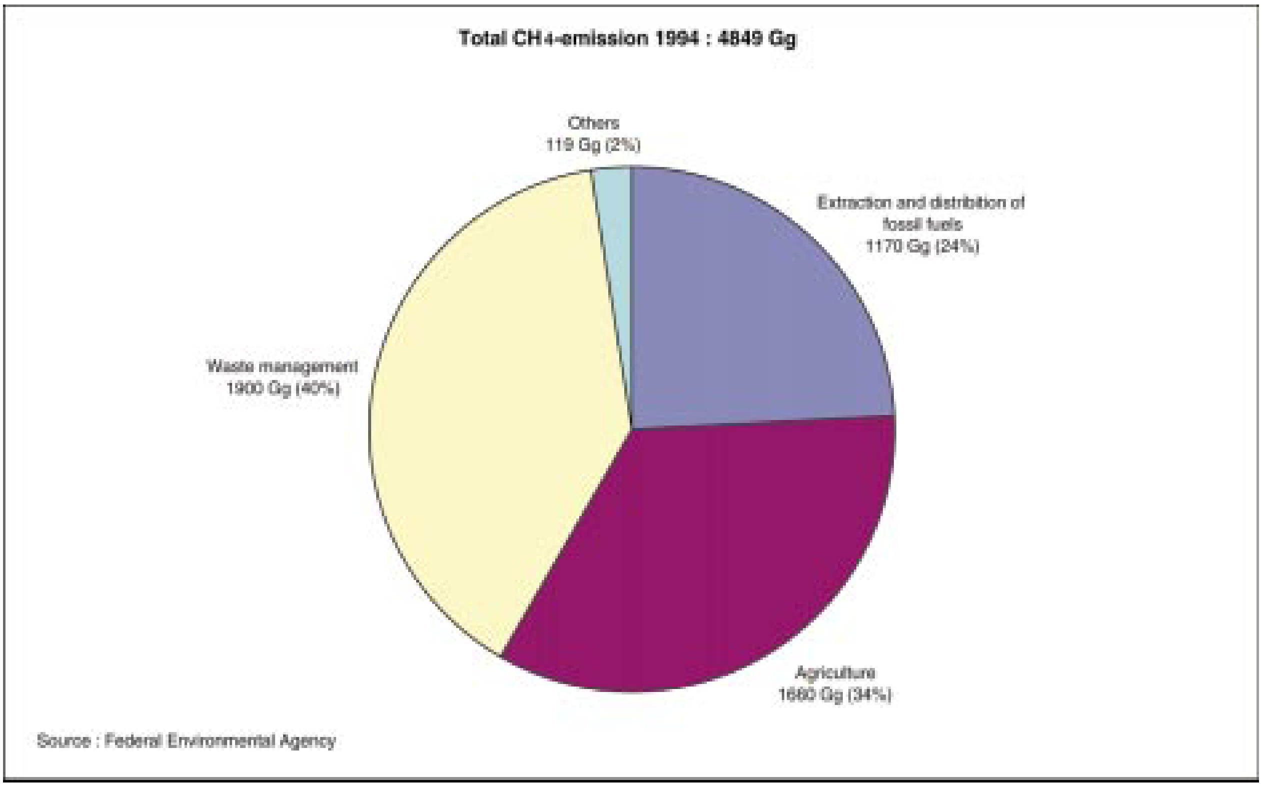
4.4.1.2 Sectoral method (Technological Approach)

In contrast with the Reference Approach, sectoral emissions calculation considers the technological particularities of the various emissions-source groups. In addition to energy-related emissions, it also examines industrial and other process emissions.

In Germany, the sectoral method has traditionally been the standard procedure for calculating emissions of all relevant components and substance groups. The main difference between it and the comparative method is that it analyses emissions in considerably greater detail. It correlates energy use, which the Reference Approach considers in toto, with the various relevant use/emissions-source groups. This in turn makes it possible to use emissions factors, which provide significantly better representation of the differences between the various emissions-source groups with regard to technical particularities of combustion. In addition, the effects of primary and secondary measures aimed at reducing pollutant emissions – measures which are mainly applied only to individual emissions-source groups – can be described much more effectively with this method.

The standard method's advantage with regard to CO_2 emissions is that it breaks emissions down by sectors. Its overall data is not more reliable, however.

Fig. 4.4.2.1: Sources of CH_4 emissions in Germany in 1994



4.4.2 Methane (CH_4)

Energy-related processes, which play such an important role in carbon dioxide emissions, play only a minor role in methane emissions. The main sources of methane emissions are waste management (gas releases from landfills and from wastewater treatment installations); agricultural animal husbandry; and fuel production, processing and distribution. Each of these three major areas contributes nearly one third of total emissions. Tables 4.4.1 through 4.4.7 provide an overview of trends in methane emissions. The statements made in Chapter 4.4.1 regarding the period under consideration and the tentative nature of the values provided apply here as well.

Overall, methane emissions decreased continually between 1990 and 1994. The trends in the individual emissions-source groups differed, however.

Until 1992, methane emissions in agriculture decreased sharply, by 19%. This decreasing trend remained strong until 1994, when it began to weaken. The contribution of these methane emissions to total emissions decreased slightly (2%). Emissions from production and distribution of fuels decreased by 25%. The contribution of this category's methane emissions to total emissions also decreased slightly (2%).

The main source of methane emissions is the waste management sector, in which emissions has been slightly increasing since 1991. This sector's contribution to total emissions increased from 33% in 1990 to 40% in 1994.

4.4.3 Nitrous oxide (N_2O)

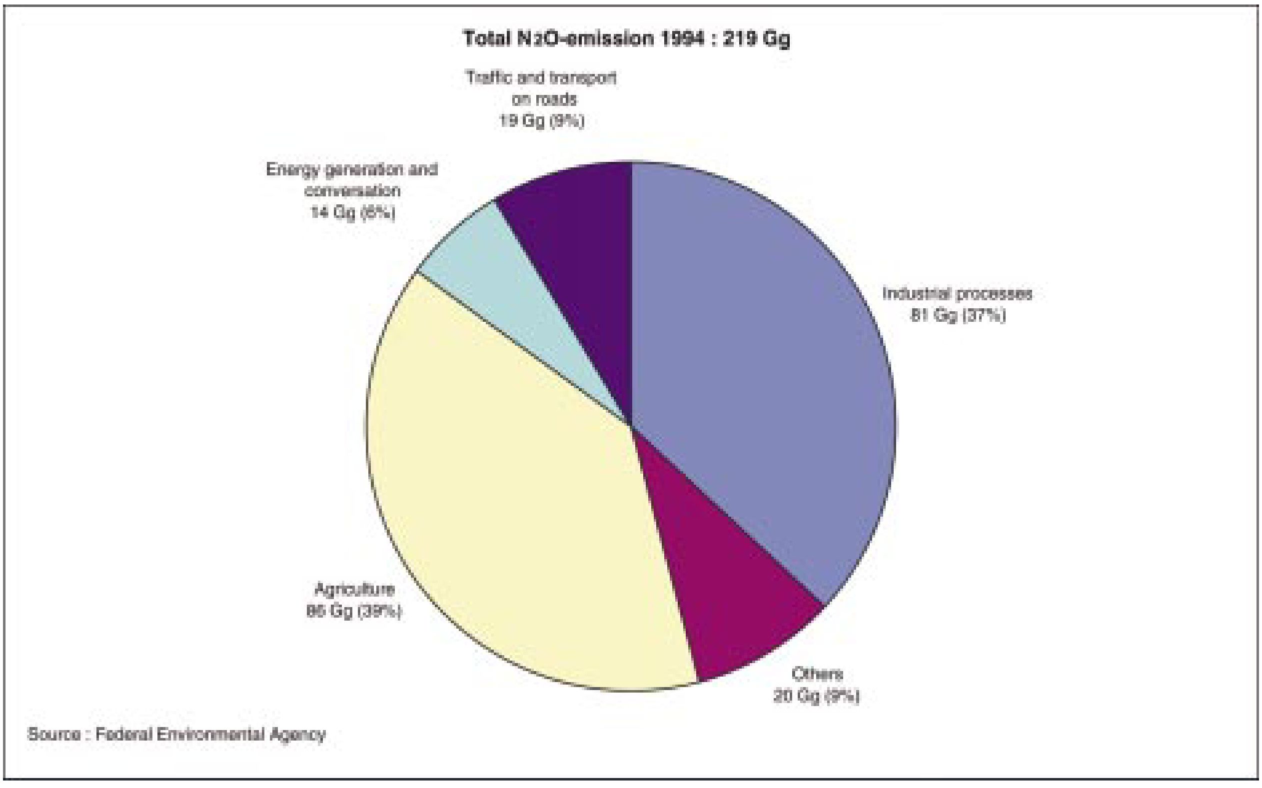
The main sources of N_2O emissions in the period under review were, in order of importance, industrial production processes (especially adipic acid production), agriculture and combustion of fossil fuels (firing systems, motor vehicles).

The IPCC guidelines for determination of N_2O emissions from farmland have been revised. The revised guidelines have been followed with regard to selection of emissions factors and to the method used to calculate N_2O emissions from agricultural land.

Consequently, and as a result of consideration of farm fertilisers of animal origin, the N_2O emissions figures differ somewhat from those in the First National Report. The result is a change in the N_2O emissions factor: from 0.032 kg N_2O/kg N-fertiliser of direct and indirect emissions to 0.0196 kg N_2O/kg N-fertiliser (only direct emissions); this is also a change to the mean value proposed by the IPCC.

N_2O emissions decreased between 1990 and 1994. The increases of N_2O emissions from adipic acid production resulted from higher production. Beginning in 1993, one manufacturer was able to stop and even roll back these increases by operating an installation for thermal decomposition of N_2O. A second manufacturer of adipic acid is making preparations for an installation that will prevent generation of N_2O. Agricultural emissions decreased sharply from 1990 to 1991; only slight further decreases have occurred since then. In the transport sector, N_2O emissions increased as a result of greater use of catalytic converters.

Fig. 4.4.3.1: Sources of N_2O emissions in Germany in 1994



Tab. 4.4.4.1: CF_4 and C_2F_6 emissions 1990 – 1995 (Mg)

Emissions source	1990	1991	1992	1993*	1994*	1995*
			CF_4			
Aluminium smelting	335	287	257	238	199	209
Manufacturing of printed circuit boards	3,4	3,6	3,8	4,0	4,3	4,3
Semiconductor industry	6,8	7,1	7,5	7,8	7,8	4,5
Secondary chemical industry	10	10	10	10	3	–
Total CF_4	355	308	278	260	214	218
			C_2F_6			
Aluminium smelting	34	29	26	24	20	21
Semiconductor industry	8,4	9,2	10,1	10,9	10,9	6,4
Total C_2F_6	42	38	36	35	31	27

* Tentative figures
Source: Schwarz, W.: Aktuelle und künftige treibhauswirksame Emissionen fluorierter Verbindungen in Deutschland im Auftrag des Umweltbundesamtes, Berlin 1996

4.4.4 Perfluorocarbons (PFC)

By far the largest source of CF_4 emissions, with a contribution of about 95%, is aluminium smelting. The other 5% of total CF_4 emissions are generated by plasma etching in the electronics industry. CF_4 was also formerly emitted as a by-product in CFC production. Some 65% of C_2F_6 emissions originate in the primary aluminium industry. Some 35% are produced through use of C_2F_6 as an etching gas in semiconductor production.

Table 4.4.4.1 provides a detailed overview of trends in CF_4 and C_2F_6 emissions.

The table shows that emissions decreased considerably from 1990 to 1995: CF_4 emissions decreased by 39%, and

Fig. 4.4.4.1: Sources of CF_4 emissions in Germany in 1994

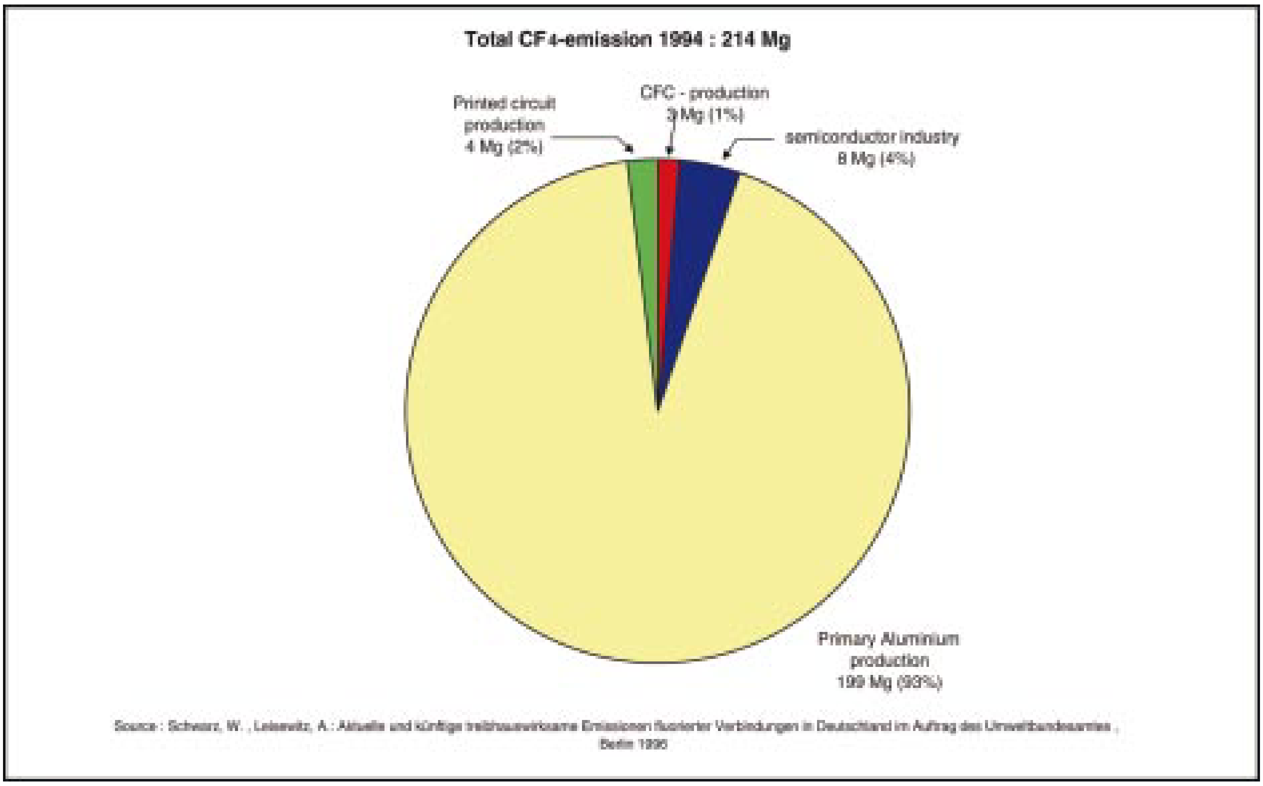
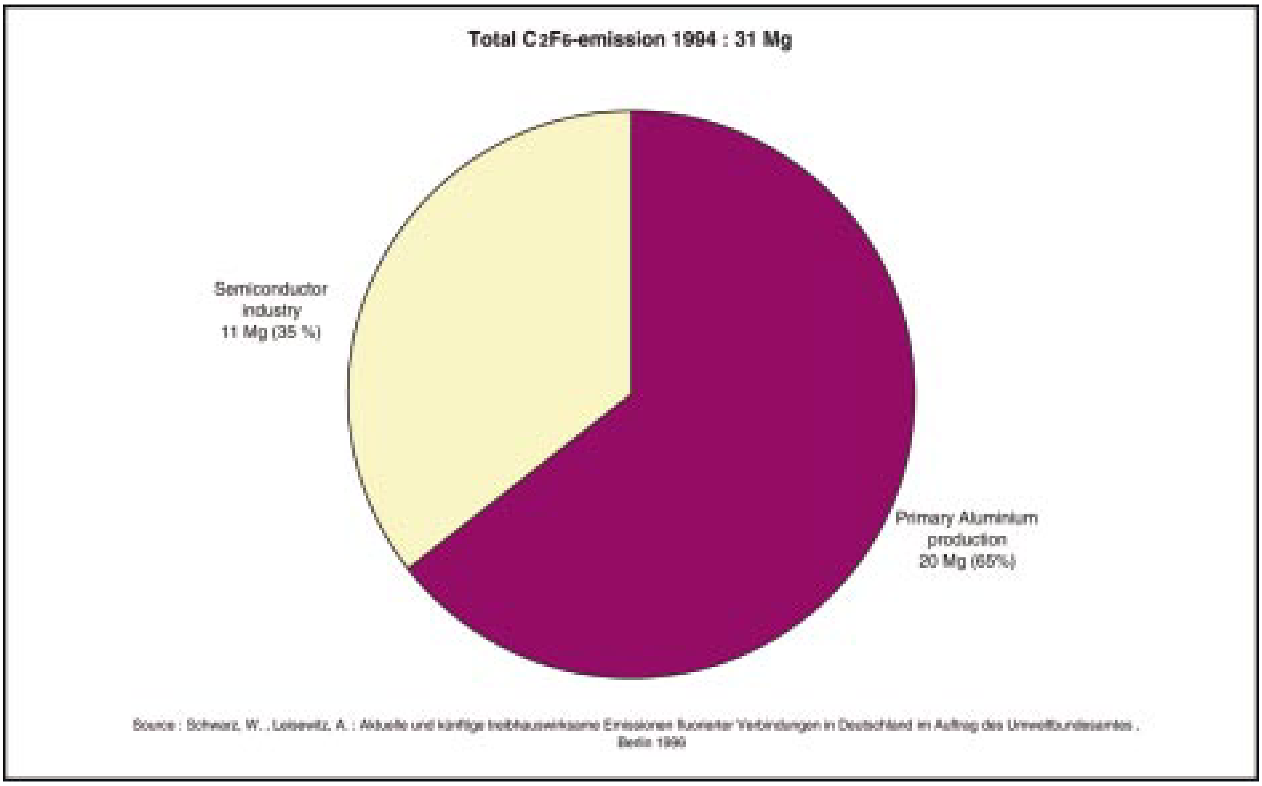


Fig. 4.4.4.2: Sources of C_2F_6 emissions in Germany in 1994



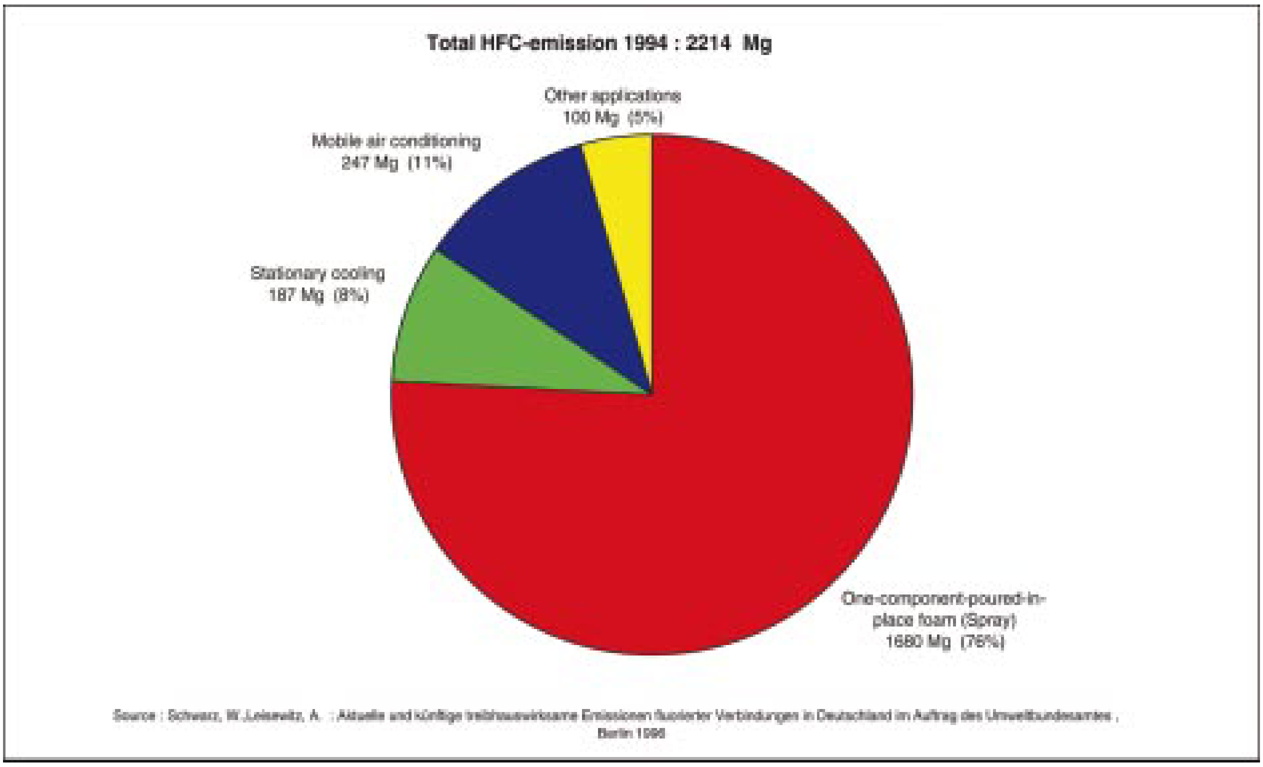
C_2F_6 emissions decreased by 36%. After 1994, CFC production generated no further CF_4 emissions.

Further reductions in PFC emissions are expected to result from the primary aluminium industry's voluntary commitment to reduce these emissions (cf. Tab. 5.2.6).

4.4.5 Hydrofluorocarbons (HFC)

Since the early 1990s, use of hydrofluorocarbons (HFC) as substitutes for CFC, which deplete the ozone layer and contribute to the greenhouse effect, has been increasing. Currently, the main sources of HFC emissions are PU insulation foams in spray cans, for which the primary propellants

Fig. 4.4.5.1: Sources of HFC emissions in Germany in 1995



Tab. 4.4.5.1: Sources of HFC emissions in Germany in 1995

Source	Mg	%
PU insulation foam	1680	76%
Stationary refrigeration systems	187	8%
Mobile refrigeration systems	247	11%
Other uses	100	5 %

are HFC 134a (CH_2FCF_3) and, increasingly, HFC 152a ($C_2H_4F_2$). Additional emissions sources are mobile and stationary freezer and refrigeration systems and production of H-CFC 22 (CF_2HC_l), during which HFC 23 (CHF_3) is produced as a by-product.

Prior to 1991/92, HFC were not available on an industrial scale in Germany as CFC substitutes, and HFC emissions were generated only in production of H-CFC 22. From 1990 to 1995, as a result of the growing use of HFC as substitutes for fully and partially halogenated fluorocarbons, HFC emissions in Germany increased from 200 Mg/a to 2214 Mg/a – i.e. increased by a factor of more than ten.

4.4.6 Sulphur hexafluoride (SF_6)

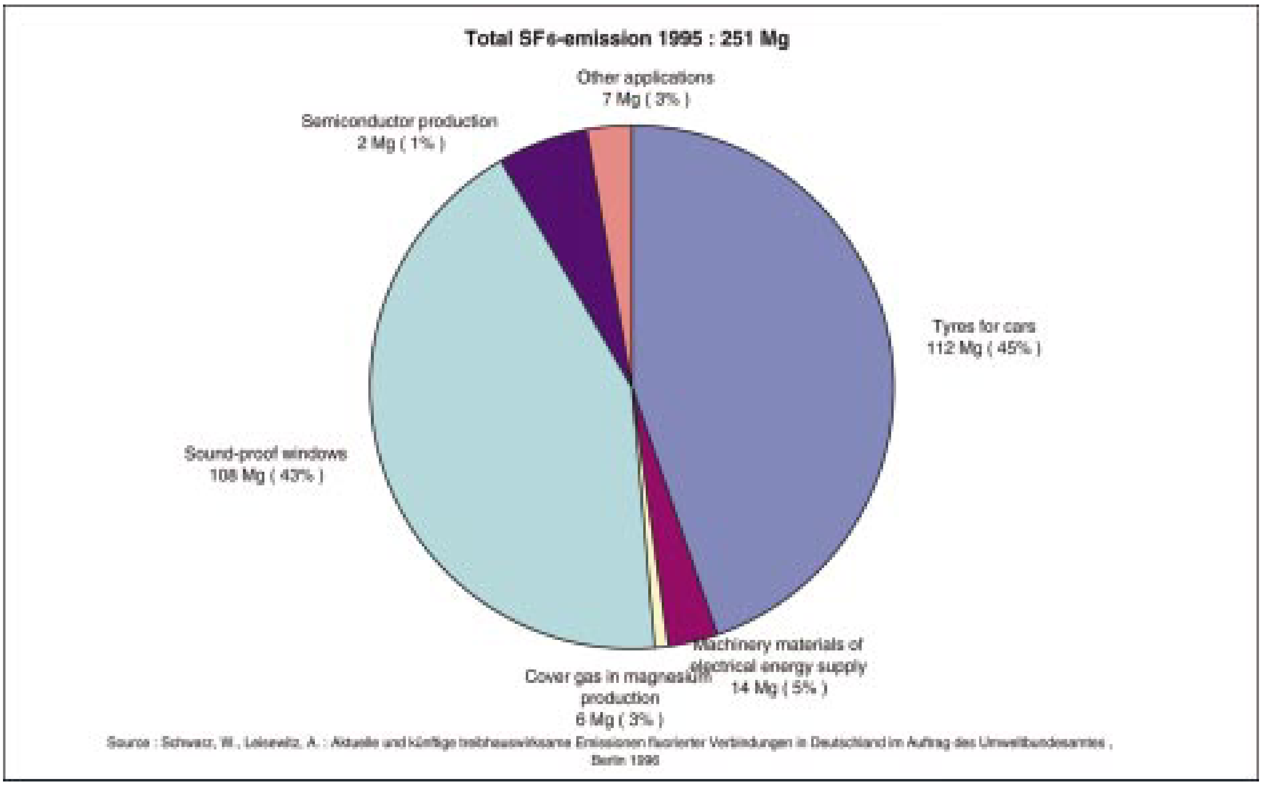
In 1995, a total of 251 Mg of SF_6 was emitted in Germany. The main emissions sources were soundproof windows, in which SF_6 is used as a sound-insulating fill gas, and automobile tyres filled with SF_6, instead of with air (SF_6 helps stabilise tyre pressure). In the electrical power sector, SF_6 is used as an insulating and arc-extinguishing gas in certain types of equipment (especially switching systems). But in spite of the large amounts of SF_6 used in this sector, electrical systems contributed only little to total SF_6 emissions, due to very low rates of leakage. Marginal amounts of emissions were produced through use of SF_6 as a protective gas in magnesium casting, through use of SF_6 as an etching gas in semiconductor manufacturing and through uses in other areas.

From 1990 to 1995, SF_6 emissions in Germany increased from 163 Mg/a to 251 Mg/a. The reason for this 54% increase of SF_6 emissions during the period under consideration is the increasing use of SF_6 as a fill gas in soundproof windows and automobile tyres; ultimately, usage increases resulted in emissions growth of 56% and 72%, respectively, in these two areas.

Tab. 4.4.6.1: Sources of SF_6 emissions in Germany in 1995

Source	Mg	%
Automobile tyres	112	45%
Electrical power industry equipment	14	5%
Magnesium casting	8	3%
Soundproof windows	108	43%
Semiconductor production	2	1%
Other uses	7	3%

Fig. 4.4.6.1: Sources of SF_6 emissions in Germany in 1995



Manufacturers and users of SF_6 in the area of electrical switching equipment and systems have now made commitments to take back returned SF_6, to re-use it and to dispose of it by environmentally compatible means.

4.4.7 Carbon monoxide (CO)

Carbon monoxide is generated primarily through incomplete combustion in engines and smaller firing systems. Process-related emissions occur mainly in the iron and steel, non-metallic minerals and aluminium manufacturing sectors.

Tables 4.4.1 to 4.4.6 show the development of carbon monoxide emissions.

As the tables show, these emissions continued to decrease from 1990 to 1994 (they had been decreasing since 1975); the total decrease in that period was 37%. All emissions-source groups contributed to this result, although the residential sector's contribution was disproportionately large. The reduction in the transport sector, at 40%, was also very substantial.

4.4.8 Nitrogen oxides (NOx ; does not include N_2O)

Nitrogen oxides occur almost exclusively in combustion processes in installations and engines; they are produced when the nitrogen contained in fuels and combustion air is oxidised. A relatively small process-related emissions contribution comes from the chemicals sector (nitric acid production). The volume data has been calculated as NO_2.

Emissions of this gas also decreased considerably during the 1990 to 1994 period – by about 16% (Tables 4.4.1 through 4.4.6). The decreases were due to conversions to low-emissions firing systems and to use of denox systems in large firing systems. Introduction of emissions-reducing technologies is yielding further decreases of nitrogen oxide emissions in the transport sector, in spite of increases in traffic volumes.

4.4.9 Non-methane volatile organic compounds (NMVOC)

About half of total emissions of non-methane volatile organic compounds (NMVOC) are produced by incomplete combustion processes, especially such processes in motor vehicles. Large installations such as power stations and industrial firing systems, on the other hand, are of minor importance in this connection. The transport sector’s emissions are not limited to exhaust emissions: emissions occur through evaporation from vehicles, as a result of tank ventilation and leaks (especially in carburettors), and they are produced during distribution of petrol, which is highly volatile (during storage, transfers and filling of tanks).

Other processes that play a significant role in emissions include solvent use and production processes in the mineral oil, chemical and food sectors.

Tables 4.4.1 to 4.4.7 show the development of NMVOC emissions in Germany. From 1990 to 1994, emissions decreased by 32%. This reduction was due to emissions laws for motor vehicles and to relevant legal provisions for industrial processes. Reduced use of solvents also contributed to the emissions decrease.

In the transport sector, the emissions reduction during the period under consideration was disproportionately large (over 50%). In 1990, the transport sector, with a 45% share, was the main contributor to overall emissions. By 1994, this sector's contribution had decreased to 32%, with the result that the single sector with the largest emissions contribution in that year was solvent use, even though that sector's emissions had decreased by 6% in absolute terms.

4.4.10 Sulphur dioxide (SO_2)

Sulphur dioxide is produced mainly through combustion of coal and oil.

Sulphur dioxide is the precursor for sulphate aerosols, which reflect and scatter visible light, thereby changing the atmosphere's optical properties. These changes tend to have a cooling effect.

No more than a summary of Germany’s SO_2 emissions can be given (cf. Tab. 4.4.1). Since 1980, when they amounted to 7.5 million t, they have continually decreased. Emissions in 1994 were only 40% of the emissions produced in 1980, and only 44% of the 1990 emissions.

4.5 Inventory of carbon storage – forests

4.5.1 Historical development of forested areas and of wood reserves

Germany’s climate is such that Germany, if left in a natural state, would have a virtually unbroken forest cover that would consist predominantly of deciduous broad-leaved forest; only a few special sites would be excluded.

Human beings have shaped the area’s forests since the New Stone Age. Large forest areas were cleared in the Middle Ages: a first wave of clearing occurred between 500 and 800 A.D., and the clearing climaxed between 1100 and 1300. At the end of this period, Germany’s total forested area was smaller than it is today. The forests that remained were subjected to overuse in the form of logging, grazing and removal of forest humus. In many areas, such practices resulted in considerable soil impoverishment.

In the early 19th century, Germany’s forests began to be systematically rebuilt. This became possible through progress in forestry science; the introduction of modern forest law and the establishment of effective forest administrations; and – especially – a) the development of new energy sources that supplanted firewood and b) the increases in yields achieved by modern agriculture. As harvests improved, farming was successively discontinued in many less favourable areas, beginning in the second half of the 19th century. These areas were then reforested.

A second wave of afforestation, brought about by structural changes in the agricultural sector, took place after the Second World War.

In the 19th century, and until the 1960s, afforestation relied heavily on conifers. This also applies to reforestation carried out to repair war damage. Conifers were chosen not only for economic reasons (high wood yield) and because of a lack of other types of seed; they were selected mainly because conifers flourish better on open areas and on degraded soils. In recent years, silviculture oriented to semi-natural forest management has encouraged planting of deciduous and mix-species stands. This trend has been appropriately supported by the Federal Government and the *Länder*.

The wood reserves in existing forests have also increased considerably since the last century. Overuse as a result of the two world wars brought setbacks, but reserves have increased continually since the wars. Many German forests are now young and are growing rapidly, because much reforestation has taken place since the last war and forests have been planted on many former agricultural areas. With these forests, accounting for a large percentage of Germany's total forest area, Germany's forests are functioning as a carbon sink.

Tab. 4.5.1.1: Forest land in Germany

Total forest area in 1990:	10.7 million hectares
Percentage of land covered by forest:	30 %
Development over the last ten years:	Increase of 5 000 hectares/year
Prediction for the next decade:	Increase of 5 000 hectares/year

Source: Federal Ministry of Food, Agriculture and Forestry (BML)

Germany's forest area now measures 10.7 million hectares, a figure equivalent to some 30 % of the country's total area. (The difference from the first national report is due to statistical adjustments of the data for the new Federal *Länder*).

4.5.2 Carbon storage in forests

Wood density varies in accordance with wood type, location, specific growth conditions and physiological age. It can vary even within one and the same tree.

The following table contains data on the mean density for the wood types found in Germany's most important forests (wood density measured in an absolutely dry state).

Taking shares of total reserves for the different wood types into account, it can be assumed that 1 m^3 wood has a dry weight of 0.5 t.

The mean carbon content varies only slightly among the different wood types; it averages 50 % of wood's dry weight. On the average, 1 m^3 wood contains 0.25 t of carbon.

German forests have rough timber reserves averaging 270 m^3/hectare. This corresponds to carbon reserves of 67.5 t/hectare. In addition, each hectare has some 30 t of branches, brushwood, roots and bark (expansion factor for conversion of rough timber into tree wood, including roots: 1.45 (BURSCHEL 1993))

The carbon reserves in the soil and humus, according to a study of the Federal Research Centre for Forest and Wood Science *(Bundesforschungsanstalt für Forst- und Holzwirtschaft – BFH)*, is about 108.9 t/hectare. Ground cover can be neglected for purposes of estimates. Consequently, some 200 t carbon/hectare are stored in trees, soil and humus; this means that Germany's forests as a whole have carbon reserves of about 2 billion t.

Tab. 4.5.2.1: Mean volume density (r_o) of the most important wood types and each tree species' share of total reserves[1)]

Mean volume density (r_o) of the most important wood types	
	g/cm^3
Spruce	0,43
Fir	0,41
Pine	0,49
Beech	0,68
Oak	0,65

Shares of total reserves, by tree species	
	%
Spruce (and similar)	41,4
Fir	2,5
Pine and larch	24,8
Beech and other deciduous	23,5
Oak	7,7

[1)]Density data according to Kollmann, F. (1951), Technologie des Holzes und der Holzwerkstoffe, volume 1, 2nd edition; Shares of total reserves: Federal Forest Inventory (BWI) I (old Federal *Länder)* and Datenspeicher Waldfonds (new Federal *Länder)*
Source: Federal Ministry of Food, Agriculture and Forestry (BML)

4.5.3 Annual carbon storage in forests

The average annual growth in German forests is about 8 m^3/hectare of rough timber (logs over 7 cm in diameter).

This growth estimate is based on model calculations using data from the Federal Forest Inventory (BWI I, key date: 1 October 1987) for the old Federal *Länder,* and from the Forest Fund Database *(Datenspeicher Waldfonds)* for the new Federal *Länder;* it is rather conservative. Regional and yield studies indicate that growth rates may be even higher. An average of about 5 m^3/hectare are removed by felling, so annual net growth amounts to about 3 m^3/hectare. This means that existing forests currently store an additional 0.75 tonnes C/hectare, or a total of 8 million tonnes carbon, per year. This is equivalent to about 30 million tonnes of CO_2. Because a large percentage of Germany's forests consists of young, rapidly growing stands, due to historical reasons, increases of reserves – and, thus, of carbon storage – can be expected to continue for several decades. But forests' capacity to store additional CO_2 is limited, however. It is exhausted when forests reach a mature stage – when they have reached their maximum biomass levels. When this occurs, the amount of carbon that is bound each year is in balance with the amount that is released. If wood use is discontinued, bound carbon can be released in a decomposition phase, to be re-bound in turn during a subsequent build-up phase. These phases vary in a complex way, by area and in time. As a rule, our forests are managed, however, so that trees are harvested before they can die their natural death. Young stands that take the place of harvested ones can bind additional carbon. Harvested wood is used to make products with various lifetimes. The carbon bound in wood products remains bound for a considerable period. It is released when wood products reach the end of their useful lifetimes – after a period of a few years or many decades, depending on the product in question – and the wood rots or is burned as fuel. Increased use of wood in products with long lifetimes can thus be of temporary use in reducing the amount of CO_2 in the atmosphere.

In annual greenhouse-gas inventories, storage of carbon in harvested and processed wood, pursuant to the valid IPCC Guidelines, is not taken into account. Instead, it is assumed that all wood used is transformed into CO_2 in the year in which it is harvested. This simplification is based on the premise that new wood products replace older ones that, having reached the end of their useful lifetime, release CO_2 by being burned as fuel or by rotting.

4.5.4 Measures to improve forests' function as sinks; carbon storage in wood products

The following measures can play a role in preserving and improving forests' function as sinks:

– Conservation of existing forests

– Expansion of forest areas

– Measures for shaping forests

– Increased use of wood

Forest conservation is comprehensively regulated by the Federal Forest Act of 1975 and the forest laws of the *Länder*. The Federal Government was quick to initiate comprehensive measures to combat so-called "new" forest damage. The annual forest-status reports describe these measures in detail.

Expansion of forest areas through initial afforestation of areas not formerly used for silviculture has been supported for years in Germany, in the framework of the joint task "Improvement of the agricultural structure and of coastal protection" (GAK), by means of investment subsidies. Since 1991, as part of transposition of a relevant EC directive, incentives for initial afforestation of agricultural land have been considerably reinforced through the introduction of an additional 20-year initial afforestation bonus for farmers and forest managers. This new support has been further enhanced by Council Regulation (EEC) 2080/92, and by transposition of this Regulation by the GAK.

Within the first few years following introduction of the initial afforestation bonus, the annual afforestation rate more than doubled, reaching 6000 to 7000 hectares. The rate has decreased somewhat since then. An annual afforestation rate of 5000 hectares can be expected in the medium term. This rate could increase Germany's total forest area by 75,000 hectares by the year 2005, in comparison with the corresponding area in 1990. On an annual average, new forests created by that year will bind an additional 1 million t of CO_2, which would be equivalent to a CO_2 reduction of 0.1 percent with respect to national CO_2 emissions in 1990.

On the whole, expectations placed on initial afforestation in Germany, with respect to contributions to CO_2 binding, should be kept at modest levels.

Increases of rotation periods, along with optimal use of growth increments, are being discussed as ways of increasing biomass in existing forests at rates beyond those described in Chapter 4.5.3, which build up reserves solely through the natural ageing process. In the view of the Federal Government, such measures cannot make more than a relatively minor contribution to improving the CO_2 picture.

Increased use of wood provides a range of different advantages with respect to the problem of climate change. In this context, wood behaves neutrally when burned as fuel, i.e. it releases only as much carbon – part of which is in the form of CO_2 – as it absorbed from the atmosphere when it grew. For this reason, use of wood and wood products (combustion/gasification) should be increased.

Increased use of wood products helps reduce greenhouse gases in that

– wood can replace raw materials that have an unfavourable greenhouse gas picture in production, processing and disposal, and

– wood use can enable the carbon stored in the wood to remain bound for long periods of time.

Use of wood in products with long lifetimes expands the "wood" carbon dioxide sink. According to an estimate of the Federal Research Centre for Forest and Wood Science, over 325 million tonnes of carbon (equivalent to 1 billion tonnes of carbon dioxide) are currently stored in wood products. Wood products thus function as an intermediate carbon sink.

The measures supporting use of wood as fuel are described in Table 5.2.1, “Sector E”. The improved Act on the Sale of Electricity to the Grid, and the market-incentives programme for renewable energies – in which modern, low-emissions wood-firing systems are also eligible for support – are worthy of particular mention.

Important examples of use of wood for products with longer lifetimes are provided by industries which use solid wood – especially the construction sector. In an important development in this area, recent amendments of building codes in several Federal *Länder* have considerably improved the framework for construction with wood (including authorisation of wood structures of up to three stories in Bavaria, Baden-Württemberg, Hesse and North Rhine-Westphalia). Similar regulations in other Federal *Länder* would be welcomed; the responsibility for such regulations lies with the *Länder,* however. Another significant development in this context is that the ARGEBAU Conference of *Länder* Ministers (of construction), in its 93rd session, held at the end of November 1996, unanimously approved a resolution to commission the conference’s General Committee with the preparation of a concept for simplifying and relaxing requirements for structural fire protection, giving special consideration to multi-storey wood structures (concept to be submitted within one year).

Major significance is also seen in the development of new wood products; in low-cost, land-conserving construction using wood; and in provision of relevant information and training for architects, engineers and building owners.

4.6 Summary of inventories and greenhouse gas emissions using CO_2 equivalents

The term “Global Warming Potential” (GWP) is often used to describe the impacts that substances have on climate. A substance’s GWP is a chronologically integrated measure of the radiative effect of a given amount of the substance, in relation to the effect of the same amount of CO_2. The GWP of a gas thus depends on the persistence of the gas in the atmosphere and on its radiative forcing, a term which refers to the direct impact that increased concentration of the relevant gas has on the radiation balance. The GWP is calculated with the help of coupled climate-chemical models and comprises two effects: The substance’s direct effect on radiation, through absorption of infrared radiation; and the substance’s indirect chemical effect on radiation, the substance’s secondary impacts on the radiation balance.

By multiplying emissions of climate-relevant gases with the appropriate GWP values, one obtains emissions figures for these gases in CO_2 equivalents, which provide a standardised basis for comparing the climate relevance of emissions of the gases.

Tables 4.6.1 through 4.6.6 list mass-oriented CO_2 equivalents, in millions of tonnes and in percentage contributions, for greenhouse gas emissions in Germany from 1990 to 1995: for CO_2, CH_4, N_2O, PFC, HFC and SF_6 (100-year time horizon).

For methane, the most recent GWP figures, as used by the IPCC Working Group I’s Second Assessment Report, from 1995 (Table 4.6.6), include the indirect greenhouse effect due to influences on tropospheric ozone production and on stratospheric water vapour production.

Tab. 4.6.1: Summary of emissions of greenhouse gases, including CO_2 equivalents, in Germany – 1990

Emissions group		Emissions absolute in Gg	Emissions CO_2 equivalent[1] in Gg	Contribution to total emissions in %
1 Energy-related emissions	CO_2	986 640	986 640	
	CH_4	1768	37 128	
	N_2O	37	11 470	
Total			1 035 238	85,4
2 Industrial processes	CO_2	27 515	27 515	
	CH_4	0	0	
	N_2O	83	25 730	
	HFC	0,200	2 340	
	SF_6	0,163	3 900	
	CF_4	0,355	2 310	
	C_2F_6	0,042	390	
Total			62 185	5,1
3 Solvent and other product use	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	6	1 860	
Total			1 860	0,2
4 Agriculture	CO_2	NR	Nr	
	CH_4	2 044	42 924	
	NO_2	96	29 760	
Total			72 684	6,0
5 Land-use changes and forestry	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	NR	NR	
Total			NR	0,0
6 Waste management	CO_2	NA	NA	
	CH_4	1 870	39 270	
	N_2O	4	1 240	
Total			40 510	3,3
Total emissions			1 212 477	100,0
Of these	CO_2	1 014 155	1 014 155	83,6
	CH_4	5 682	119 322	9,8
	N_2O	226	70 060	5,8
	HFC	0,200	2 340	0,2
	SF_6	0,163	3 900	0,3
	CF_4	0,355	2 310	0,2
	C_2F_6	0,042	390	0,0

[1] Source for greenhouse potential IPCC: The Science of Climate Change, Prepared by Working Group I, Technical Summary for circulation at SBSTA/AGBM, Feb./March 1996

NR Not relevant
NA No data available

Tab. 4.6.2: Summary of emissions of greenhouse gases, including CO_2 equivalents, in Germany – 1991

Emissions group		Emissions absolute in Gg	Emissions CO_2 equivalent[1] in Gg	Contribution to total emissions in %
1 Energy-related emissions	CO_2	950 625	950 625	
	CH_4	1 631	34 251	
	N_2O	39	12 090	
Total			996 966	85,7
2 Industrial processes	CO_2	24 623	24 623	
	CH_4	0	0	
	N_2O	84	26 040	
	HFC	0,200	2 340	
	SF_6	0,182	4 350	
	CF_4	0,308	2 000	
	C_2F_6	0,038	351	
Total			59 704	5,1
3 Solvent and	CO_2	NR	NR	
other product use	CH_4	NR	NR	
	N_2O	6	1 860	
Total			1 860	0,2
4 Agriculture	CO_2	NR	NR	
	CH_4	1 805	37 905	
	N_2O	87	26 970	
Total			64 875	5,6
5 Land-use changes	CO_2	NR	NR	
and forestry	CH_4	NR	NR	
	N_2O	NR	NR	
Total			NR	0,0
6 Waste management	CO_2	NA	NA	
	CH_4	1 814	38 094	
	N_2O	4	1 240	
Total			39 334	3,4
Total emissions			1 162 735	100,0
Of these	CO_2	975 248	975 248	83,9
	CH_4	5 250	110 250	9,5
	N_2O	220	68 200	5,9
	HFC	0,200	2 340	0,2
	SF_6	0,182	4 350	0,4
	CF_4	0,308	2 000	0,2
	C_2F_6	0,038	351	0,0

[1] Source for greenhouse potential IPCC: The Science of Climate Change, Prepared by Working Group I, Technical Summary for circulation at SBSTA/AGBM, Feb./March 1996

NR Not relevant
NA No data available

Tab. 4.6.3: Summary of emissions of greenhouse gases, including CO_2 equivalents, in Germany – 1992

Emissions group		Emissions absolute in Gg	Emissions CO_2 equivalent[1] in Gg	Contribution to total emissions in %
1 Energy-related emissions	CO_2	901 383	901 383	
	CH_4	1 594	33 474	
	N_2O	40	12 400	
Total			947 257	84,9
2 Industrial processes	CO_2	25 179	25 179	
	CH_4	0	0	
	N_2O	93	28 830	
	HFC	0,302	2 470	
	SF_6	0,204	4 880	
	CF_4	0,278	1 810	
	C_2F_6	0,036	330	
Total			63 499	5,7
3 Solvent and other product use	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	6	1 860	
Total			1 860	0,2
4 Agriculture	CO_2	NR	NR	
	CH_4	1 718	36 078	
	NO_2	83	25 730	
Total			61 808	5,5
5 Land-use changes and forestry	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	NR	NR	
Total			NR	0,0
6 Waste management	CO_2	NA	NA	
	CH_4	1 881	39 501	
	N_2O	0	1 240	
Total			40 741	3,7
Total emissions			1 115 165	100,0
Of these	CO_2	926 562	926 562	83,1
	CH_4	5 193	109 053	9,8
	N_2O	226	70 060	6,3
	HFC	0,302	2 470	0,2
	SF_6	0,204	4 880	0,4
	CF_4	0,278	1 810	0,2
	C_2F_6	0,036	330	0,0

[1] Source for greenhouse potential IPCC: The Science of Climate Change, Prepared by Working Group I, Technical Summary for circulation at SBSTA/AGBM, Feb./March 1996

NR Not relevant
NA No data available

Tab. 4.6.4: Summary of emissions of greenhouse gases, including CO_2 equivalents, in Germany – 1993

Emissions group		Emissions absolute in Gg	Emissions CO_2 equivalent[1] in Gg	Contribution to total emissions in %
1 Energy-related emissions	CO_2	893 100	893 100	
	CH_4	1 430	30 030	
	N_2O	41	12 710	
Total			935 840	84,9
2 Industrial processes	CO_2	25 200	25 200	
	CH_4	0	0	
	N_2O	86	26 660	
	HFC	1,165	3 750	
	SF_6	0,226	5 400	
	CF_4	0,260	1 690	
	C_2F_6	0,035	320	
Total			63 020	5,7
3 Solvent and	CO_2	NR	NR	
other product use	CH_4	NR	NR	
	N_2O	6	1 860	
Total			1 860	0,2
4 Agriculture	CO_2	NR	NR	
	CH_4	1 688	35 448	
	NO_2	81	25 110	
Total			60 558	5,5
5 Land-use changes	CO_2	NR	NR	
and forestry	CH_4	NR	NR	
	N_2O	NR	NR	
Total			NR	0,0
6 Waste management	CO_2	NA	NA	
	CH_4	1 895	39 795	
	N_2O	4	1 240	
Total			41 035	3,7
Total emissions			1 102 313	100,0
Of these	CO_2	918 300	918 300	83,3
	CH_4	5 013	105 273	9,6
	N_2O	218	67 580	6,3
	HFC	1,165	3 750	0,3
	SF_6	0,226	5 400	0,5
	CF_4	0,260	1 690	0,2
	C_2F_6	0,035	320	0,0

[1] Source for greenhouse potential IPCC: The Science of Climate Change, Prepared by Working Group I, Technical Summary for circulation at SBSTA/AGBM, Feb./March 1996

NR Not relevant
NA No data available

Tab. 4.6.5: Summary of emissions of greenhouse gases, including CO_2 equivalents, in Germany – 1994

Emissions group		Emissions absolute in Gg	Emissions CO_2 equivalent[1] in Gg	Contribution to total emissions in %
1 Energy-related emissions	CO_2	879 300	879 300	
	CH_4	1 289	27 069	
	N_2O	42	13 020	
Total			919 389	84,7
2 Industrial processes	CO_2	25 200	25 200	
	CH_4	0	0	
	N_2O	81	25 110	
	HFC	1,942	3 980	
	SF_6	0,242	5 790	
	CF_4	0,214	1 386	
	C_2F_6	0,031	280	
Total			61 746	5,7
3 Solvent and other product use	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	6	1 860	
Total			1 860	0,2
4 Agriculture	CO_2	NR	NR	
	CH_4	1 660	34 860	
	NO_2	86	26 660	
Total			61 520	5,7
5 Land-use changes and forestry	CO_2	NR	NR	
	CH_4	NR	NR	
	N_2O	NR	NR	
Total			NR	0,0
6 Waste management	CO_2	NA	NA	
	CH_4	1 900	39 900	
	N_2O	4	1 240	
Total			41 140	3,8
Total emissions			1 085 655	100,0
Of these	CO_2	904 500	904 500	83,3
	CH_4	4 849	101 829	9,4
	N_2O	219	67 890	6,3
	HFC	1,942	3 980	0,4
	SF_6	0,242	5 790	0,5
	CF_4	0,213	1 386	0,1
	C_2F_6	0,031	280	0,0

[1] Source for greenhouse potential IPCC: The Science of Climate Change, Prepared by Working Group I, Technical Summary for circulation at SBSTA/AGBM, Feb./March 1996

NR Not relevant
NA No data available

Tab. 4.6.6: GWP figures, mass-oriented and oriented to a 100-year time horizon (typical uncertainty range ± 35 %; pursuant to Second Assessment Report of the IPCC, Working Group I, December 1995)

Greenhouse gas	Chemical formula	GWP value
carbon dioxide	CO_2	1
methane[1)]	CH_4	21
nitrous oxide	N_2O	310
hydrofluoro-carbons		
HFC - 23	CHF_3	11700
HFC - 32	CH_2F_2	650
HFC - 41	CH_3F	150
HFC - 43 - 10mee	$C_5H_2F_{10}$	1300
HFC - 125	C_2HF_5	2800
HFC - 134	$C_2H_2F_4$	1000
HFC - 134a	CH_2FCF_3	1300
HFC - 152a	$C_2H_4F_2$	140
HFC - 143	$C_2H_3F_3$	300
HFC - 143a	$C_2H_3F_3$	3800
HFC - 227ea	C_3HF_7	2900
HFC - 236fa	$C_3H_2F_6$	6300
HFC - 245ca	$C_3H_3F_5$	560
perfluorocarbons		
perfluoromethane	CF_4	6500
perfluoroethane	C_2F_6	9200
perfluoropropane	C_3F_8	7000
perfluorobutane	C_4F_{10}	7000
perfluoropentane	C_5F_{12}	7500
perfluorohexane	C_6F_{14}	7400
perfluorocyclobutane	$c\text{-}C_4F_8$	8700
sulphur hexafluoride	SF_6	23900
chloroform	$CHCl_3$	5
methylene chloride	CH_2Cl_2	9
trifluoroiodomethane	CF_3I	< 1

[1)] The GWP for methane includes indirect effects of tropospheric ozone formation and stratospheric water vapour formation
Source: Second Assessment Report of Working Group I of the IPCC, December 1995

Tab. 4.6.7: Total climate-relevant emissions in Gg of CO_2 equivalents

Year	1987	1990	1991	1992	1993[2)]	1994[2)]	1995[2)]
direct greenhouse gases pursuant to FCCC	1 278 000	1 212 477	1 162 739	1 115 165	1 102 313	1 085 655	1 071 034
CFC/halons	396 336	246 992	195 296	126 368	86 160	45 952	34 464
Sum of CO_2 equivalents	1 674 336	1 459 469	1 358 035	1 241 533	1 188 473	1 131 607	1 105 498
compared to 1987 in %	100	87	81	74	71	68	66
compared to 1990 in %	115	100	93	85	81	78	76

[1)] The breakdown for CFC and halons is based on production data for 1990.
[2)] Preliminary data
Source: the Federal Environmental Agency

Greenhouse gas emissions (including substances controlled by the Montreal Protocol):

Obligations to report on the production, use and emissions of chlorofluorocarbons (CFC) and halons are found only within the framework of the Montreal Protocol. But since this group of gases also are greenhouse gases, a relevant summary is included here.

Assessment of emissions of CFC and halons is difficult. A distinction must be made between direct or immediate emissions and old emissions. Sources of direct emissions include aerosol cans containing CFC, fully halogenated chemicals in laboratories, insulating foams and refrigerants. Old emissions of CFC and halons consists of the minor releases, occurring year after year, from the systems and hard foams into which the substances were placed in the past. Production data for the year 1990 permits breakdown of CFC and halon data into individual component data. The figures listed in Tab. 4.6.7 for climate-relevant emissions including CFC and halons were obtained on the basis of such breakdowns and through use of the appropriate GWPs.

4.7 Specific greenhouse gas emissions

4.7.1 Per-capita greenhouse gas emissions

Table 4.7.1.1 lists per-capita greenhouse gas emissions.

In 1990, annual per-capita carbon dioxide emissions in Germany, at 12.8 tonnes, were significantly higher than the average for the European Union (EU 15), which was some 9 t per year. The reasons are found in Germany's high degree of industrialisation, its energy mix, its high standard of living, its climate – which requires heating of buildings during the cold part of the year (mainly October to April) and in the especially high per-capita CO_2 emissions in the new Federal *Länder* prior to reunification.

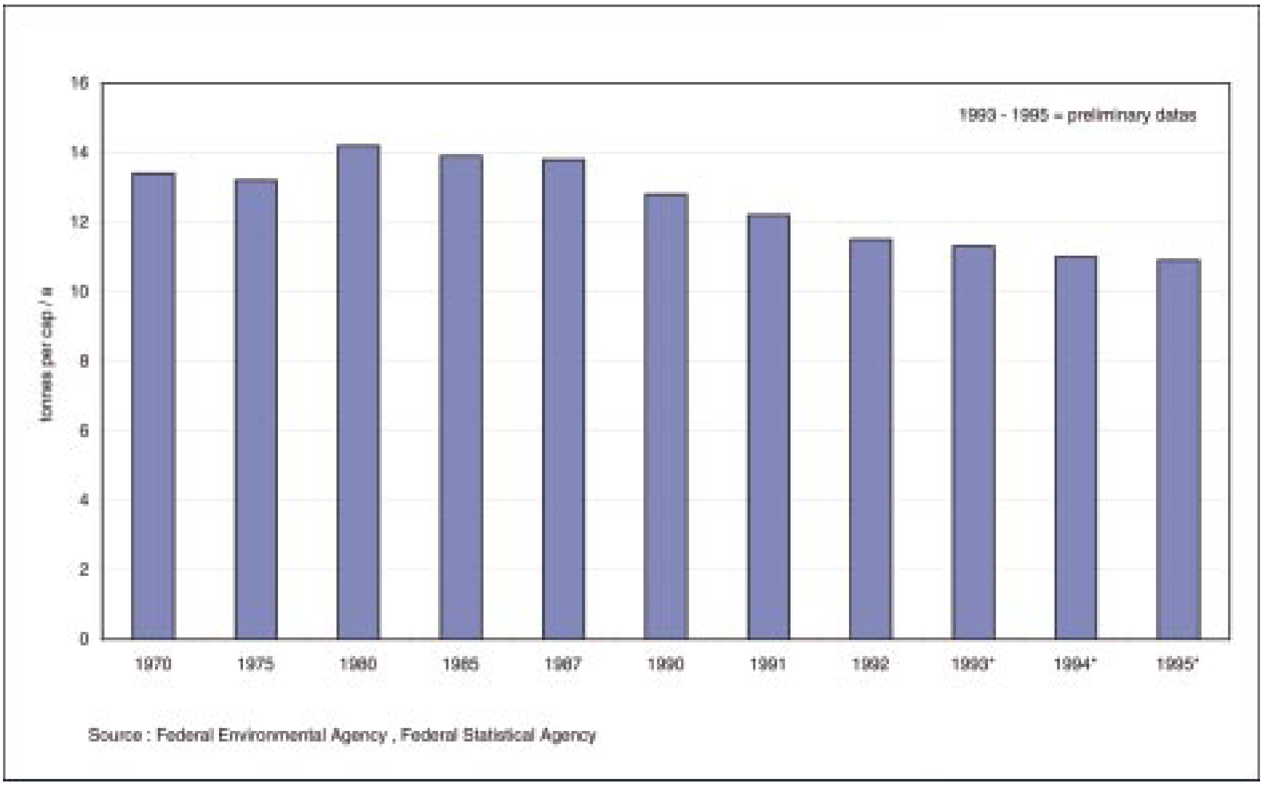
The per-capita CO_2 emissions in the new Federal *Länder* in 1990, 19.0 tonnes, were considerably higher than those in the old Federal *Länder* (11.2 tonnes). The high figure in the new Federal *Länder* was due primarily to that area's low energy efficiency and to the important role played by lignite in its primary energy consumption. From 1990 to 1995,

Tab. 4.7.1.1: Development of CO_2, CH_4 and N_2O emissions per inhabitant and year in Germany, from 1970 to 1995

Greenhouse gas	1970	1975	1980	1985	1987	1990	1991	1992	1993[*)]	1994[*)]	1995[*)]
CO_2 (t/pc)	13,4	13,2	14,2	13,9	13,8	12,8	12,2	11,5	11,3	11,1	10,9
CH_4 (kg/pc)	82,3	77,4	78,2	76,2	77,0	71,6	65,6	64,4	61,8	59,5	58,5
N_2O (kg/pc)	2,6	2,6	2,9	3,1	3,1	2,8	2,8	2,8	2,7	2,7	2,6

[*)] preliminary data
pc = per capita
Source: UBA, Statistical Yearbook

Fig. 4.7.1.1: Development of CO_2 emissions per inhabitant and year in Germany, 1970–1995 (in t)



annual per-capita CO_2 emissions in Germany (total) decreased by about 2 tonnes, from 12.8 to 10.9 tonnes. They decreased continuously in the new Federal *Länder* until 1995; by 1995, they reached 11.1 tonnes, which was almost

Fig. 4.7.1.2: Development of CH_4 emissions per inhabitant and year in Germany, 1970–1994 (in kg)

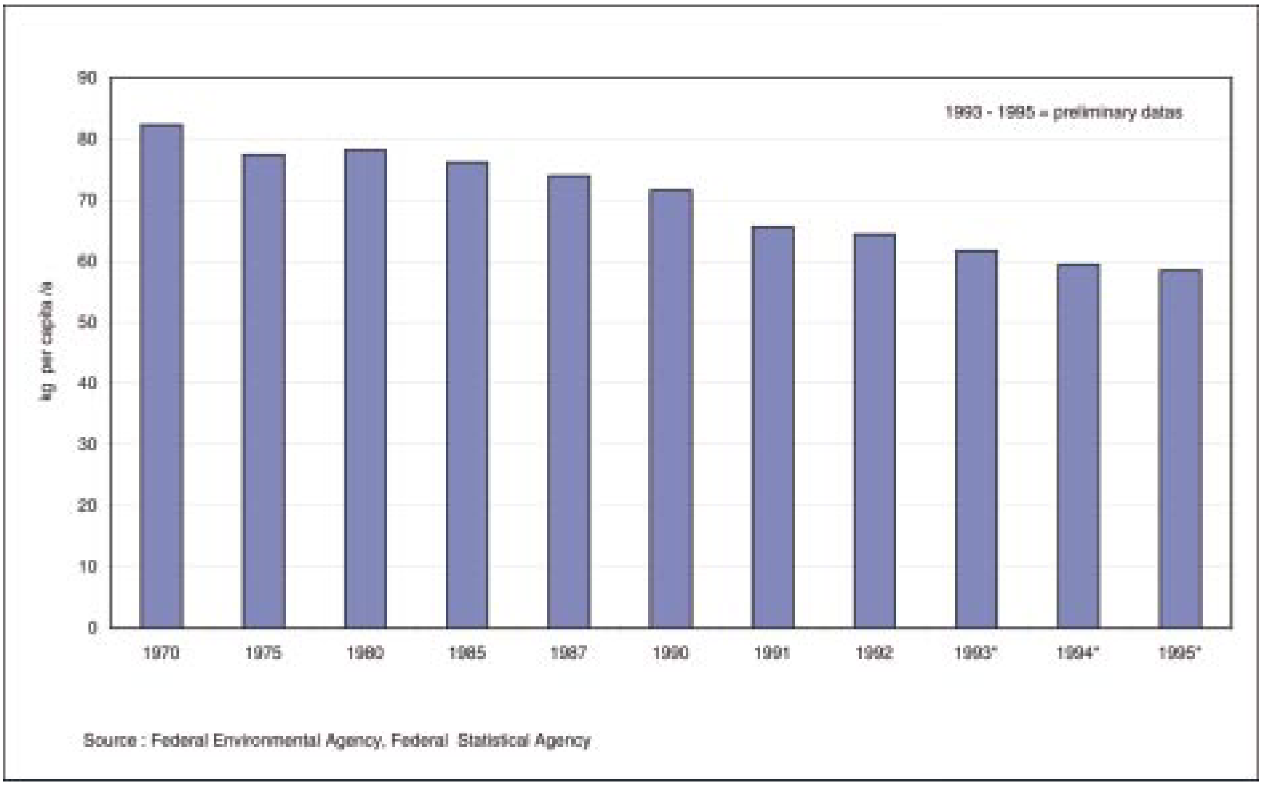
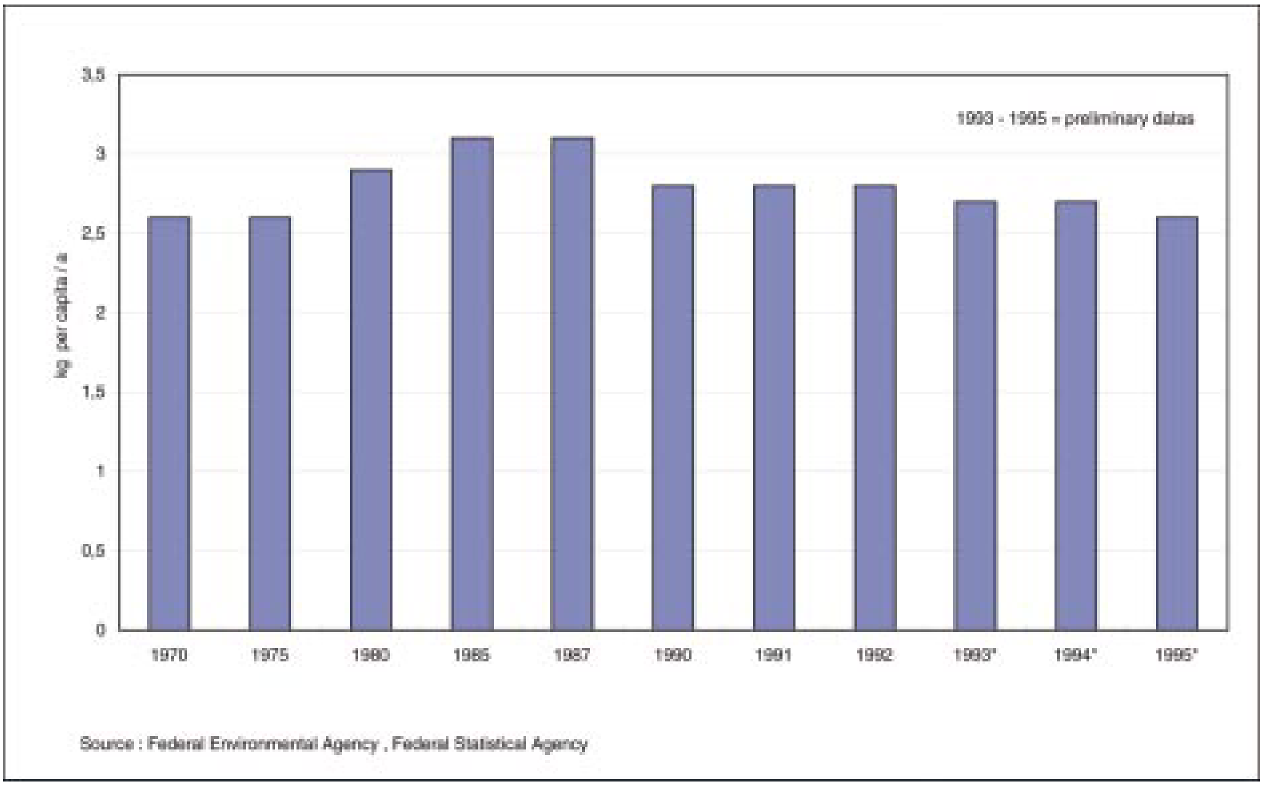


Fig. 4.7.1.3: Development of N_2O emissions per inhabitant and year in Germany, 1970–1994 (in kg)



as low as per-capita CO_2 emissions in the old Federal *Länder* (10.9 tonnes per inhabitant) for the same year.

The continual reduction in per-capita CH_4 emissions since 1970 has slowed since the early 1990s (preliminary data).

A trend over time can now be given for per-capita N_2O emissions, for which Germany's First National Report contained only data for 1990. From 1990 to 1995, annual per-capita N_2O emissions decreased from 2.8 to 2.6 kg.

4.7.2 Relationship between CO_2 emissions and gross domestic product

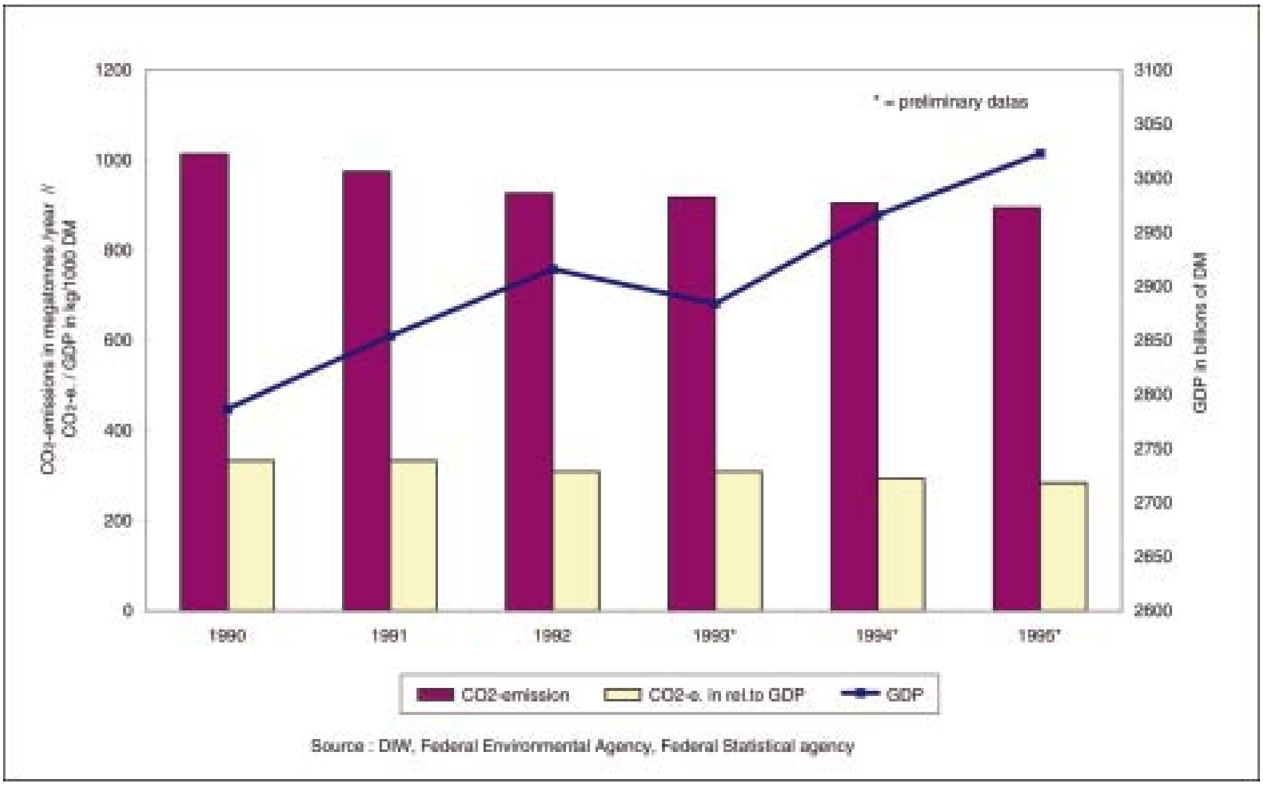
Table 4.7.2.1 shows how economic growth and CO_2 emissions have been decoupled. From 1990 to 1995, the ratio of energy-related CO_2 emissions to GDP decreased by about 19% in Germany. This shows that the process of increasing energy efficiency and of converting to fuels with lower carbon content, a process begun in the 1970s, is continuing.

Tab. 4.7.2.1: CO_2 emissions in relation to gross domestic product (GDP) in Germany (in 1991 prices)

Year	CO_2 emissions[1)] (Gg)	GDP (in billions of DM)	CO_2 emissions in relation to GDP (in kg/1 000 DM)
1990	1 014 000	2 787[3)]	364
1991	975 000	2 854	342
1992	927 000	2 916	318
1993	918 000[2)]	2 884	318
1994	905 000[2)]	2 966	305
1995	895 000[2)]	3 023	296

[1)] Data in accordance with IPCC regulations (without maritime bunkering and international air transports)
[2)] preliminary data
[3)] Source: German Institute for Economic Research (DIW), Political Scenarios for Climate Protection (Politikszenarien für den Klimaschutz)
Source: Federal Environmental Agency (UBA), Federal Statistical Office

Fig. 4.7.2.1: CO_2 emissions in relation to GDP in Germany (in 1991 prices)



5. Policies and measures

5.1 General political framework and greenhouse gas reduction objectives

The Federal Government was early in developing a comprehensive national climate protection strategy. The Federal Government's climate protection programme contains measures for reducing emissions of CO_2 and other greenhouse gases (CH_4, N_2O, CF_4, C_2F_6, SF_6, the ozone precursors NOx, CO, NMVOC and the laughing-gas precursor NH_3), and it provides for continuation and expansion of CO_2 storage in forests and wood products. This programme is being developed and implemented step-by-step.

By resolution of 13 June 1990, the Federal Government established the "CO_2 reduction" Interministerial Working Group, which is charged with identifying the potential for reduction of greenhouse gas emissions (especially CO_2). In the framework of this "CO_2 reduction" Interministerial Working Group, and under the chairmanship of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, working parties were established for the following topic areas: energy supply (chaired by: Federal Ministry for Economics), transport (chaired by: Federal Ministry of Transport), buildings and structures (chaired by: Federal Ministry for Regional Planning, Building and Urban Development), new technologies (chaired by: Federal Ministry of Education, Science, Research and Technology) and agriculture and silviculture (chaired by: Federal Ministry of Food, Agriculture and Forestry).

The Federal Government is aiming to reduce CO_2 emissions by 25% by the year 2005 (based on the reference year, 1990).

Reduction and limitation of other climate-relevant emissions – such as emissions of methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF_6) – have also been included in the national climate protection strategy.

To date, the "CO_2 reduction" Interministerial Working Group has submitted three reports on climate protection strategy in Germany to the Federal Cabinet: in November 1990, December 1991 and September 1994. The Working Group is continuing its work, and it has been commissioned by the Federal Cabinet to submit its next report in May 1997 and its 5th report in 1999. The fourth report is to contain objectives and emissions reduction measures for the greenhouse gases CH_4, N_2O, CF_4, C_2F_6, the ozone precursors NOx, CO, NMVOC and the laughing-gas precursor NH_3; it is also expected to describe progress made in reducing CO_2 emissions and to present further refinements of the Federal Government's climate protection strategy, taking overall economic and financial policy resources into account.

5.2 Measures and instruments for climate protection since 1990

Since 1990, the Federal Government has been implementing a comprehensive and co-ordinated package of measures within the framework of its climate protection strategy. This package covers a broad spectrum of regulatory measures, economic instruments and other supporting measures (such as research, training and education, provision of information and advising).

Many of these measures were described in the First National Report. Since then, the number of measures has grown to over 130. The following measures from the period since September 1994, when the First National Report appeared, are worthy of particular mention – in addition to the special efforts being made to modernise the new Federal *Länder* (cf. also Chapter 3.9):

– German industry's declaration on climate protection (updated version from 27 March 1996),

– The German automobile industry's 1995 commitment to reduce fuel consumption,

Fig. 5.1.1: "CO_2 reduction" IWG

"CO_2-Reduction" IWG

WP I	**WP II**	**WP III**	**WP IV**	**WP V**
(Energy supply)	(Transports)	(Buildings/structures)	(New technologies)	(Agriculture and silviculture)

– Other incentive programmes in behalf of energy-saving and intensified use of renewable energies, and

– The amendment of the Ordinance on Small Firing Installations (1st Ordinance for the Implementation of the Federal Immission Control Act).

The policies and measures for CO_2, CH_4, N_2O, NOx, NMVOCs, PFC and SF6 are listed in Tables 5.2.1–5.2.7, arranged by sectors. Table 5.3.1 contains other planned measures and instruments for climate protection. In order to facilitate comparison, the measures numbers from Germany's First National Report pursuant to the Framework Convention on Climate Change have been adopted, and numbering of additional measures builds on this system.

Measures to reduce greenhouse gases controlled by the Montreal Protocol are not included here.

Furthermore, additional specific measures of the Federal *Länder* and of local authorities to reduce CO_2 and other greenhouse gas emissions are described in Chapters 5.4.2 and 5.4.3.

The abbreviations in Tables 5.2.1 to 5.3.1 have the following meanings:

Type of measure:

E	economic instrument
R	regulation, law, guideline/
V	voluntary agreement
I	information
ET	education and training
D	research and development

Sectors:

Carbon dioxide (CO_2)

C	Cross-sectoral
E	Energy and transformation industries
T	Transport
IE	Industry (energy-related)
IN	Industry (non-energy)
R	Residential, commercial and institutional
F	Fugitive fuel emissions
A	Agriculture
L	Land-use change and forestry

Methane (CH_4)

W	Waste management (including sewage treatment)
A	Agriculture (non-energy)
F	Fugitive fuel emissions
IE	Industry (energy-related)
IN	Industry (non-energy)
L	Land-use change and forestry

Nitrous oxide (N_2O)

IE	Industry (energy-related)
IN	Industry (non-energy)
A	Agriculture (non-energy)
T	Transport
E	Energy and transformation industries
L	Land-use change and forestry

Other greenhouse gases and precursors (NOx), (NMVOCs), (PFCs), (SF_6)

T	Transport
E	Energy and transformation industries
IE	Industry (energy-related)
IN	Industry (non-energy)
R	Residential, commercial and institutional
L	Land-use change and forestry
S	Solvent and other product use
W	Waste management (including sewage treatment)

Expected effect:

The “expected effect” refers to the predicted reductions in Gg, with respect to the relevant prediction year. In assessing the effects, it must be remembered that political action in most cases consists not of structural changes – for example, “Expansion of combined heat and power generation” – but of measures to support such changes. Such measures pose extremely challenging requirements for effects analysis, since the reactions of the persons directly affected, and the secondary effects resulting from these reactions, are very difficult to predict. The smaller the degree to which political instruments restrict the relevant freedoms of the involved parties, the more difficult it is to predict the effects of measures. An added difficulty is that political instruments often function in combination; consequently, effects of individual instruments cannot be precisely stated. Finally, numerous measures (information, advising, even certain regulatory measures) are qualitative in nature.

The effects analysis integrates purely qualitative information, individual predictions of experts and integrated model analyses. Qualitative estimates are unavoidable especially when measures cannot be sufficiently well quantified, when little empirical data is available regarding effect paths or when significant interactions occur that preclude clear allocation of effects. Quantitative assessments by experts take account of primary effects (effects on persons directly concerned), secondary effects (influences, “wake” effects etc.), estimates regarding catalysed technical measures (for example, construction of installations), calculations of impacts on the energy sector (for example, substitution effects) and calculations of impacts on emissions.

Integrated global analyses must be carried out to examine interdependencies between measures and within the energy system.

The climate protection measures described below have been studied with the above-described methods of analysis. The CO_2-reduction effects listed are findings from the Federal Environmental Agency’s research project “Policy scenarios for climate protection”.

All analyses are subject to the problem that the precision of the parameters decreases as the projection period increases. Initial allocations have been carried out in Table 5.2.1.

Test mechanisms and reports on experience are listed under “Monitoring”.

NA = no information available.

Tab. 5.2.1: Summary of policies and measures: CO_2

This section does not include measures for reduction of greenhouse gases controlled by the Montreal Protocol. In addition, specific measures of the Federal *Länder* and of local authorities for reduction of greenhouse gases are described in Chapters 5.4.2 and 5.4.3.

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	expected effect 2000	2005	2010	2020	Monitoring
(53) Model projects "Generation of heat and power from renewable raw materials"	E, D	To improve the possibilities for using renewable raw materials for generation of heat and power, especially for clarifying some relevant open questions in the areas of logistics and combustion technology; the Federal Government is supporting model projects for generating heat and power from renewable raw materials, in order to test large-scale biomass- incineration plants operating in the megawatt range. The Federal Ministry of Food, Agriculture and Forestry (BML) is providing funding within the framework of the measure "Subsidies for support of renewable raw materials". Another aim is to reduce emissions of air pollutants.	A	ongoing project					
(55) Joint task "Improvement of the agricultural structure and of coastal protection" (GAK)	E	This Federal/*Länder* programme is supporting: – extensive methods of cultivation, – extensive grassland management, – ecologically oriented cultivation methods (organic), – use of renewable energies in agriculture and – investments in energy-saving in agriculture.	A	ongoing project					
(56) Bonuses for land set-asides	E	Pursuant to a resolution of the EC Agricultural Council from May 1993, bonuses for set-aside land are also to be paid if renewable raw materials that are intended for energy production are cultivated on this "set-aside land". In 1995, renewable raw materials were cultivated on about 360,000 hectares of set-aside land. Use of renewable raw materials always has a CO_2-reduction effect when the materials replace fossil raw materials. This holds in both the chemical/technical and energy sectors.	A	ongoing project					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	expected effect 2000	2005	2010	2020	Monitoring
(63) *Fachagentur Nachwachsende Rohstoffe* (Agency for renewable raw materials) (FNR)	E	The "Agency for renewable raw materials" was founded at the initiative of the Federal Government in October 1993. The Federal Ministry of Food, Agriculture and Forestry (BML) provides institutional support. The tasks of this agency, located at 18276 Gülzow bei Güstrow, Hofplatz 1 (Tel.: 0 38 43/69 30-0, Fax: -120), include research and development for lines of products made from renewable raw materials. The R&D covers product manufacture, use and disposal, taking cost-effectiveness and environmental requirements into account. The agency also collects and processes technical information, provides advising and informs the public. One emphasis of the project support is improvement of the possibilities for using biomass as a fuel; biomass is renewable and is largely neutral with respect to CO_2.	A	began its work in October 1993					
(120) Concept of the Federal Government for research, development and demonstration projects from 1996 to 2000 in the area of "Renewable raw materials"	E	The emphases of the support concept, which follows upon a similar concept for the period 1990–1995, in the chemical and technical sectors include starches, sugars, vegetable oils and fats, plant fibres, lignocellulose/wood and other substances in plants. In the area of energy production with renewable raw materials, progress is being sought primarily in the area of "solid biomass". To this end, demonstration projects for combustion systems in different output classes are being supported, along with projects demonstrating use of biomass in existing coal-fired stations, biomass gasification and optimisation of small combustion systems. In fiscal year 1997, some 56 million DM in Federal funds is available for support of research, development and demonstration projects.	A	ongoing programme					
(121) Guidelines for support of research and develop-	D	Support is being provided for use, in the agricultural sector, of innovative procedures that help improve environmental protec-	A	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	expected effect 2000	2005	2010	2020	Monitoring
ment projects in the agricultural sector aimed at environmental protection (FER-BML)		tion. The support emphasises projects in the following areas: 1. Conservation and development of natural resources; 2. Reduction of soil pollution, of environmental stresses on plants and animals and of unwanted substances in plant and animal products, including clean-ups and integrated cultivation methods; 3. Protection of bodies of water in rural areas and of waters relevant to food production; includes use of sewage sludge in agriculture and landscape-ecology projects in connection with measures of water-resources management; 4. Introduction of new techniques for saving energy, and environmentally compatible energy production in agricultural operations. In 1996, support emphasised projects aimed at reducing emissions from animal husbandry. Relevant investments and project-related expenditures are eligible for support. The subsidies normally amount to 25 %; under certain conditions, they range up to 50 %. 100 % of costs for scientific consultation are subsidised by the Federal Ministry of Food, Agriculture and Forestry (BML). Project sponsor: Projektträger Agrarforschung und -entwicklung bei der Bundesanstalt für Landwirtschaft und Ernährung, 60083 Frankfurt am Main, Postfach 18 02 03.							
(133) Support of renewable energies in the agricultural sector	E	In the framework of the Federal Ministry of Food, Agriculture and Forestry's (BML) measure "Subsidies for support of renewable raw materials", research, development and demonstration projects in the area of biomass, a renewable fuel, are being supported – along with projects in chemical and technical sectors. In the framework of the Joint task "Improvement of the agricultural structure and of coastal protection", investment subsidies for installations that use bio-	A	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	expected effect 2000	2005	2010	2020	Monitoring
		mass, a renewable fuel, are being granted to small agricultural and silvicultural operations (run on either a full-time or part-time basis).							
(2) Support for local and regional energy supply and climate protection concepts	E	The Federal Government has drawn on its relevant experience in the old Federal *Länder* to support a range of model projects in the new Federal *Länder* that have demonstrated energy supply concepts that include CO_2 reduction. The energy-agencies – which, increasingly, are being funded by the *Länder* – can help support development of energy-supply-concepts. A detailed evaluation of the relevant joint programme of work by the Federal Ministry of Education, Science, Research and Technology (BMBF) and Federal Ministry for Regional Planning, Building and Urban Development (BMBau) has been available since 1991.	C	concluded					Evaluation carried out in 1991
(6), (112) Support of renewable energies	E	The 1994 Federal budget provided initial funding of 10 million DM to support individual measures in behalf of use of renewable energies. A total of 100 million DM has been earmarked for continuation of this market-incentive programme from 1995 until 1998, when the programme is scheduled to end.	C	ongoing programme	143	143			
(7) ERP environmental and energy-saving programme	E	The programme supports the installation, expansion and modernisation of facilities and machinery that a) save energy and use it efficiently; b) use of renewable energies; c) enhance air quality; d) handle and treat wastewater. Low-interest loans of up to 1 million DM in the old Federal *Länder*, and up to 2 million DM in the new Federal *Länder*, and covering up to 50 percent of eligible costs, are provided. Maximum loan amounts may be exceeded in cases of projects with particular environmental policy significance. Private commercial enterprises are eligible to apply; small and	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	expected effect 2000	2005	2010	2020	Monitoring
		medium-sized companies in industry and trade receive preference. Applications can be submitted through any bank. The ERP loans are disbursed through the Deutsche Ausgleichsbank, Wielandstraße 4, 53170 Bonn, Tel.: 0228/831-2103, Fax: -2559.							
(8) Support for advising of companies	E, I	Areas for which support is provided include advising regarding economic, organisational and technical questions in connection with efficient energy use (energy-saving advice). Companies eligible to apply include legally independent commercial enterprises, if their turnover in the fiscal year prior to their application did not exceed 30 million DM, as well as agricultural-sector companies whose turnover in the fiscal year prior to their application did not exceed 2 million DM. Subsidies are granted for up to 50% of the relevant invoiced advising costs, up to maximum of 4000 DM. In each case, total subsidies of up to 8000 DM may be applied for. Industrial companies submit applications, after completion of advising, to the Association of German Chambers of Industry and Commerce, Adenauerallee 148, 53113 Bonn, to the Federation of German Industries (BDI), Postfach 510548, 50968 Köln or to the business-promotion association of the Federation of the Self-employed *(Gewerbeförderungsgesellschaft des Bundesverbandes der Selbständigen mbH).* Craft companies apply to the German Crafts Federation *(Zentralverband des Deutschen Handwerks – ZDH),* Postfach 120270, 53044 Bonn, and agricultural companies apply to the Federal Office of Food and Forestry *(Bundesamt für Ernährung und Forstwirtschaft).* Subsidies are paid only when applicants have themselves paid the invoiced advising fees in full. Recipients of advising sub-	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		sidies from other public funds are ineligible for the programme. Applications are to be submitted to the relevant central offices (business, commerce and industry institutions). These organisations also have the relevant application forms. Further information can be obtained from the Federal Ministry of Economics, Postfach 5171, 65726 Eschborn.							
(9) Support of the *Forum für Zukunfts-energien e.V.*	E, I	The Federal Ministry of Economics has supported the Forum for Future Energies *(Forum für Zukunftsenergien),* Godesberger Allee 90, 53175 Bonn, Tel.: 0228/959 55-0, since the Forum was founded in 1989. The Forum's main focuses are on efficient energy use and renewable energies. The Forum for Future Energies was founded in order to serve as a liaison between the main different views and opinions regarding the best future energy supply, and to promote objective, constructive dialogue between all parties concerned. Support has continued, but has been gradually reduced, through 1996. As of 1997, no further public funding will be provided, since the Forum is then to be financed completely by the business sector.	C	active since 1989					
(10) Information on use of renewable energies	I	In 1993, the Federal Ministry of Economics published the first edition of a brochure entitled "Increasing use of renewable energies" *(Erneuerbare Energien – verstärkt nutzen)*; the fourth edition of this brochure has now appeared. The brochure contains information about possibilities for using renewable energies in Germany, as well as information about available support and institutions that can provide further information and advice. The Federal Ministry of Education, Science, Research and Technology (BMBF) has published a brochure entitled "Renewable energies" (Erneuerbare Energien) that describes current applications and the most recent research and devel-	C	ongoing updates and new editions as necessary					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		opment relative to renewable energies. The FNR (cf. (63)) publishes information about the possibilities for using biomass. The publication "Biomass – use for energy purposes" *(Biomasse – Energetische Nutzung)*, which has appeared within the framework of the BINE-project info service, describes possibilities for using biomass, a renewable fuel, for energy purposes. The BINE information service *(Bürger-Information Neue Energietechniken und nachwachsende Rohstoffe Umwelt)* – Citizens' information about new energy technologies and renewable raw materials and the environment), which is supported by the Federal Ministry of Education, Science, Research and Technology (BMBF), provides information about new energy technologies and their applications in housing construction, industry, business, municipalities and agriculture, as well as about environmental research (Informations-Dienst BINE, Mechenstraße 57, 53129 Bonn). The "ABCs of support related to energy" *(Förderfibel Energie)*, which is published and regularly updated by the *Forum für Zukunftsenergien* and the Karlsruhe Technical Information Centre *(Fachinformationszentrum Karlsruhe)*, 76344 Eggenstein-Leopoldshafen, Tel.: 07247/808-222, Fax: -666, provides information about available public support for use of renewable energy sources and efficient energy use.							
(11) Information on saving energy and on efficient energy use	I	The Federal Ministry of Economics, Postfach, 53107 Bonn, has published a series of brochures on the topic of "thrifty and efficient energy use". These publications describe, in clear language, the range of possibilities available to concerned citizens for saving energy. The Federal Ministry for Regional Plan-	C	published					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		ning, Building and Urban Development (BMBau), Postfach 205001, 53170 Bonn, has published a brochure with a similar aim: "Guide to saving energy in Your Home" *(Energiesparbuch für das Eigenheim)*. Still another brochure is available that describes the Federal Ministry of Economics' support programme "On-side advice on saving energy" *(Energiesparberatung vor Ort)*.							
(130) Infrastructure programme of the KfW Reconstruction Loan Corporation	E	The infrastructure programme of the KfW Reconstruction Loan Corporation supports low-interest, long-term financing of municipal infrastructure measures. Especially welcome are environmentally relevant measures that help improve the environmental situation in Germany. Support is provided for municipal investments in water-resources and waste-management projects and especially for measures for energy efficiency and conversion to environmentally compatible fuels. Those eligible to apply include backers of investment measures – i.e. local authorities, districts and administrative associations, special-purpose associations, privately owned companies and non-municipal investors such as groups providing private management. Loan terms range up to 30 years, and up to 5 redemption-free start-up years are permitted. The KfW supports up to 50 percent of the external financing, and no limit on loan size has been set. Combinations with public support funding are permitted.	C	ongoing programme					
(40) Specialised programme for environmental research and technology	E	The programme supports investments for development of environmental technologies: – or identification of cause/effect relationships, – for development of technologies for avoidance, reduction and recycling of pollutants and – for development of cleaner modernisation technologies.	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		As a rule, up to 50 % of investments are subsidised. Those eligible to apply include commercial enterprises, municipal regional authorities and private parties.							
(47) Research and development concerning use of solar energy	E, D	The following additional research and development concerning use of solar energy is being carried out: – Refinement of technologies for solar-heating and photovoltaic solar systems, with the aim of making systems economically competitive; continuation of new component development, – Expansion of applied solar technology research in major research establishments (within the framework of an integrated solar energy research programme), – Refinement of technologies for cost-effective manufacture of high-efficiency crystalline silicon cells, – Study of materials and processes for manufacturing thin-film solar cells from amorphous silicon and connecting semi-conductors.	C	work in progress					
(48) Research and development concerning secondary energy systems integrated with renewable-energy systems	E, D	The following R&D work is being carried out on secondary energy systems integrated with renewable-energy systems: – Intensive research into, and development of, high-energy batteries (energy storage units), which are expected to play an important role in further development of electric cars (among other applications). Emphases of this work include improving battery energy density and durability and reducing the specific costs. – Development and testing of high-temperature fuel cells (energy converters) for use in power stations. This work is focused on the melted carbonate fuel cell (MCFC), which will soon be ready for demonstration, and on the ceramic-oxide fuel cell (COFC). COFC units with outputs of	C	in progress					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		about 50 kW are being developed. The permeable membrane fuel cell (PEMFC) appears suitable for mobile applications; development of the PEMFC is being supported within a broad-based integrated project. In general, fuel cells, because of their potentially high efficiency and their very low emissions, are considered to have considerable promise as electrochemical energy converters. – Development of hydrological, geological and physical chemical thermal storage systems to support use of renewable energies within integrated systems.							
(49) Research and development concerning efficient energy use	E. D	Under the heading “efficient energy use”, support is being focused, in the area of energy research, on technologies oriented to final energy consumption in the sectors “Residential and Institutional” and “Industry”, with the aims of reducing losses and exploiting potential for saving energy. A typical feature of this area of support is that a relatively large number of development projects, many of them quite small, are supported, taking the subsidiarity principle into account. Projects are being supported primarily in small and medium-sized companies. The most important results of these efforts include: – Basic research and experiments in the area of translucent thermal insulation have shown that new materials applied to solid outer walls of buildings or within skylights can improve energy yields in both passive and active solar systems (such as flat-collector systems). As part of a comprehensive integrated project, the prerequisites are being created for a range of practically oriented system developments and tests. – Increased combination of ventilation and heating systems, in conjunction with heat recla-	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		mation, has become especially important as a result of enhanced energy efficiency. Indoor-air quality and indoor-air flows have also acquired greater significance in this context. Sophisticated, calculation-intensive computer programmes now permit simulation and evaluation of buildings.							
(118) 4th energy research programme	E, D	A main focus of the 4th energy research and energy technologies programme, which was promulgated on 22 May 1996, is on helping to ensure that all technologies are developed and then made available that show promise in terms of long-term and sustainable decreases of CO_2 emissions. At the same time, methods are being developed for designing measures and identifying technological areas, as part of system studies, that can contribute most efficiently, under actual conditions, to CO_2 reduction. A maximum of 750 million DM per year has been earmarked for the programme for the coming years.	C	ongoing programme					
(65) Ordinance on Packaging	R	The Ordinance on Packaging regulates, within the framework of the Waste Avoidance and Waste Management Act (AbfG), the obligations of manufacturers/sellers to take back and recycle packaging; it also sets forth priority for substance recycling.	C	came into force in 1991					
(69) Improvement of training and further training of architects, engineers, technicians, craftsmen	ET, I	This long-running programme, in which funding is provided for informational and training events focusing on energy efficiency, is being continued. In the area of vocational training, similar learning goals are already regularly included when training ordinances for relevant occupations are revised or prepared. In this context, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety has commissioned the Federal Chamber of Architects *(Bundesarchitektenkammer)* to prepare curricular	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		units for further training of architects, engineers and craftsmen in the areas of efficient energy use and use of renewable energy. The result, the handbook "Energy efficient construction and modernisation" *(Energiegerechtes Bauen und Modernisieren)*, has been available since early 1996 in bookstores.							
(71) Investment programme for reducing environmental pollution	E	This programme of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) accepts applications from businesses and municipal authorities (Contact: the Federal Environmental Agency (UBA), Postfach 33 00 22, 14191 Berlin, Tel.: 0 30/89 03-0, Fax: -22 85). It provides investment subsidies, as well as interest subsidies for loans from the Deutsche Ausgleichsbank granted within the framework of the Deutsche Ausgleichsbank's environmental programme. Support is provided for large-scale project demonstrating, in model form, how – Installations can be adapted to the state of the art, in order to reduce pollution, – Advanced processes can be used to prevent environmental pollution and – Environmentally compatible products and substitutes can be manufactured and used. Since 1996, climate protection projects have been an emphasis of the programme.	C	ongoing programme					
(72) Environmental programme of the KfW Reconstruction Loan Corporation	E	The KfW environmental programme supports investments that help to improve the environmental situation in Germany significantly. Supported investments include those made to eliminate or prevent air pollution; to reduce smell emissions, noise and vibrations; to improve wastewater treatment, waste disposal and treatment; to save energy and to use renewable energies. Eligibility: commercial enterprises from Germany and abroad, if they are carrying out measures in Germany (manufac-	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		turing, crafts, retail, other types of services and entrepreneurs in agriculture and silviculture), as well as freelance professionals and companies which are partly owned by the public sector, by churches or by charitable organisations. The programme provides low-interest loans – as a rule, of up to 10 million DM of financing requirements – and up to two-thirds of the total investment sum. For projects of companies with annual turnover of less than 100 million DM (including turnover of affiliated companies), loans are provided for up to three-fourths of the required investment sum. Applications must be submitted through applicants' home banks to the Kreditanstalt für Wiederaufbau Frankfurt/Main. Loans provided through this programme can also be granted as supplements to ERP loans (but not those from the ERP Environmental and energy-saving programme), and may be granted in addition to other public support.							
(73) Environmental programme of Deutsche Ausgleichsbank	E	The DtA environmental programme of Deutsche Ausgleichsbank supports investments in all areas of environmental protection, especially projects for prevention or reduction of environmental pollution (preventive, integrated environmental protection) and for energy saving and efficient energy use. The programme provides low-interest loans of up to 75% of investments (normal case). Applications may be submitted by: – Small and medium-sized German and foreign companies, and freelance professionals, – Municipal companies, local authorities, municipal associations and other public authorities or institutions, in special cases, – Private households, for investments in the area of renewable energies (for example, solar heating, heat pumps, photovoltaic and biomass systems); (cf. also (117)	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect				Monitoring
					2000	2005	2010	2020	
		Applications may be submitted through any bank. Municipal companies, local authorities and other similar institutions should submit applications directly to Deutsche Ausgleichbank (DtA). Loans from the DtA environmental programme are disbursed through Deutsche Ausgleichsbank, Wielandstraße 4, 53170 Bonn, Tel.: 0228/831-2103, Fax: -2559.							
(74) Environmental protection guarantee programme: liability exemption in connection with loans from the DtA environmental programme, to support manufacturers of preventive environmental protection equipment	E	The programme provides guarantees for investments supporting manufacture of innovative environmentally compatible products, as well as loans to finance production-systems. The products and production systems must be able to prevent environmental pollution or to reduce it on a lasting basis. Small and medium-sized commercial enterprises are eligible to apply. Deutsche Ausgleichsbank, in co-operation with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the German Federal Ministry of Finance (BMF), provides liability exemptions in the amount of 80% of the loan. Loans can be granted for up to 100 % of costs eligible for support, up to a maximum of 1,000,000 DM. Applicants should use the relevant forms available from the Deutsche Ausgleichsbank (DtA), Wieland-str. 4, 53170 Bonn, Tel.: 0228/831-2103, Fax: -2559, and submit applications through their own banks.	C	ongoing programme					
(75) Federal-*Länder* Joint task “improvement of the regional economic structure”	E	This programme provides support for projects of commercial enterprises and business-serving infrastructure projects. Eligibility for subsidies for commercial investments: commercial enterprises. Subsidies may be granted only for company locations within the relevant support region. In the old Federal *Länder*, subsidies amount to 18 percent of the eligible investment volume; in the new Federal *Län-*	C	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		der (including the western part of Berlin), up to 35 percent. Where the subsidies are for small and medium-sized enterprises (SME), they may be up to 10 percentage points larger in the old Federal *Länder*; SME subsidies in the new Federal *Länder* may be up to 15 percent points larger. All of the new Federal *Länder* are included in the support region. Before subsidies are granted, it must be checked whether prevention or greatest possible reduction of emissions, and proper waste disposal, will indeed take place. Organisations that are eligible to apply for infrastructure projects include local authorities and other municipal authorities, and other non-profit sponsors. Investment subsidies can cover up to 80 percent of the eligible investment volume. Eligible types of measures include environmental protection carried out for newly developed industrial and business sites; restoration of abandoned industrial sites (including treatment of left-over contamination, where this is economically acceptable); provision of energy and water-supply services and distribution systems, and of installations for disposal and treatment of wastewater and waste. In all cases, support is limited to measures which are directly required for business. The *Länder* can provide guarantees with 50 % federal backing for investments that fulfil the prerequisites for support.							
(79) Orientation advising on environmental protection for small and medium-sized companies in the new Federal *Länder*	E, I	The programme provides subsidies for orientation advising regarding environmental protection, in order to help companies take the necessary economic, technical, organisational and legal measures to deal with environmental pollution and meet stricter environmental regulations. Eligibility: legally independent commercial enterprises with up to 50 million DM of annual turnover, as well as private per-	C	The programme ended on 31 October 1994					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		sons seeking to go into business for themselves. Subsidies of up to 85% of invoiced advising costs, up to a maximum of 3,400 DM, are paid.							
(80) Orientation advising on environmental protection for local authorities in the new Federal *Länder*	E, I	Beginning in November 1991, the project “Orientation advising on environmental protection for local authorities in the new Federal *Länder*” provided support for orientation advising to improve environmental protection on the municipal level. All cities, local authorities, rural districts, municipal associations, municipal special-purpose associations in the new Federal *Länder*, including the city districts of Berlin (East), were eligible to apply. The project terminated at the end of October 1996. Costs of up to 4,000 DM for orientation advising were recognised; local authorities were reimbursed for 85% of these (maximum of 3,400 DM). The local authorities’ own share was thus 15%. The funding for the project (total of 12 million DM) was provided by the German Federal Environment Foundation (DBU). With this support, a total of 2,750 consultations were supported. 10% of the consultations dealt with the topic of “energy”. Through the programme, local authorities received specific information on measures for saving energy in public buildings, on possibilities for thermal insulation and on use of renewable energy sources.	C	ended October 1996					
(81) Municipal loan programme for the new Federal *Länder*	E	The programme supported municipal real investments, especially those for improving business-relevant infrastructures, and including emphases on municipal environmental protection measures and energy efficiency. Eligible organisations included local authorities, districts, municipal associations, special-purpose associations, other authorities and public-law institutions and municipal companies	C	The programme ended in 1992					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		with primarily municipal backing and located in the new Federal *Länder*. Investments were supported through low-interest loans.							
(83) Technical information concerning efficient energy use and use of renewable energies	I	The Federal Ministry of Education, Science, Research and Technology (BMBF) is supporting provision of technical information concerning efficient energy use and the use of renewable energies. The main relevant sources are the Karlsruhe Technical Information Centre's *(Fachinformationszentrum Karlsruhe – FIZ)* "Citizens' information on energy saving and on use of new energy technologies" *(Informationsdienst BINE,* Mechenstraße 57, 53129 Bonn, Tel.: 0228/23208-6, Fax: -9) and "Information about municipal power supply" *(Informationen zur kommunalen Energieversorgung – KEV)*; the "Information centre for heat pumps and refrigeration technology" *(Informationszentrum für Wärmepumpen und Kältetechnik – IZW,* Postfach 2465, 76344 Eggenstein-Leopoldshafen), which is located within the FIZ; the "Central office for solar technology" *(Zentralstelle für Solartechnik – ZfS),* Verbindungsstraße 19, 40723 Hilden, Tel.: 02103/2444-0, Fax: -40); and the "Institute for industrialisation of construction" *(Institut für Industrialisierung des Bauens,* Postfach 210560, 30405 Hannover); and the "Indoor-climate technical institute" *(Fachinstitut Gebäude-Klima,* Danziger Straße 20, 74321 Bietigheim-Bissingen, Tel.: 07142/54498, Fax: 61298), which provides information about building ventilation systems.	C	implemented					
(84) Studies on optimising the CO_2-reduction-programme	D	The ministries involved in the "CO_2 reduction" IWG have commissioned numerous studies, within their own ministry research programmes, that are helping to optimise and implement the CO_2-reduction programme.	C	continually updated					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(86) Research on specific regulatory instruments	D	The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has commissioned a range of projects in which specific regulatory instruments are to be analysed with regard to their effectiveness, their frameworks and their chances for success. This analysis is focusing particularly on the following issues: – Third-party financing, contracting – Further training for architects, – Active management in district-heating companies, – The Merseburg energy-supply concept, – Economic principles applying to use of geothermal energy. – To promote wider practical application of integrated resources planning as an instrument for enhancing energy efficiency and reducing CO_2 emissions, the German Ministry for the Environment has supported the IRP case study of the city of Hanover's municipal services company *(Stadtwerke)*. This report contains valuable findings about the conditions for using IRP and describes relevant practical steps. This study has provided strong impetus for developing IRP into an important business area for power companies.	C	concluded					
(87) System analysis within the IKARUS project	D	In December 1990, the Federal Ministry of Education, Science, Research and Technology (BMBF) commissioned the Jülich research centre (prime contractor), and some 20 additional scientific institutes, to prepare a range of tools with which concerned users (science, industry, associations, unions and federal ministries) can develop and evaluate strategies for reducing climate gas emissions. As part of the Instruments for Climate Gas Reduction Strategies (IKARUS) project, computermodels of the German energy sector are being developed (for Germany as a whole and for the sub-sectors transport,	C	ongoing project					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		indoor heating, district heating/ electricity and industry) and relevant databases are being prepared. The databases contain technical information, including emissions factors and costs for all technologies, relevant to the German energy sector for the years 1989, 2005 and 2020. In addition, status quo data is also being stored to the extent possible: for example, for residential buildings, industrial processes and the transport sector. The tools can be used, for example, to identify the technologies that will be needed in the year 2005 to achieve the aim of reducing CO_2 emissions by 25% and simultaneously minimising the costs to the economy as a whole. They are also expected to provide answers to many relevant detailed questions, in the residential, transport, industry and district heating/electricity sectors. IKARUS is thus expected to help improve overall understanding of the ways in which the highly interconnected German energy sector functions and reacts and to provide a more reliable basis for further strategic considerations. The most important gases for which data is to be stored include carbon dioxide (CO_2), methane (CH_4), non-methane volatile organic compounds (NMVOC), nitrogen oxides (NOx) as NO_2, nitrous oxide (N_2O), carbon monoxide (CO) and stratospheric water vapour (H_2O). To ensure that the tools are available for a wide range of uses, the tools are being developed for personal computers (IBM and IBM-compatibles). Development is emphasising user-friendliness, as well as data comparability (transparency) and plausibility of the strategies developed with the system. The IKARUS project advisory board serves as a liaison to the "CO_2 reduction" IWG, and thus to the relevant Federal Government ministries and their subor-							

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		dinate agencies. This board, which is supporting the project, is headed by the Federal Ministry of Education, Science, Research and Technology (BMBF) and is identical with working group 4 of the "CO_2 reduction" IWG, "New technologies".							
(88) German environmental certification mark: "Blauer Engel"	I, E	Since 1977, the "Blue Angel" *(Blauer Engel)* environmental certification mark has been used to call consumers' attention to products that support efficient energy use and to products that employ renewable energies. Such products include – CFC-free and energy-saving refrigerators and freezers, – Low-emissions oil-atomising burners, – Special gas-fired boilers, – Combination water heaters and circulation heaters for gaseous fuels, – Burner/boiler units with gas burners and fans, – Oil burner/boiler units, – Solar-powered products, – Natural gas condensing boilers, – Gas room heaters and gas heating elements, – Lubricants and forming oils that biodegrade rapidly, – Environmentally compatible workplace computers, – Low-emissions gas burners with fans, – Electronic adapters for fluorescent lamps, – Low-emissions, recyclable printers.	C	implemented					Product list is regulary reviewed by the "Environmental Mark Jury" *(Jury Umweltzeichen)*
(103) Special preference accorded to renewable energies in the building code	R	On 20 June 1996, the German Parliament approved an addition to Article 35 para. 1 of the Building Code *(Baugesetzbuch)*: a new Number 7, which expressly establishes special preferences for wind and hydropower systems. The addition reads as follows: "An outdoor project is permissible only if it does not conflict with the public interest, if the site has been adequately developed and if it … 7. serves the	C	In force since 1 January 1997					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		purposes of research into, development of or use of wind power or hydropower." Within the framework of the amendment of the Building Code, planning regulations were introduced to take concerns of local authorities into account, as well as requirements for nature conservation and landscape management. The new regulations came into force on 1 January 1997.							
(105) Improvement of the framework for vocational training and for further training	ET, R	The Federal Government is continuing to work to ensure that the Federal Chamber of Architects, the Federal Chamber of Engineers and the Standing Conference of Ministers of Education and Cultural Affairs of the *Länder* (KMK) increasingly give regard to renewable energies and efficient energy use in connection with amendments of, and additions to, the framework ordinances for the relevant courses of study and for further training. The Federal Ministry of Economics takes the areas of renewable energies and efficient energy use into account in framing training ordinances for the commercial sector.	C						
(109) Planning of the parliament and government district in Berlin with regard to environmental protection requirements, especially climate protection requirements	R	The Federal Government wishes to take ecologically oriented approaches to the construction and conversion of government and parliament buildings in Berlin. The aim of this effort is to achieve exemplary energy efficiency for all buildings, on the basis of object-oriented energy concepts. As part of this effort, all construction measures are to surpass the 1995 Heat Insulation Ordinance's standards for admissible heating requirements by least 20 percent, wherever possible; and the use of climate-control systems operated with electrical energy obtained from fossil fuels is to be kept to a minimum. In addition, major photovoltaic systems are planned for all five major new buildings and additions (Federal President's Office,	C	ongoing project					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		Federal Chancellor's Office, housing for members of parliament in the Moabit section of the Werder and additions to the Federal Foreign Office and the Ministry of Transport). The Reichstag is to receive its power supply from a small-scale CHP station fired with rapeseed-oil-based fuel. The Federal Government has appointed an independent energy commissioner to supervise implementation of the energy-saving construction and renovation. In addition, current planning also calls for exemplary building management systems to be installed. Intelligent control equipment is to be installed to optimise operational energy efficiency.							
(122) Technical information: "in-company energy management"	I	To support efficient energy use in industrial plants and installations, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has made available a generally applicable "Guide for in-company energy management". This guide shows a reliable, practically tested approach for finding intelligent solutions for more efficient, more cost-effective energy use, within the framework of the European environmental management system, other voluntary measures – such as German industry's declaration on climate protection – and certain licensing procedures. Beginning with a section on technical analysis of the current energy use of systems or companies, the guide shows how to prepare well-founded energy use concepts, describes typical relevant channels for decision making in companies and outlines planning for necessary technical measures.	C	concluded					
(123) Joint-Implementation co-ordination office	R	The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety has established an office for co-ordination of the "Pilot Phase for Activities Implemented Jointly".	C	implemented					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(124) Support of third-party financing/contracting models	I	To help in assessment of third-party financing models, the Ministry for the Environment commissioned a report that describes the advantages and disadvantages of third-party financing for the user. In connection with this report, a political guide was also prepared, along with guides to third-party financing for combined heat and power generation systems in industry and commerce, for hospitals and for heating systems for residential buildings.	C	concluded					
(125) AIJ research	D	The German Ministry for the Environment, in co-operation with the Federal Environmental Agency, has commissioned a research project on “Simulation of Joint Implementation within the Framework Convention on Climate Change, on the basis of selected projects”. In the framework of this research project, 4 simulation projects, in 4 different project categories (power station modernisation, renewable energies, industry, demand side management) were examined for suitability as Joint Implementation projects. In addition, proposals for institutional design of a JI administration were prepared. Overall, the study has identified concrete approaches for practical execution of Joint Implementation in the areas studied.	C	ongoing project					
(126) AIJ projects	E	During the pilot phase for Joint Implementation (“Activities Implemented Jointly” – AIJ), the Federal Government wishes to test relevant projects that are as revealing and multi-faceted as possible. To date, two official German pilot projects have been recognised by the governments of their host countries as being AIJ projects. These projects are: – A project to supply remote regions of Indonesia with electricity from renewable energies; some 1,000 photovoltaic systems will replace diesel-generator systems. This	C	ongoing project					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		project is being carried out by the E 7-initiative (joint initiative of 7 of the world's very large power companies, under the leadership of RWE-Energie). – Construction of two wind power systems in Latvia, by PreussenElectra AG. Other projects are currently being prepared (modernisation of a combined heat and power plant, enhancement of the efficiency of fossil-fired power stations, use of hydropower, fuel conversions, use of district heating).	C						
(127) European environmental mark	I, E	The Council Ordinance (EEC) of 23 March 1992 concerning a Community system for awarding an environmental mark has been transposed in Germany. The EU's environmental mark is to be awarded to products that have reduced environmental impacts throughout their total lifetimes, including development, manufacture, sale and use – and that thus reduce energy and resources consumption. The European environmental mark is currently available for the following product groups: – Washing machines – Dishwashers – Lights and – Refrigerators.	C	implemented					
(129) Investment-promotion Act for the economic recovery programme in the new Federal *Länder* *(Investitionsförderungsgesetz Aufbau Ost – IfG)*	E	Since 1995, the Federal Government has given the new Federal *Länder* annual financial assistance, pursuant to the IfG, of 6.6 billion DM for particularly significant investments. This assistance, which is to last for ten years, is intended as a means of compensating for differences in economic strength and of supporting economic growth. The *Länder* are permitted to use 5.9 billion DM of this annual support in a broad range of different support areas, under their own responsibility – for example, also for CO_2-reduction measures. Pursuant to the IfG, measures in the areas of environmental protection, supply of energy and	C						

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect				Monitoring
					2000	2005	2010	2020	
		drinking water, transport, housing construction and urban development are eligible for support.							
(110) German industry's voluntary commitment on climate protection	V	German industry's declaration on climate protection, which was issued on 10 March 1995 on the occasion of the Berlin climate protection summit meeting, was updated and considerably expanded on 27 March 1996. In an overarching declaration of the Federation of German Industries, and in individual declarations issued by 19 industry associations, German industry has stated its willingness to make special efforts to reduce its specific CO_2 emissions, and its specific energy consumption, by 20% by the year 2005, based on the 1990 levels. 12 associations also made a commitment regarding absolute reduction of CO_2 emissions. The industry's voluntary commitment covers over 71% of industrial final energy consumption, over 99% of the public power supply and parts of the "residential" and "institutional" sectors. Compliance with the commitments will be monitored by an independent agency, in the framework of a monitoring system (Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), Hohenzollernstraße 1–3, 45128 Essen). Its first report is scheduled for summer 1997. In this connection, the Federal Government has again stated its willingness to postpone additional regulatory measures for climate protection and to give priority to German industry's own initiative. In addition, if an EU-wide CO_2/energy tax is introduced, the Federal Government plans to push for exemptions for industrial companies participating in the voluntary commitments and to support full crediting of results achieved through the voluntary commitment – on the condition that commitments were fully complied with.	C		18200	32500			Annual reports

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(134) Guidelines for "municipal climate protection"	I	Local authorities – the local players – have an important role in climate protection. Local authorities contribute to greenhouse gas emissions as they carry out their appointed tasks; on the other hand, their access to individual citizens enables them to fulfil their environmental policy responsibility in the area of municipal climate protection particularly effectively. In order to give local authorities practical information about the opportunities for municipal climate protection, and about the challenges it involves, and in order to support them in developing and implementing properly adapted municipal climate protection concepts, the German Institute for Urban Studies *(Deutsches Institut für Urbanistik – DifU)*, under commission to the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), is preparing a "Guide for preparation and implementation of municipal climate protection concepts". The guide is due to be published in spring 1997.	C	ongoing project					
(116) Environmental Audit Act	R	The European Union's Environmental Audit Ordinance was transposed with the Environmental Audit Act. As a result of this Act, environmentally friendly companies can add an environmental seal of approval to their company logo if they agree to regular review of the environmental compatibility of their production processes. The Act's central purposes are to provide for certification of independent, reliable and expert environmental auditors and environmental auditors' organisations who will execute the Environmental Audit Ordinance, and to supervise these persons and organisations effectively. Reduction of greenhouse gas emissions is accomplished especially through analysis and evaluation of the power use of the companies who submit to "eco-audits".	C						

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(140) Research project: "Policy scenarios for climate protection"	D	A research project focusing on "Policy scenarios for climate protection" has been initiated by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The project will draw on results of the IKARUS project and its tools. The project's primary purpose is to estimate future energy-related greenhouse gas emissions and to derive additional measures that will help achieve the climate protection objective of the Federal Government. The results of the projects are presented in Chapter 6.	C	ongoing project					
(142) Report on "Overall economic assessment of CO_2-reduction strategies"	D	RWI and ifo, working under commission to the Federal Ministry of Economics, have prepared a report on the "Overall economic assessment of CO_2-reduction strategies". The report assesses CO_2-reducing measures in connection with their overall economic consequences, in a total of three different scenarios. The report concludes that the Federal Government's package of measures will achieve a 17% CO_2 reduction by the year 2005. Without the population growth assumed by the study, a CO_2 reduction of 22% could be achieved, however. Additional measures would be required to achieve the 25% aim. The reports also call attention to economic problems posed by the measures they consider necessary, especially the measures' large capital requirements and their consequences for the employment market, if the CO_2 objective is to be achieved by the year 2005.	C	concluded					
(3) Act on the Sale of Electricity to the Grid	E	The Act on the Sale of Electricity to the Grid came into force on 1 January 1991. With this Act, the Federal Government has established minimum compensation rates for electricity generated from renewable energies, along with an obligation to accept such electricity into the public network. As a result, the Act has considerably improved the framework for renewable	E	in force since 1 January 1991	4863	6484			October 1995: report on experience with the act

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		energies. An amendment to the Act from mid-1994 expressly extends the Act to cover electricity generated from organic residues and waste from commercial wood processing (limited to plants of up to 5 MW electrical output). In addition, the compensation for electricity from hydropower plants and from organic residues and waste materials was improved. Even higher compensation levels continue to be in force for electricity from wind and solar energy. In fall 1995, the Federal Ministry for Economics presented a report on experience gained with the Act on the Sale of Electricity to the Grid. Considerable technical and economic progress was seen especially in the area of wind power systems. On the other hand, regional differences in the wind power "burden" are expected in future. For this reason, reforms are currently being considered that would distribute this burden more equitably and limit support under the Act on the Sale of Electricity to the Grid to a necessary minimum.							
(5) Federal/ *Länder* district heating-modernisation programme in the new Federal *Länder*	E	Between 1992–1995, the Federal Government and the new Federal *Länder*, acting in the framework of a joint Federal-*Länder* programme, have each provided half of total funding in the amount of 1.2 billion DM aimed at enhancing the position of combined heat and power generation in the new Federal *Länder*, and at modernising the district heating sector in that area. This funding was used to support 1,346 projects, of 585 companies, involving a total investment volume of 5.6 billion DM. The programme funds were used for modernisation of typical district heating facilities, with emphasis on combined heat and power generation, district heating networks and building interconnection stations, including the relevant measurement and control equipment. The largest portion of the investments, at 57%, was	E	concluded					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		focused on power-generation installations, as a means of directly enhancing the position of combined heat and power generation. The programme was scheduled to terminate in 1995; it involved a task of the *Länder* for which the Federal Government was providing only start-up financing. Subsidies were permitted to cover up to 35% of eligible costs; the average support level was about 21%. The district heating modernisation programme has played a central role in maintaining district heating's comparatively large share – 23% – of the indoor-heat sector in the new Federal *Länder*, and in expanding use of combined heat and power generation. It has also represented a significant, lasting commitment to efficient energy use, environmental protection and conservation of resources.							
(12) 4th Ordinance on the Execution of the Federal Immission Control Act *(4. BimSchV)*	R	As part of its efforts in behalf of immis-sions protection, the Federal Government has removed wind power-systems from the scope of application of the 4th Ordinance on Execution of the Federal Immission Control Act (installations subject to licensing). This has considerably simplified administrative procedures for such systems, since wind power-systems no longer require authorisation under legal criteria for immissions protection.	E	in force					
(13) Tax breaks for combined heat and power generation	E, R	As part of the amendment of the Mineral-Oil Tax Act enacted by the Tax-amendment Act of 28 February 1992, the spectrum of tax breaks provided for use of fuel oils and gases (such as natural gas) in engines was expanded. The tax breaks are provided for qualified combined heat and power generation, regardless of the purpose for which the resulting mechanical energy and heat are used – under the condition that on an annual average 60% of the generated heat and power are used, with respect to the amount of oil used.	E	in force					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(118) Application/implementation of the Federal Immission Control Act in the new Federal *Länder* (GFAVO, TA Luft)	R	The Ordinance on Large Firing Installations (GFAVO) of 22 June 1983 introduced effective regulations for reducing emissions from large combustion plants in the old Federal *Länder*. Whereas in the old Federal *Länder* measures for compliance with the Ordinance on Large Firing Installations (13th Ordinance for Implementation of the Federal Immission Control Act) have now been concluded, implementation in installations in the new Federal *Länder* is now in full swing. In a process continuing until 30 June 1996, some of the existing power stations in the new Federal *Länder* were retrofitted with modern environmental protection equipment. Obsolete combustion systems have been/are being gradually decommissioned. The power stations and industrial firing installations with unlimited remaining use periods that fall under the 13th Ordinance for the Implementation of the Federal Immission Control Act were rapidly modernised. Retrofits for these installations had to be concluded by 30 June 1996. Old systems with limited remaining use periods must be decommissioned no later than 1 April 2001. The modernisations have increased the efficiency of many power plants, thereby reducing CO_2 emissions.	E, IE	in force, implementation in progress					
(41) Research into, and technical refinement of, power station and firing technology, especially technology for environmentally compatible use of coal	E, D	Main results: – Fluidised bed combustion technology with atmospheric circulation has been successfully marketed for small and medium-sized combined heating and power stations, both in Germany and abroad. – As part of implementation of the Ordinance on Large Firing Installations, flue-gas desulphurisation and denox techniques are being applied on a large scale in power stations. – A number of coal gasification processes have reached a suf-	E,IE						

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		ficient level of technical maturity to be applied in gas and steam-turbine power stations. Planning for such power stations is at an advance stage. – Within the "high-temperature gas turbine" and "Tecflam" integrated research projects, painstaking groundbreaking research has made it possible to increase the output and efficiency of turbines and to reduce generation of pollutants in combustion. As a next step, findings from concepts for new power stations with improved efficiencies and lower emissions must be implemented in concrete planning for demonstration plants. The considerably enhanced efficiency of such plants can help reduce production of the greenhouse gas CO_2.							
(42) Research and development concerning gas and steam-turbine power stations	E, D	Although power stations technology has made substantial progress in recent decades, environmental protection requirements necessitate further research. One promise of gas and steam-turbine power stations, due to their higher efficiency, is lower emissions and fuel consumption for the same electricity and heat output. But before this promise can be realised, new high-temperature gas turbines must be developed (in addition to other equipment) that use high input temperatures and have optimised internal flows and coolant-gas conditions. Within the framework of an integrated project involving industry, the German Aerospace Research Establishment (DLR) and institutes of higher education, the necessary technological basis for such turbines is being developed. In addition, a range of different concepts for generating electricity with combined steam and gas-turbine power stations is being studied, focusing on mo-	E						

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		dern technologies such as charged fluidised bed combustion, integrated coal gasification and pressurised coal-dust combustion. Planning is also being carried out for a combined-technology lignite-fired power station with pressurised fluidised-bed combustion. This station is to be build in the new Federal *Länder*.							
(43) Research and development concerning use of renewable energies	E	Long-term support is being provided for research and development, including basic research, in this area. The following topics are primary focuses of support: – Solar systems for heating process water, – Increased use of passive solar systems, – Use of biomass for energy generation (heat, electricity, propulsion), – Achieving application maturity of monocrystalline and polycrystalline silicon cells, – Obtaining a broad range of relevant experience through demonstration and testing of on-the-line and off-the-line photovoltaic power-supply systems, including systems in some 180 agricultural operations without mains connections, – Achieving market maturity and obtaining initial operational experience with small and medium-sized wind power systems, now that experience has been gained in the construction and operation of large systems, – Development of systemcomponents for generating and storing hydrogen and for applying hydrogen technology – including high-performance electrolysis ("Hot Elly").	E	Support in progress	23	23			
(45) Programme to support testing of wind power systems: "250 MW Wind"	E	Support is being provided for the installation and operation of some 1,600 wind power systems, representing a total installed capacity of 400 MW, at suitable locations in Germany. Those eligible to apply for the programme include private per-	E, R	ongoing programme	562	562			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		sons, private-law partnerships and legal entities, authorities and public-law institutions. The programme has largely been concluded. The 10-year period continues for gathering operational data for relevant wind power systems, which have been subsidised by the Federal Ministry of Education, Science, Research and Technology (BMBF) – either with investment subsidies (up to 90,000 DM) or with subsidies to defray installation costs, in the amount of 6 Pf/kWh (up to 25 % of total investment costs). The total cost of the "250 MW wind power support programme" will reach some 400 million DM by the year 2007.							
(50) Nuclear energy research/ reactor-safety research	D	In future, the main R&D support in this area will be aimed at reactor safety and issues relative to disposal of radioactive waste, along with various aspects of refinement of innovative reactor concepts with inherent passive safety components. The primary aims of reactor safety research are to provide the scientific and technical basis for evaluating the safety of nuclear installations and to provide impetuses for improving and refining safety technology. Important examples of such research include development within the Franco-German joint project "European Pressurized Water Reactor" (EPR) and studies on enhancing the safety of boiling-water reactors. Significant results: – Experimentally oriented confirmation and expansion of the material-mechanics data-base for components subject to dynamic stresses and ageing. – From evaluation of completed studies in an earlier hot-steam reactor project: verification of the safety reserves for pipeline stresses in a nuclear power plant resulting from thermal shocks, aircraft crashes or earthquakes. The suitability and effectiveness of system procedures and accident management mea-	E						

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		sures were studied in the primary cycle integrated test bed, on a 1:1 scale, at the Upper Plenum Test Facility (UPTF). – In addition, R&D measures were carried out in support of the Federal Government's legal obligation to plan, construct and operate final storage sites. – Results to date of studies concerning the direct final storage of spent fuel elements have shown that this technology is feasible, even with strict safety requirements. The demonstration tests have been completed. In 1994, on the basis of results of these tests, the "Article Act" *(Artikelgesetz)* was prepared. This Act, which was promulgated in July 1994, makes direct final storage legally possible along with disposal following reprocessing. In the framework of studies on disposal of radioactive and chemical/toxic waste, it was possible to demonstrate that long-term sealing-off of pollutants from the biosphere is a technically feasible, proven option; that final storage of radioactive waste in granite is fundamentally possible; and, finally, that enough basic knowledge concerning safe storage of chemical and toxic waste in deep geological formations is available to permit establishment (among other results) of specifications for processing and conditioning of such waste, for the relevant conveying and filling techniques and for the cavern-management technology required for salt, the final storage medium. Additional measures, some of which are currently being prepared: – Refinement of methods/procedures for evaluating the remaining lifetimes of reactor components, – Experimental and analytical studies for evaluation of mea-							

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect				Monitoring
					2000	2005	2010	2020	
		sures relative to facilities' internal emergency protection, – Improved description of processes occurring during major reactor incidents, – Test-bed analysis of complex system processes, for simulation of incident sequences and the effectiveness of counter-measures, – Studies of safety-related characteristics of new reactor systems, – Probabilistic safety analysis studies of boiling water reactors, – Training programme for young scientists, aimed at enhancing competences in nuclear technology, – Continuation of basic research for implementation of final storage sites in salt and other geological formations, – Refinement of methods and procedures for reviewing and demonstrating the long-term safety of final storage sites (geomechanics, geochemistry, spreading scenarios, spreading models), – Optimisation of measures for monitoring fissile material, in co-operation with EURATOM and the IAEO. Institutionally supported nuclear energy research: In the major research establishments Jülich Research Centre (FZJ) and Karlsruhe Research Centre (FZK), continuing relevant work consists mainly of long-term efforts to enhance the safety of nuclear fission facilities and of nuclear waste disposal.							
(51) Nuclear fusion research	E, D	Nuclear fusion, along with solar energy, fuel cells, and breeder reactors, is one of the options for achieving a long-term, safe, environmentally compatible and resources-conserving energy supply. Development of this energy source is a major challenge that can be met only through long-term efforts. The German fusion-programme is part of the European programme. It is receiving institu-	E						

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		tional-support. In three major research establishments, the Max Planck Institute for Plasma Physics (IPP), Garching and Greifswald; the Jülich Research Centre (FZK); and the Karlsruhe Research Centre (FZK), studies in plasma-physics and technical development of nuclear fusion are being carried out, on a work-sharing basis, in major experiments and large test facilities. According to current estimates and planning, commercial fusion reactors could become available at about the middle of the next century.							
(54) Geothermal energy	E, D	Research into geothermal energy is receiving Federal funding through the Federal Ministry of Education, Science, Research and Technology (BMBF), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry of Economics. In 1994, the BMBF provided approx. 5.7 million DM for concrete projects; in 1995, it provided 3.7 million DM and for 1996 and 1997 it is providing a total of some 8 million DM. The Federal Ministry of Economics supported a geothermal deep-level project in 1994. In the framework of support for renewable energies (6), support is provided for use of geothermal energy from depths of up to 400 m.	E, R	ongoing programme	35	35			
(89) Amendment of the Energy Management Act (EnWG)	R	The purpose of the Amendment of the Energy Management Act *(Energiewirtschaftsgesetz – EnWG)* is to help introduce effective competition within the electricity and gas industries. Relevant efforts are also aimed at eliminating exclusive rights of passage and demarcation contracts, as well as improving network access for third parties, taking into account considerations of European and regional policy, and not limiting local authorities' rights to levy taxes on concessions. This reform, therefore, is in line with EU-	E	in preparation					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		wide efforts to increase competition between providers of line-bound energy. In June 1996, the Council of Energy Ministers approved a joint position on this issue. On 23 October 1996, the Federal Cabinet approved the national draft of the energy law amendment. In framing this amendment, the Federal Government will place a special emphasis on combined heat and power generation and on renewable energies.							
(144) Reduction of subsidies for domestic hard coal	E	Federal subsidies for sale of domestic hard coal are to be decreased in steps until the year 2005. This will reduce use of domestic hard coal. The issue of what energy sources will be used as substitutes remains to be decided.	E	ongoing programme					
(59) Conservation of existing forests	R, E, I	Since 1982, with its action programme “Save the forests” *(Rettet den Wald)*, the Federal Government has been introducing wide-ranging measures to combat new types of forest damage caused primarily by air pollution. Forest conservation is comprehensively regulated by the Federal Forest Act of 1975 and by the forest acts of the Federal *Länder.*	L	Implemented by the 1975 Federal Forest Act and the “Save the Forests” action programme	3000	3000	3000	3000	Annual forest-condition inventory, periodical forest inventories
(60) Support for new afforestation	E	In Germany, new afforestation has been supported for many years within the “joint task” framework. The support consists of two components: – Subsidies to help defray initial investment costs: particular emphasis is placed on planting semi-natural deciduous and mixed-species forests. Up to 85% of eligible costs for planting of deciduous stands are reimbursed; up to 70% of eligible costs for planting of mixed-species stands are reimbursed. – Since 1991, a new-afforestation bonus has also been paid: farmers and forest owners can receive, for up to 20 years, a bonus as compensation for income losses resulting from set-asides of agricultural land.	L	Council Regulation (EEC) 2080/92 has been transposed through the framework plan for the joint task "Improvement of the agricultural structure and of coastal protection" (GAK) and through *Länder* programmes	600	1000	1300	2000	*Länder* reports regarding GAK compliance

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		In 1993, this support was improved: the amount of the bonus – depending on the soil quality of the newly afforested farmland or grassland, as well as on the tree species selected – now ranges up to 1,400 DM per year and hectare. Afforestation currently amounts to 5,000 hectares/year.							
(61) Silvicultural measures	E, I	Stable, high-yield forests with large biomass and carbon reserves, and that have large annual biomass and carbon increments, play a valuable role in this connection – also with respect to the carbon-cycle. In this light, silvicultural approaches in which clear-cutting is largely avoided gain considerable significance, since clear-cutting causes temporary humus losses through which CO_2 is released and nutrient levels decreased. Forest management can thus play a significant role in conservation and development of optimally structured forest ecosystems. The Federal Government, in conjunction with the *Länder* – and within the framework of the joint task “Improvement of Agricultural Structure and Coastal Protection” – is supporting numerous silvicultural measures aimed at conservation and development of stable, healthy forests.	L	Silvicultural guidelines of the of the *Länder*; support of silvicultural measures in the GAK	NA	NA	NA	NA	BWI II
(1) Federal table of charges for electricity	R	The Federal table of charges for electricity *(Bundestarifordnung Elektrizität)*, which came into force in 1990, strengthened incentives for private households, business and agriculture to use electricity wisely: it increased the dependency of electricity rates on consumption.	R	in force					
(4) Elimination of the excise duty on lamps	E	The excise duty on lamps was eliminated as of 1 January 1993. As a result, tax on energy-saving lamps is no longer different than that for conventional lamps (lightbulbs).	R	excise duty eliminated					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(113) Information campaign on "climate protection"	R	In 1995/96, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) carried out a campaign entitled "Climate protection initiative of the German Ministry for the Environment – change your ways, man". This nationwide campaign, which addressed itself directly to citizens through informational events and a telephone infoline, disseminated information about climate-protection-oriented behaviour. The aim of the campaign was to motivate a large part of the population to become involved in climate protection. The campaign provided specific information about how small changes in daily behaviour can have an effect in terms of climate protection and saving energy.	R	concluded					
(29) Amendment of the Heat Insulation Ordinance	R	The amended version of the Heat Insulation Ordinance *(Wärmeschutzverordnung)* came into force on 1 January 1995. The new ordinance is expected to reduce annual heating energy requirements for new buildings by 30% in comparison with previous regulations. In addition, heating requirements specifications must be prepared for all new buildings, a requirement expected to enhance market transparency in the area of energy-saving construction. For measures in existing buildings, the amendment sets forth conditional requirements: those parts of buildings affected by measures must have insulation levels approximately equivalent to that customarily found in new buildings.	R	came into force on 1 January 1995	3500	7000			
(30) Amendment of the Heating Installation Ordinance	R	The amended version of the Heating Installation Ordinance *(Heizungsanlagen-Verordnungen)* came into force on 1 June 1994. The new ordinance also transposes a significant part of the EC heating system boiler directive (Directive 92/42/EEC), which sets forth requirements for minimum efficiencies of oil-fired and gas-fired boilers used to heat buildings and whose out-	R, C	came into force on 1 June 1994	4800	9700			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		puts are between 4 and 400 kW. Beginning on 1 January 1998, new heating system boilers must carry the CE mark pursuant to the EC heating system boiler directive and must be certified to conform to the directive as low-temperature boilers or as condensing boilers.							
(31) Advising concerning thrifty, efficient energy use in residential buildings – on-site advising	E, I	Support is provided for on-site advising by engineers regarding structural thermal insulation, heating systems and use of renewable energies. Support is provided only for advising in buildings used predominantly as residences and whose construction permits were issued before 1 January 1984. Engineers are eligible to apply for the programme as advisors – especially engineers working in the areas of architecture, civil engineering, structural physics, electrical engineering, mechanical engineering and building systems. Advisors who work for power companies are ineligible. The programme provides subsidies of up to 1,600 DM, depending on the size of the building in question. Applications should be submitted to the *Rationalisierungskuratorium der Deutschen Wirtschaft e.V.* (RKW), Postfach 5867, 65733 Eschborn.	R	ongoing programme					
(32) Support-area Act pursuant to the Tax-amendment Act of 24 June 1991 and the Act on securing the futures of sites of 13 September 1993	E	The Support-area Act *(Fördergebietsgesetz;* pursuant to the 1991 Tax-amendment Act of 24 June 1991, the Act on securing the futures of sites *(Standortsicherungsgesetz)* of 13 September 1993 and the 1996 Annual Tax Act *(Jahressteuergesetz)* of 11 October 1995) provides tax breaks from 1991 to 1998 for building modernisation and repairs, including modifications for use of renewable energies, in the new Federal *Länder.* Up to 50 % of expenses (as of 1997, up to 40 %) for such measures buildings that generate revenue (for example, commercially used buildings and apartment buildings) can be written off in the first five years; all expenses can	R	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		be written off within a ten-year period. For buildings used for own residential purposes, up to 10 percent of expenses – up to a maximum of 40,000 DM – may be deducted annually from the basis of assessment for income taxes, for up to ten years. For new residential buildings, the special deduction has been reduced to 25 %.							
(33) Housing modernisation programme of the KfW Reconstruction Loan Corporation	E	The housing modernisation programme of the KfW Reconstruction Loan Corporation *(Kreditanstalt für Wiederaufbau)*, Postfach 111141, 60046 Frankfurt am Main, provides low-interest loans for renovation and modernisation of housing, as well as creation of new rental apartments in existing buildings, in the new Federal *Länder*. As of the end of August 1996, over 48 billion DM of the programme's total volume of 60 billion DM (for the period 1990 to 1997) had been committed; of this amount 40 billion DM went to private persons. The low interest rates, which are provided for a 10-year period, are up to 2 percent lower than market rates; for loans applied to industrially prefabricated housing, for which 10 billion DM of the total volume has been reserved (and committed, since March 1995), they are 3 percent lower. The low interest rates are funded exclusively from the Federal budget. Overall, this measure will cost the Federal Government a total of some 14 billion DM. To date, committed funds have been used to support measures in 2.7 million apartments, a figure that represents over 40 percent of the total number of apartments in the new Federal *Länder*. Some 14.9 billion DM has been invested in energy-saving measures.	R	ongoing programme	6200	6200			
(111) KfW programme for CO_2-emissions reductions in existing buildings	E	The KfW's (Reconstruction Loan Corporation's) programme for CO_2-emissions reductions in existing buildings finances measures to reduce pollutant emissions, involving energy saving,	R	ongoing programme	1900	1900			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		in residential buildings in the old Federal *Länder*. Financing is in the form of low-interest loans. The low interest rates, which are up to 2 percent lower market rates, are provided for a 10-year period; a total loan volume of 1 billion DM has been provided from Federal budget funds. This volume had been completely committed by the end of June 1996. The Reconstruction Loan Corporation *(Kreditanstalt for Wiederaufbau – KfW)* is using its own funds to support continuation of the programme: a total of 2 billion DM in additional loans are being offered at the same programme terms. Support is provided for modernisation of thermal insulation on the exteriors of existing residential buildings (if their construction permits were issued before 1 November 1977), subject to the condition that the modernisation meets the requirements of the new Heat Insulation Ordinance. Installation of low-temperature boilers and condensing boilers is also being financed. Measures in some 77,000 apartments have been (co)financed with total funds committed to date of 1.2 billion DM. In 25 percent of all loan approvals, installation of condensing boilers is planned.(For information: KfW, Postfach 111141, 60046 Frankfurt am Main)							
(117) "50,000 Roofs" solar initiative of the Deutsche Ausgleichbank, from the DtA's environmental programme	E	The Deutsche Ausgleichsbank (DtA), Wielandstraße 4, 53170 Bonn, has added a "50,000 Roofs solar initiative" to its environmental programme. This programme for use of renewable energy is now available for private residences in the old and new Federal *Länder.* The programme is being financed with the DtA's own funds. The following types of measures are supported: – Solar water heating systems – Photovoltaic systems – Heat pumps – Biomass systems – Biogas systems – Geothermal systems	R	ongoing programme	30	80			

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		Private households can receive support for up to 100% of eligible investments.							
(34) The joint programme "Economic Recovery in the new Federal *Länder*" *(Aufschwung Ost)*	E	The special joint programme "Economic Recovery in the new Federal *Länder*" *(Gemeinschaftswerk "Aufschwung Ost")* provided subsidies in the amount of 20%, in the area of the new Federal *Länder*, for modernisation of heating systems, thermal insulation and other housing-related, energy-saving measures. In 1991 and 1992, Federal authorities provided a total of 1.5 billion DM for the programme. This funding supported modernisation and renovation in some 882,000 apartments.	R	concluded	1400	1400			
(35) Subsidies for construction of public (low-rent) housing	E	Each year, the Federal Government provides the *Länder* with financial assistance (in the form of "commitment frameworks" – *Verpflichtungsrahmen)* for construction of public (low-rent) housing. This assistance is also available for supporting modernisation and renovation in existing buildings, especially measures to save energy and reduce CO_2 and SO_2 emissions.	R	ongoing support	300	700			
(36) Experimental housing construction and urban development *(Experimenteller Wohnungs- und Städtebau - ExWoSt)*; the research area "Reducing pollution in urban development"	D	In the framework of its ministerial research programme "Experimental housing construction and urban development", the Federal Ministry for Regional Planning, Building and Urban Development (BMBau) has established the research area "Reducing pollution in urban development". On a basis of 12 model projects, the considerable possibilities available in urban development and housing construction for saving energy/reducing CO_2 are to be developed and tested with the help of integrated concepts for planning development, construction, utilities and transport. This work is expected to provide models for different types of cases of urban development. The execution phase for the research area is scheduled to run from 1994 to 1997. It will be followed by evaluation and presentation of the findings (evaluation	R	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		phase). This evaluation phase is to be completed by April 1998.							
(37) Act on investment facilitation and on land for housing construction *(Investitions-erleichterungs- and Wohn-baulandgesetz)*	R	In order to accelerate authorisation and licensing procedures, the amended version of Article 8 a of the Federal Nature Conservation Act, approved in the framework of the "Act on investment facilitation and on land for housing construction" of 1 May 1993, has accomplished the following: compensations under nature conservation law are now decided as a subordinate aspect of the balancing of interests that takes place in the early development planning. This means that the question of whether a construction project can be approved under planning law must also be resolved with respect to nature conservation law within the framework of the development planning *(Bauleitplanung)*. After such resolution, intervention regulations under nature conservation law remain applicable to outdoor projects, however. The *Länder* are now called on to act appropriately – they can mandate, in their directives concerning application of nature conservation law, that the use of renewable energy sources is normally, in and of itself, a contribution to environmental protection that must be taken into account in reviewing the necessity and determining the extent of compensatory measures. This does not means that individual-case reviews, using the relevant legal criteria, can be done away with, however.	R	in force					
(38) Reduction of barriers to investment in housing construction in the territory of the former GDR, for cases in which ownership questions have not been settled	R, E	In recent years, housing associations (co-operatives and municipal companies) have often been hesitant to claim support funding. This hesitation has primarily been due to unsettled questions of ownership, along with the resulting difficulties in securing loans, and to other difficulties, such as the refusal of municipal supervisory authorities to approve borrowing, reductions of loan amounts due to risks of	R	implemented					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		long-term municipal overindebtedness and questions of cost-effectiveness. The 1st and 2nd Ordinance on Basic Rents (*Grundmietenverordnung)*, and the Act on Assistance for Old Debts *(Altschuldenhilfegesetz)*, which provides for interest assistance and limitation of old debts to 150 DM/m² of living space, have decisively strengthened the liquidity of housing associations, however. Improved profits, in conjunction with clarification of the loan relationships prevailing in old debts, are clearing the way for financing modernisation and renovation. In addition, barriers to investment have been removed by the Act on Assets *(Vermögensgesetz)* and by the 1st and 2nd Act on the Amendment of Assets law *(Vermögensrechtsänderungsgesetz)* and the Act on Assets of Housing Associations *(Wohnungsgenossenschafts-Vermögensgesetz)*.							
(39) Information for building owners, architects, planners, engineers, craftsmen	I	The Federal Ministry for Regional Planning, Building and Urban Development (BMBau), Postfach 205001, 53170 Bonn, has published a brochure “Guide to Saving Energy in your Home” *(Energiesparbuch für das Eigenheim)* that provides guidance to building owners and other interested parties in selecting and executing modernisation and energy saving measures. In 1994, this brochure was revised and a large number of copies for the public was printed. In the new Federal *Länder,* the brochure’s tips and recommendations are particularly useful aids in finding solutions that are both cost-effective and reasonable in terms of energy policy. The Federal Ministry for Regional Planning, Building and Urban Development has had experts prepare a series of guides to modernisation of industrially prefabricated and constructed housing (“slab housing”). These guides, which are available to the interested public, should help to reduce uncer-	R	being continued and regularly updated					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		tainty in planning modernisation measures for such buildings. Other brochures have been made available to concerned experts, within the framework of research into structural damage. Currently, the Institute for Conservation and Modernisation of Structures *(Institut für Erhaltung und Modernisierung von Bauwerken)* is preparing component-oriented modernisation catalogues. In addition, the Federal Ministry for Regional Planning, Building and Urban Development is preparing standard specifications texts similar to those found in the book of standard specifications for renovation and modernisation of prefabricated parts.							
(44) Programme for promotion of photovoltaic systems	E	Demonstration of the feasibility of using photovoltaic systems in Germany. This has included the “Federal-*Länder* 1000-roof photovoltaic programme”, involving 2,250 systems, as well as the “Photovoltaic demonstration in the Federal sector”, involving some 110 systems in the agricultural and transport sectors, and a supporting measurement and evaluation programme. The support programme was successfully concluded with 1,988 installed systems (as of the end of 1995), with total installed generation capacity of 5.25 MW. The comprehensive evaluations that were carried out have been documented and point to considerable possibilities for improvement. The programme has successfully encouraged refinement of the relevant practical systems, especially by small and medium-sized companies.	R	concluded	3	3			
(46) “Solarthermie 2000” programme for promoting solar-heating systems	E	The “Solarthermie 2000” programme has been designed as a field test for demonstration and testing of solar water heating systems in public buildings in the new Federal *Länder*. Findings from this field test, in addition to analysis of the long-term behaviour of existing systems, will provide a basis for testing solar decentralised (small-scale) district heating systems.	R	ongoing programme	1	2			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(77) Advising concerning efficient energy use, provided by the *Arbeitsgemeinschaft der Verbraucherverbände (AgV;* Consumer associations' working group), on commission to the Federal Ministry of Economics	I	The Consumer associations' working group (AgV) – with financial backing from the Federal Ministry of Economics – is carrying out energy advising, in co-operation with the consumer advice centres of the *Länder*, in 330 major cities. The advice provided to citizens covers all questions regarding thrifty, efficient energy use, including use of renewable energies. Advising in the centres is supplemented by year-round mobile advising services – "advice buses" that systematically visit small and medium-sized cities and communities to ensure that energy advising is available throughout the country.	R	ongoing programme					
(85) Amendment of the Fee Table for Architects and Engineers (HOAI)	E, R	On 15 March 1994, the Federal Government approved the 5th Ordinance for Amendment of the fee table for architects and engineers (HOAI). The amendment provides for "special services" in the interest of efficient energy use and use of renewable energies, applying to cases in which services provided exceed the services generally required to properly fulfil contractual obligations. The purpose of the amendment is to give architects and engineers fee incentives and to encourage them to increase their services aimed at CO_2 reduction and at use of renewable energies and efficient energy use. The amendment has come into force.	R	The amendment has come into force					
(101) 2nd Ordinance for Amendment of the Ordinance on Small Firing Installations *(1. BImSchV –* 1st Ordinance for the Implementation of the Federal Immission Control Act)	R	The Federal Cabinet's second CO_2 resolution, dated 7 November 1990, contains a mandate for adapting the maximum permissible waste-gas-loss standards pursuant to the Ordinance on Small Firing Installations (1st Ordinance for the Implementation of the Federal Immission Control Act) to the current state of the art. The justification for this amendment is the fact that over 20% of all energy-related CO_2 emissions in Germany come from small firing installations (last revision: 1993). Old systems contribute disproportion-	R	The amendment has been in force since 1 November 1996	700	1400			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		ately to this share of total emissions. Over 30% of the some 12 million oil and gas firing installations are over 15 years old. These installations have comparatively poor energy efficiency. The relevant amendment of the 1st Ordinance for the Implementation of the Federal Immission Control Act came into force on 1 November 1996. Old systems must be brought in line with the new waste-gas-loss standards within 3 to 8 years; the exact period for a given installation depends on the installation's output. The amendment has considerably reduced the permissible losses "through the chimney": the permissible waste-gas loss (with respect to the thermal value of the fuel in question), once the transition phase has elapsed, has been reduced to 11% for installations with outputs between 4–25 KW; to 10% for installations with outputs between 25–50 KW; and to 9% for installations with outputs over 50 KW.							
(106) Support for provision of information regarding third-party financing	I	The EU SAVE directive calls on Member States to promote use of third-party financing in the public sector. The Federal Ministry of Economics' discussions on the topic of "Energy saving and renewable energies" included consideration of possibilities for third-party financing. The conclusion was reached that no fundamental hindrances to implementation of third-party financing projects are seen. On the other hand, if this financing model is to become more common, especially in the area of public administration, the model's advantages will have to be more intensively publicised. Currently, the Federal Ministry of Economics is reviewing possibilities for publishing a guide to third-party financing in the public sector.	R	Partly implemented	400	1000			
(108) Law on labelling with regard to energy consumption	R, I	The purpose of this law is to improve consumer information regarding energy consumption of electrical household appliances.	R	legislative process in progress					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		This is to be accomplished by means of standardised labels and data sheets; energy consumption is to be reduced through introduction of appliance-specific standards for maximum energy consumption. In September 1992, the Council of the EC approved a framework directive on energy labelling; in September 1996 it approved directive 96/57/EC of the European Parliament and of the Council on "Requirements with regard to the energy efficiency of household electrical refrigerators and freezers and relevant combinations". This directive obligates the Member States, beginning in September 1999, to ensure that all appliances sold comply with the required energy consumption standards. The Federal Government is currently transposing the framework and efficiency directive, and the relevant execution directives, into national law.							
(130) Act on Assistance for Old Debts *(Altschuldenhilfegesetz)* of 23 June 1993	E	The Act on Assistance for Old Debts *(Altschuldenhilfegesetz)* has relieved the housing sector in the new Federal *Länder* of accumulated debts in the amount of some 29.5 billion DM. This debt relief has created new financial latitude; in particular, it has created new opportunities to carry out modernisation. The Act will affect some 2.6 million residential units that companies applying for assistance under the Act have promised to renovate and modernise.	R	implemented					
(115) Subsidies for owners of "low-energy" houses	E	Homeowners can receive subsidies in addition to the standard subsidy for owner-occupied homes, and in the amount of up to 500 DM per year, for an eight-year period, by installing certain heat pumps, solar systems or heat-recovery systems before they move in; purchasers of new "low-energy" (energy efficient) homes can qualify by purchasing homes already equipped with such energy-saving devices. Homeowners and	R	in force	400	400			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		purchasers of new homes can obtain annual support of 400 DM if their homes' annual heating energy requirements are at least 25% less than standards established by the Heat Insulation Ordinance ("low-energy" house – *Niedrigenergiehaus)*.							
(142) The "Solar-optimised construction" programme of the Federal Ministry of Education, Science, Research and Technology (BMBF)	D	The programme's aim is to support further development of "passive" solar energy systems/solar heating systems, so that use of such systems can be increased. In the long term, such systems are expected to permanently reduce heating requirements.	R	ongoing programme					
(14) Amendment of the mineral-oil tax	E	In 1991, the mineral-oil tax on carburettor and diesel fuels was increased as follows: Petrol leaded from by to 0.92 DM/l 0.16 DM/l 1.08 DM/l Petrol unleaded from by to 0.82 DM/l 0.16 DM/l 0.98 DM/l Diesel fuel from by to 0.55 DM/l 0.07 DM/l 0.62 DM/l To compensate for the smaller increase of the tax on diesel fuel, the motor-vehicle tax on automobiles with diesel engines was increased by 7.50 DM/100 cm^3. The added tax revenue resulting from the increase of the mineral-oil tax, approx. 8.5 billion DM per year, is to be used to reduce the debt of German Railways *(Deutsche Bahn)* and to finance urgent tasks in the transport sector. The government's assumption of German Railways' debt is a prerequisite for the reform of the railway sector. This action makes a vital contribution to strengthening the railway, an environmentally compatible mode of transportation.	T	implemented	3500	5000			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(131) Reduction of the mineral-oil tax for gas-powered vehicles	E	As part of the annual tax act *(Jahressteuergesetz)* for 1996, a decrease of the mineral-oil tax for gas-powered vehicles used for public transportation was approved, to come into effect on 21 October 1996. The purpose of this action is to improve the framework for introduction of this technology: LP gas from 612.50 DM/1000 kg to 241.00 DM/1000 kg Natural gas from 47.60 DM/MWh to 18.70 DM/MWh This measure is scheduled to terminate on 31 December 2000.	T	in force					
(15) Emissions-oriented taxation for heavy utility vehicles	E	See Table 5.2.4	T	in force since 1 April 1994	NA	NA			
(92) Emissions-oriented tax for automobiles	E	See Table 5.2.4	T	in force as of 1 July 1997	NA	NA			
(16) 1992 Federal Traffic Infrastructure Plan	E	The 1992 Federal Traffic Infrastructure Plan *(Bundesverkehrswegeplan)* brought a change in the Federal Government's transport-investment policy: the emphasis of this policy was placed on the more environmentally compatible modes of transportation, railways and waterways, for which some 54% of total investments in the Plan's period of applicability (1991–2012) are planned. For the first time, the Federal Traffic Infrastructure Plan provides for greater investments in the railway infrastructure (some 213.6 billion DM) than in national long-distance motorways (some 209.6 billion DM). The purpose of this emphasis is to give the railway sector a modern, high-performance infrastructure that will enable it to increase its share of the transport market. This Federal Government emphasis in transport-investment policy is to be retained even during the necessary budget consol-	T	Approved	NA	NA	NA	NA	NA

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		idation – to which the transport-sector budget must make a contribution.							
(17) Increasing use of local public transportation	E	Pursuant to Germany's Basic Law, responsibility for local public transportation lies predominantly with the *Länder.* The Federal Government's influence (Federal Ministry of Transport) is found primarily in its legislative jurisdiction over the Passenger-Transportation Act *(Personenbeförderungsgesetz),* the Regionalisation Act *(Regionalisierungsgesetz)* and the support regulations found in the Act on Financing of Municipal Transport *(Gemeindeverkehrsfinanzierungsgesetz – GVFG).* Budgeting for the GVFG, and development of federal programmes in behalf of local public transportation, are subject to approval of the *Länder*. Part of the investments pursuant to the Act on Expansion of the German Railway Network *(Bundesschienenwegeausbaugesetz)* are used for local public rail transportation. One of the aims of this financial assistance has always been to increase the attractiveness of local public transportation, and thus increase use of such transportation, in order to shift the "modal split" in favour of local public transportation. The emissions reduction resulting from a major shift of passengers away from private motor vehicles and to local public transportation, especially in areas with heavy traffic, is obvious. CO_2 emissions can be positively influenced through increased use of local public transportation. Since 1967, the Federal Government has provided over 45 billion DM worth of financial assistance – pursuant to the GVFG, as of 1971 – for measures in the local public transportation sector. This assistance has made possible investments of considerably over 60 billion DM.	T	ongoing support	3000	3400			

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		Support has been provided for measures such as construction and expansion of subways and city trams, of central bus stations and maintenance facilities and of traffic-control systems for municipal roads; financing has also been provided for "park + ride" facilities and for procurement of new buses with lower emissions. Since 1992, procurement of other types of vehicles for local public transportation, as well as construction of attractive bus and tram stops and installation of equipment to speed up local public transportation, have also been eligible for support.							
(19) Research programme on city traffic (FOPS)	D	Within the framework of the annually renewed "City traffic research programme" *(Forschungsprogramm Stadtverkehr – FOPS)* research projects are carried out that are aimed at increasing use of environmentally compatible forms of mobility. These projects are of special significance in strengthening the local public transportation sector.	T	ongoing programme	500	1000			
(20) Improving continuity of traffic flow	D	Traffic-control measures help increase traffic safety and the continuity of traffic flow – for example, by increasing the efficiency with which the road network is used. As a result, such measures also help reduce the environmental pollution caused by road traffic, especially because traffic-flow-control systems are used in connection with speed limits. As of the end of 1996, a total of 550 km of roads were subject to variable speed limits and equipped with systems to warn of traffic jams and fog. In addition, a total of 1,300km of autobahn are equipped with variable signs that provide recommendations for alternate routes. As of the end of 1996, the Federal Ministry of Transport (BMV) had spent a total of over 650 million DM on traffic-control measures on autobahns. The pro-	T	ongoing programme	600	1200			

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		gramme for controlling traffic on German autobahns has been extended for the period from 1996 to 2001. As a result of this programme, by the year 2001 some 1,100 km of autobahn will be equipped with systems for variable speed control. A total of some 2,100 km will then be equipped with variable signs that provide recommendations for alternate routes. These efforts will require an average of about 100 million DM per year.							
(21) Information on energy-saving and environmentally compatible driving habits	I	In 1993, within a comprehensive information and awareness campaign, the Federal Ministry of Transport (BMV), Postfach 200100, 53170 Bonn, published a brochure entitled "Less CO_2 in traffic – do your part" ("Weniger CO_2 im Verkehr – machen Sie mit") and the Federal Ministry of Economics, Postfach, 53107 Bonn, published "The book of energy saving" *(Kraftstoffsparbuch)*. The primary aims of these brochures are to make drivers more aware of fuel-saving driving habits, to encourage them to use public transportation and, in general, to foster greater environmental awareness on the part of automobile users. In 1994, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Postfach 120629, 53048 Bonn, launched an information campaign on environmentally compatible behaviour entitled "All about your car" *(Rund ums Auto)*. In addition, in 1994 the Federal Environmental Agency, Postfach 330022, 14191 Berlin, issued a publication with a comprehensive chapter on environmentally compatible driving habits. And the Federal Ministry of Transport (BMV) has published several informational pamphlets that highlight environmentally compatible driving habits and that call for increased use of bicycles.	T	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(22) Research projects and information regarding urban traffic planning and cleaner city traffic	D	In March 1992, the research project "wide-area traffic abatement" *(flächenhafte Verkehrsberuhigung)*, a joint effort of the Federal Ministry for Regional Planning, Building and Urban Development (BMBau), of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and of the Federal Ministry of Transport (BMV), was completed. During its ten years of existence, this model project provided important impetuses to local authorities and the *Länder* for reorientation in urban-traffic-planning. The pedestrian-zone and traffic-abatement-area systems comprise a wide range of instruments with which local authorities can reduce environmental pollution caused by urban traffic. In July 1993, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety presented its comprehensive brochure "Environmentally compatible city traffic" *(Umweltschonender Stadtverkehr)*. Its purpose is to give local-level policymakers and administrators practical information and ideas for implementing the findings from research projects on environmentally compatible traffic in cities and communities.	T	concluded					
(138) The German automobile industry's declaration on a voluntary commitment to reduce fuel consumption	V	In spring 1995, the German automobile industry made a voluntary commitment vis-à-vis the Federal Government to further reduce the average fuel consumption of automobiles. This commitment provides for the following to be achieved: the fuel consumption of new vehicles of German manufacturers, beginning in the year 2005, is to be reduced by an average of 25%, in comparison with relevant average fuel consumption in 1990. In addition, the German automobile industry has stated its willingness to update this commitment, before the year 2000, with the aim of achieving an average reduction of over one-third.	T						

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
(23) Railway structural reform	R	On 1 January 1994, the laws reforming federal railway structures came into force. The central action of these laws was to transform Deutsche Bundesbahn (German Federal Railway) and Deutsche Reichsbahn (the railway system in the area of the former GDR), which were structured as government agencies, into a private stock corporation. One of the main aims of the structural reform is to create a framework that will improve the railways' performance and competitiveness and enable them to increase their shares of the transport market. As of 1 January 1996 local rail passenger transport systems have been regionalised; this change has significantly improved the possibilities for integrating railway traffic within local and regional short-range transport concepts.	T	in force					
(24) Freight centres	E	The Federal Government is also providing financial assistance, pursuant to the Act on Financing of Municipal Transport *(Gemeindeverkehrsfinanzierungsgesetz – GVFG)* for the construction and expansion of public traffic areas of freight centres. Freight centres *(Güterverkehrzentren - GVZ)* are an important element in efforts to promote co-operation in the goods-transport sector. GVZs, by bringing together companies that provide transport services and related supplementary services, facilitate bundling and distributing of goods transports. Their function will be optimised when a considerable number of GVZs, distributed throughout Europe if possible, are networked. Within local-transport systems, GVZs provide the basis for co-operative, efficient organisation of distribution traffic (urban logistics).	T	ongoing programme	500	1000			
(26) Research programme on	D	In order to support efforts to reduce emissions, the Federal	T	ongoing programme					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
"Pollution in aviation"		Ministry of Education, Science, Research and Technology (BMBF) is combining the relevant emphases of the programmes "Aviation research" *(Luftfahrtforschung)* and "Pollution in aviation" *(Schadstoffe in der Luftfahrt)* into one integrated research programme. This move will ensure that activities aimed at decreasing pollutant emissions of aircraft engines, and at analysing the effects of aircraft pollution, are more closely linked and co-ordinated. The combination will improve the effectiveness of ongoing work, thereby enhancing the development of environmentally compatible technologies.							
(27) Transport research	D	In co-operation with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry for Regional Planning, Building and Urban Development (BMBau) (among others), the Federal Ministry of Transport (BMV) commissions numerous R&D projects aimed at providing specific assistance for decisions regarding technical aspects of transport policy. The aim of these activities is to provide environmentally compatible mobility – by encouraging different modes of transportation to co-operate and form an integrated transport network; by ensuring that each mode of transportation is optimally used; and by maintaining and expanding an integrated transport infrastructure network. As part of these efforts, issues of climate protection are also being studied. In addition, the BMBF and the Federal Ministry of Economics are supporting projects in the areas of air transport and ground-based transport and traffic systems.	T	ongoing programme					
(62) Tax exemption for pure rape methyl ester (RME)	E	Pure RME is completely exempt from mineral-oil tax. This also applies when RME is added to other fuels in motor-vehicle fuel tanks. In pure form, RME can be used as a fuel in conventional	T	in force					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		diesel engines approved to use it. Vehicle manufacturers have already approved certain vehicles for use of “biodiesel”. Older vehicles may require conversion before manufacturers will approve them for biodiesel. RME reduces CO_2 emissions when used as a substitute for diesel fuel. By amendment of the Ordinance on Execution of the Mineral Oil Tax Act, dated 30 July 1996, fuels obtained from renewable raw materials, if they contain no more than 3% hydrocarbons, may be used without being taxed.							
(93) Road-use tolls	E	The introduction of road-use tolls for heavy trucks has made an important contribution to juster allocation of road costs among traffic participants. In addition, such tolls have positive effects in controlling traffic and in encouraging more carefully considered use of motor vehicles. The Act on tolls on autobahn use *(Autobahnbenutzungsgebührengesetz)* of 30 August 1994 has implemented the agreement of 9 February 1994 between Germany, Denmark and the Benelux countries concerning tolls on use by heavy trucks of certain roads. In keeping with Council Directive 93/89/EEC of 25 October 1993, trucks with at least 12 tonnes total permissible weight have been subject to road-use tolls since 1 January 1995. The maximum permissible toll is 1,250 ECU (some 2 500 DM); this limit will be reviewed as of 1 January 1997, and then every two years. The EU intends to increase the tolls; a relevant directive proposal is currently being considered. Sweden will soon join the toll alliance. The Federal Government is considering the introduction of automatically registered, route-oriented tolls for heavy trucks in the early part of the next decade, and is seeking to replace the current system of time-oriented	T	in force since 1 January 1995					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		tolls with an automatic toll-levying system.							
(94) CO_2 emissions of new automobiles	E, R	At the environmental ministers meeting on 25–26 June 1996, conclusions were approved regarding the European Commission's memorandum on the topic "A Community Strategy for reducing CO_2 emissions of automobiles and for decreasing average fuel consumption". The conclusions set forth an objective of 120 g CO_2/km (which corresponds approximately to an average fuel consumption of about 5 l for vehicles with gasoline engines and about 4.5 l for diesel vehicles); this objective is to be attained by the year 2005 – if possible; by 2010 at the latest – for new automobiles. The strategy's measures for attaining this objective include voluntary commitments, market incentives and provision of consumer information.	T		3000	7000			
(95) German Railways' development concept for combined road/rail transports	E	The German Railways' development concept of 18 January 1996 for combined rail/road transports calls for new construction and expansion of railway freight stations at 52 sites in the Federal Republic of Germany. Total investments of about 4 billion DM are planned for implementation. By the year 2010, approx. 90 to 100 million t of total freight transports are to be transported by rail, as combined rail/road transports, for the majority of the transport distance.	T	currently being implemented	300	1000			
(96) Use of modern information technology for preventing and regulating traffic (telematics)	D	The Federal Government is supporting intensified use of modern information, control and communications systems in the transport sector (telematics) and has reached agreement with industry and the transport sector concerning a joint approach. Telematics is expected to make a substantial contribution to the solution of transport and environmental problems. Telematics enhances the efficiency with which the transport infrastructure and transport capacities are	T	ongoing project					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		used, and helps link and network different modes of transportation, thereby providing attractive incentives for shifting transports from roads to more environmentally compatible modes of transportation. It can also help reduce traffic (for example, by reducing no-load trips). Overall, use of telematics applications, including the planned automatic toll system for heavy trucks, will help decrease environmental harmful emissions, especially CO_2 emissions, and help enhance transport safety.							
(98) Amendment of the Common Rules of Procedure *(Gemeinsame Geschäftsordnung)* of federal ministries	R	The first report of the "CO_2 reduction" IWG of 7 November 1990 proposed that, in order to reduce CO_2 emissions in the transport sector, future drafts of laws and ordinances should describe the legislation's expected consequences on traffic and the environment. By resolution of 21 June 1995, the Federal Cabinet has added a clause to the Common Rules of Procedure (*Gemeinsame Geschäftsordnung* – GGO) that now requires federal ministries to state, in future drafts of federal laws and ordinances, "if necessary ... what effects on traffic are to be expected" (Article 40 para. 2 No. 3 GGO II). The introduction of this clause is expected to foster a new awareness, in preparation of drafts of federal laws and ordinances, regarding problems of traffic origins. It is recommended that the *Länder* and local authorities adopt similar regulations for their own legislative procedures.	T	in force					
(99) Introduction of traffic-impact reviews	R	A research project entitled "Case studies for traffic-impact assessments in federal legislative and ordinance procedures" has been carried out, under commission to the Federal Ministry of Transport (BMV), aimed at supporting practical application of the traffic-impact clause. As part of this research project, a catalogue of questions is being prepared that	T	implemented					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect				Monitoring
					2000	2005	2010	2020	
		will support officials in carrying out the reviews required by the traffic-impact clause.							
(100) Shifting of international transit traffic from roads to railways and waterways	R, I	In co-operation with transport-sector experts, a “freight transit through Germany” concept has been developed and presented to the public. In the main, the concept calls for increasing use of trains and ships (inland waterways) – environmentally compatible modes of transportation with considerable capacity reserves – for goods transits, in order reduce road traffic. The next step is to implement the package of measures the transit concept describes.	T	ongoing project	100	500			
(141) Mobility research	D	In December 1996, the Federal Cabinet approved an initiative on mobility research, which had been prepared under the direction of the Federal Ministry of Education, Science, Research and Technology (BMBF), and with the co-operation of the Federal Ministry of Transport (BMV), Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Federal Ministry for Regional Planning, Building and Urban Development (BMBau) and Federal Ministry of Economics. As a result, a framework is now in place, for the next few years, for the Federal Government’s transport and mobility research policy. The initiative calls for the following emphases: – promotion of structures that reduce traffic; – enhancement of the transport system’s efficiency (in particular, through improvement of the performance of modes of transportation; through tighter networking of modes of transportation, to form an integrated transport system; through optimisation of transport handling and management; through spreading of peak traffic volumes over time and throughout the available infrastructure)	T	ongoing project					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		– reduction of stresses on the environment and resources (especially through long-term approaches to reduction of climate-relevant gases, air pollutants and noise, and through recycling) – improving understanding of mobility and transports.							

Tab. 5.2.2: Summary of policies and measures: CH_4

This section does not include measures for reduction of greenhouse gases controlled by the Montreal Protocol.
In addition, specific measures of the Federal *Länder* and of local authorities for reduction of greenhouse gases are described in Chapters 5.4.2 and 5.4.3.

Measure name	**Type of measure**	**aim of the measure; description**	**Sector**	**Implementation status**	Expected effect				**Monitoring**
					2000	2005	2010	2020	
(52) Research into thermal treatment of waste	E, D	The Federal Ministry of Education, Science, Research and Technology (BMBF) has concentrated most of its funding for development and optimisation of incineration technology in the following three areas: – Optimisation of process controls, for improvement of combustion, and as primary measures for reducing pollutant emissions. – Optimisation of combustion chambers, to achieve primary-zone reductions of pollutant emissions. – Flue-gas scrubbing and treatment of solid incineration residues. Primary emissions reduction measures, in particular, help to achieve compliance, at considerably reduced cost, with emissions standards in the Ordinance on combustion systems for waste and similar combustible substances (17th Ordinance for the Implementation of the Federal Immission Control Act). Other significant thermal processes include pyrolysis and hydration. The latter of these is also being practically applied – for example, to plastics from German Dual System (DSD) waste collections. A pyrolysis installation for treatment of hazardous waste scheduled to go into operation in Salzgitter.	W	ongoing project					
(66) Technical Instructions on Waste from Human Settlements *(TA-Siedlungsabfall)*	R	This administrative provision was issued within the framework of the Waste Avoidance and Waste Management Act, with the purposes of reducing the amount of solid waste from human settlements that must be placed in landfills and of promoting waste separation and recycling. It also requires old landfills to collect landfill gas and use it for energy production. This provision provides a reduction of CO_2 and CH_4. In addition, it requires sepa-	W	Came into force on 1 June 1993	650	1300	1470	1640	

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		rate collection, and composting or fermentation, of organic waste. In agriculture, organic waste compost can be substituted, to a certain extent, for mineral fertiliser.							
(67) Technical Instructions on Waste *(TA-Abfall)*, Part 1	R	In 1990, the TA Abfall, Part 1, was issued to define the state of the art for recycling and other disposal of waste requiring special supervision. It sets high standards for the construction, operation and post-care of installations for waste storage; chemical/ physical and biological waste treatment; waste incineration and deposition. Its requirements for pre-treatment of waste bring about a reduction of CO_2 and CH_4 emissions during deposition.	W	Came into force completely on 1 April 1991	18	18	18	18	
(68) Closed Substance Cycle and Waste Management Act	R	Revision of the former Waste Avoidance and Waste Management Act *(Abfallgesetz)* to produce a new Closed Substance Cycle and Waste Management Act *(Kreislaufwirtschafts- und Abfallgesetz)*. The new law not only provides for more environmentally compatible waste disposal, but is also aimed at improving resources conservation and waste avoidance. The new Act establishes the following priority for dealing with waste: – Waste avoidance, – Use for substance recycling and energy recovery, – Waste disposal. Implementation of the new Act will reduce both CO_2 emissions and CH_4 emissions.	W	in force					
(57) Improvement of livestock animal digestive efficiency, in order to reduce methane emissions	R, E	The Federal Government's measures for improving livestock animal digestive efficiency reduce methane emissions per animal and per product unit. Specific measures regarding animal feeds can help decrease methane emissions, especially those of ruminants. Through the use of certain additives permitted by the Feedstuffs Ordinance, contributions to emissions reduction can be achieved both directly – for example, through influence on stomach metabolism	A	in force and being implemented					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		– and indirectly – through improvements in yields. As a result of the 22 December 1989 version of the Animal Husbandry Act, further progress in animal husbandry can be expected primarily as improvements in animal digestive efficiency. For example, from 1990 to 1995, milk production per cow was increased by 600 kg/year; this decreased specific methane emissions by some 5%. In addition, scientific studies have been commissioned for development of new procedures for keeping livestock – procedures that are acceptable under labour-economic, farm-economic and ecological criteria – in which straw is added to manure to help reduce semi-liquid manure production, thus possibly helping to diminish a further methane source.							
(143) Use of pit gas in the hard-coal mining industry	V	In 1990, the German hard-coal mining industry developed a concept for intensifying use of pit gas (which is always produced as a by-product of coal mining). By implementing this concept, the German hard-coal mining industry has now increased the percentage of the methane, in its pit-gas removal installations, that is used for energy recovery: from 70 to about 78%. Overall, this effort, so the industry's data, has reduced methane emissions by over 30%. More extensive methane-reduction measures are now being studied; for example, the Federal Environmental Agency is carrying out a study on avoidance of climate-relevant methane emissions in hard-coal mining.	E	ongoing project	580	730	730	730	

Tab. 5.2.3: Summary of policies and measures: N_2O

This section does not include measures for reduction of greenhouse gases controlled by the Montreal Protocol.In addition, specific measures of the Federal *Länder* and of local authorities for reduction of greenhouse gases are described in Chapters 5.4.2 and 5.4.3.

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(58) Support for extensive methods of agriculture	E	Agricultural CO_2 emissions are produced through energy use, both direct (fuels, heating oil, etc.) and indirect (mineral fertilisers, pesticides and herbicides, feedstuffs, seed and young plants, machines, lubricants, farm buildings, etc.). By reducing indirect energy use, extensive methods of production, including organic farming, can make a significant contribution to reduction of CO_2 emissions in agriculture. Use of raw materials with a favourable CO_2 balance in chemical and technical applications, and in the energy sector, can play a significant role in reducing CO_2 emissions in agriculture and silviculture. On the other hand, the competitiveness of such materials in the energy sector, which is far more significant than others in terms of the volumes involved, is still limited. Measures pursuant to Council Ordinance of 30 June 1992 (EEC/2078/92) on environmentally compatible agricultural methods that protect natural habitats are being implemented in Germany through increased support for environmentally compatible production methods. The emphasis of these supporting measures is on support for the following areas: – extensive methods of cultivation, including cultivation of permanent crops; – extensive management of grassland and conversion of farmland into extensively managed grassland and – organic farming. In 1995, organic farming was practised by about 1.3% of all farms in Germany. Organic farming is expected to remain a	A	ongoing project					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		very small segment of the market for the near future. More extensive production methods and land set-asides will reduce emissions of climate-relevant gases in the agricultural sector and help save energy. To an increasing degree, 21 agricultural environmental programmes of the 16 *Länder* are involved in such efforts. Nationwide in 1994/95, 2 million hectares of agricultural land were extensively cultivated within the framework of the above measures. From 1993 to 1996, a total of 1.1 billion DM was invested in this sector. Nonetheless, it must be remembered that the agricultural sector accounts for only about 3% of consumption of fossil fuels in Germany, meaning that any reduction der CO_2 emissions brought about by this measure will occur within a very limited framework. Yield increases of over 1/3 have been achieved over the last 20 years for important market crops, as a result of progress in the areas of breeding, production technology and farm fertiliser management. These increases have made it possible to reduce indirect energy use significantly, without any reductions in nitrogen-input levels. It cannot yet be determined whether extensive production methods also reduce climate-relevant gases with respect to product units (per kg of grain, milk or meat).							
(64) Fertiliser Ordinance	R	The Fertiliser Ordinance for determination of proper practice in fertiliser use, and which also transposes the EC nitrate directive, also contributes to reduction of N_2O emissions from agricultural fertiliser use.	A	The Ordinance was issued in February 1996, has been completely in force since 1 July 1996.					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(139) Technical measures for adipic acid production	V	On the basis of the Federal Government's discussions with the two adipic acid manufacturers in Germany, highly effective technical measures are now being introduced that will reduce N_2O emissions from adipic acid production to 10 Gg/a in 1998 (1990: 68 Gg/a).	IN	ongoing project					

Tab. 5.2.4: Summary of policies and measures: NO_x

This section does not include measures for reduction of greenhouse gases controlled by the Montreal Protocol.
In addition, specific measures of the Federal *Länder* and of local authorities for reduction of greenhouse gases are described in Chapters 5.4.2 and 5.4.3.

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(118) Application/implementation of the Federal Immission Control Act in the new Federal *Länder (GFAVO, TA-Luft)*	R	The Ordinance on Large Firing Installations (GFAVO) of 22 June 1983 introduced effective regulations for reducing emissions from large firing installations in the territory of the old Federal *Länder*. Whereas in the old Federal *Länder* measures for compliance with the Ordinance on Large Firing Installations (13th Ordinance for the Implementation of the Federal Immission Control Act) have now been concluded, application of the Ordinance to installations in the new Federal *Länder* is in full swing. As of 30 June 1996, some of the existing power stations in the new Federal *Länder* had been retrofitted with modern environmental protection equipment, and obsolete firing systems were gradually being decommissioned. Rapid modernisation was carried out in those power stations and industrial firing installations that have unlimited remaining use periods and that fall under the 13th Ordinance for the Implementation of the Federal Immission Control Act. Retrofits in such installations was required to be completed by 30 June 1996. Old installations with limited remaining-use periods must be decommissioned no later than 1 April	E	in force, implementation in progress					

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
		2001. The modernisations have increased the efficiency of many power stations, thereby reducing CO_2 emissions.							
(15) Emissions-oriented motor-vehicle tax for heavy trucks	E	On 1 April 1994, emissions-oriented taxation of vehicles with an approved total weight of over 3.5 t was introduced.	T	in force since 1 April 1994					
(92) Emissions-oriented motor-vehicle tax for automobiles	E	In a planned second stage, to come into force on 1 July 1997, taxation of automobiles will also become more emissions-oriented.	T	in force as of 1 July 1997					

Tab. 5.2.5: Summary of policies and measures: NMVOCs

This section does not include measures for reduction of greenhouse gases controlled by the Montreal Protocol. In addition, specific measures of the Federal *Länder* and of local authorities for reduction of greenhouse gases are described in Chapters 5.4.2 and 5.4.3.

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
(18) Gas-balance System Ordinance	R	Since 1993, when the Gas-balance System Ordinance came into force, NMVOC emissions produced through refuelling of vehicles have been considerably reduced.	T	in force	NA	NA			

Tab. 5.2.6: Summary of policies and measures: PFC

This section does not include measures for reduction of greenhouse gases controlled by the Montreal Protocol.
In addition, specific measures of the Federal *Länder* and of local authorities for reduction of greenhouse gases are described in Chapters 5.4.2 and 5.4.3

Measure name	Type of measure	aim of the measure; description	Sector	Implemen-tation status	Expected effect 2000	2005	2010	2020	Monitoring
(136) Declaration of the German primary aluminium industry	V	In 1995, following relevant discussions between the Federal Government and the German primary aluminium industry, this industry made a voluntary commitment reduce CF_4/C_2F_6 emissions by 50% by the year 2005, by comparison to levels in 1987, and to verify the reductions by means of an appropriates measuring programme.	IN	ongoing project					

Tab. 5.2.7: Summary of policies and measures: SF_6

This section does not include measures for reduction of greenhouse gases controlled by the Montreal Protocol. In addition, specific measures of the Federal *Länder* and of local authorities for reduction of greenhouse gases are described in Chapters 5.4.2 and 5.4.3

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect				Monitoring
					2000	2005	2010	2020	
(135) Declaration on the use of SF_6 in electrical switching equipment and systems in Germany (voluntary commitment)	V	To reduce emissions of sulphur hexafluoride, which is used in closed systems – as an insulating and arc-extinguishing gas in modern switching equipment and electrical transmission and distribution systems – manufacturers and users of sulphur hexafluoride in switching systems and equipment issued the following commitment, after negotiations with the Federal Government: – Manufacturers shall accept returned used sulphur hexafluoride, for purposes of re-use or, if necessary, disposal, – To prevent sulphur hexafluoride emissions to the greatest possible extent during operation of switching systems, – As far as it is possible, to clean and re-use used sulphur hexafluoride on location, – To permit only properly trained and qualified employees to work with sulphur hexafluoride and to carry out maintenance work for switching systems, – To provide data on the use of sulphur hexafluoride (SF_6 monitoring).	E, IN, IE	ongoing project					

5.3 Additional planned measures and instruments for climate protection

Tab. 5.3.1: Additional planned measures and instruments for climate protection

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(114) New amendment of the Heat Insulation Ordinance by the end of the decade	R	The Federal Government expects further adaptations of requirements levels to be possible for new buildings before the end of this decade, taking relevant central considerations into account (especially the energy price trends and economic requirements in the construction and housing sectors); these adaptations should lead to additional reductions in consumption of some 25% to 35%. In good time prior to the amendment of the Ordinance, the Federal Government will present a report, based on comprehensive studies, describing the implementation of the requirements now planned and showing further possibilities for making structural and technical improvements. This report will provide a basis for conclusions regarding measures for further reductions in consumption and emissions.	R	planned					
(91) Increase in the EU minimum tax rates for mineral oil	E	Fuel taxes and prices differ widely throughout the European Union. To reduce the existing tax discrepancies within the EU, the Federal Government is seeking further EU harmonisation of mineral-oil tax, aimed at increasing the minimum mineral-oil tax levels within the European Community. The proposed directive for taxation of energy products, presented by the European Commission at the meeting of the Council for Economic and Financial Issues on 17 March 1997, would also serve this aim. The Federal Government also supports higher fuel prices in the EU as a means of reducing consumption and, consequently, emissions. Finally, drivers in areas along Germany's borders still tend to drive to neighbouring countries to refuel.	T	planned					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(97) Taxation of aircraft fuels	E	Within the EU, aircraft fuels for commercial air transport are exempted from mineral-oil tax pursuant to Art. 8 para. 1 letter b) of directive 92/81/EEC. Consequently, unilateral elimination of this tax exemption by Germany would violate EC law; such elimination would be possible only after relevant unanimous amendment of the directive. In addition, mutual tax exemptions have been agreed in a number of bilateral air-transport agreements based on the ICAO Treaty. The Federal Government is again expressing support for the elimination of this tax exemption (which would have to take place on at least an EU-wide basis), within the framework of the review of the tax exemptions of Art. 8 of the Directive on the Mineral-oil tax structure. The review is planned to take place by 31 December 1997.	T	planned					
(102) Instruments for increasing energy efficiency of existing buildings	E, I	The potential inherent in existing buildings and structures for reducing CO_2 emissions is a key to the implementation of the CO_2-reduction programme. For this reason, the Federal Government will also study ways to achieve greater emissions reductions in existing buildings. The following measures are worthy of mention in this connection: The new Heat Insulation Ordinance takes existing buildings into account in that it tightens requirements – where technically possible and economically acceptable – for heat insulation retrofits in existing buildings, for cases in which the extent of renovation and modernisation measures exceeds certain levels. Comprehensive retrofits cannot be generally prescribed, since the investments required to exploit potential for saving energy are not cost-effective under current energy prices and would place unreasonable burdens on citizens.	R	planned					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		For this reason, the Federal Government has also initiated support measures aimed at accelerating the pace of energy-saving investments in buildings (Housing modernisation programme of the Reconstruction Loan Corporation – *KfW-Wohnraummodernisierungsprogramm;* the KfW CO_2 reduction programme). In addition, on 18 March 1997, the Federal Government approved a DM 25 billion programme for continuance of job-creating investments. The following measures are included in this programme: – A DM 3 billion addition, for 1997, to the housing modernisation programme of the Reconstruction Loan Corporation (and within the framework of the existing programme). The programme supports accelerated repair and modernisation of prefab housing in the new Federal *Länder* (interest reduction: 1%, financed by the Reconstruction Loan Corporation, in addition to the federally funded reduction of up to 2%), – A DM 2 billion addition to the Reconstruction Loan Corporation's programme to reduce CO_2 emissions in existing buildings in the old Federal *Länder* (interest-rate reductions of up to 2%), to support investments in thermal insulation and for replacement of obsolete heating systems, – DM 4 billion to finance municipal investments in the new Federal *Länder,* and improvements in terms for DM 3 billion worth of related measures in the new Federal *Länder* subject to funding caps.							
(104) Standardisation of licensing practices for installations that use renewable energies	R	Efforts should be made to standardise licensing practices for use of renewable energies – i.e. to harmonise the relevant procedures. The Federal Government has requested the competent bodies within the Working party of the *Länder* ministers for con-	C	planned					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
		struction, housing and settlement (ARGE Bau) to consider this question again.							
(107) Introduction of an (at-least) EU-wide CO_2/energy tax that does not affect total revenue or competition	E	The Federal Government continues to support harmonisation of energy taxation within the European Union in terms of CO_2/ energy perspectives. No consensus on this issue has been achieved, although Germany has supported the European Commission's proposed directives for an EU-wide CO_2/energy tax (proposed in 1992 and May 1995) from the start. On 17 March 1997, the European Commission, in response to a request of the Council for Economic and Financial Issues, presented a new proposed directive for taxation of energy products. In principle, the Federal Government supports the approach of applying a harmonised mineral-oil tax, using CO_2/energy criteria, in a manner that is ecologically sensible and does not affect competition to other fuels. In other words, the Federal Government supports precisely targeted harmonisation, within the European Union, of CO_2/energy taxation. If an EU-wide CO_2/energy tax is adopted, the Federal Government will also support exemptions, or full credit of relevant results, for companies that participate in industry's voluntary commitments – under the condition that commitments are fulfilled.	C	planned					
(132) Enhancing consideration of renewable energies in the Building Code	R	The government's bill for amendment of the Building Code and of regional planning law (BR-Drs. 635/96), would improve climate protection by expressly mentioning use of renewable energies as a requirement to be taken into account in development plans *(Bauleitplanung)*. Plans calls for the bill to be passed in 1997 and to come into force on 1 January 1998.	C	planned					

Measure name	Type of measure	aim of the measure; description	Sector	Implementation status	Expected effect 2000	2005	2010	2020	Monitoring
(128) New regional planning principle with regard to transport	R	All public agencies must apply the basic principles for regional planning to regionally significant planning and measures. The Federal Government's bill for amendment of the Building Code and of regional planning law (BR-Drs. 635/96) reformulates the principle for transport. The new principle would require prerequisites for shifting transports to environmentally compatible modes of transportation such as railways and waterways to be improved in areas and corridors with large transport volumes. Development of settlements should be so influenced, by means of appropriate allocation and mixing of various types of land use, that additional transports are avoided (Section 2, Art. 2 para. 2 No. 12 EROG).	T	planned					

5.4 Other organisations involved in climate protection policy

5.4.1 European Union

The Federal Government is also actively supporting harmonisation of climate protection policy within the European Union (EU).

Through resolutions of the joint council of ministers of the environment and of energy, of 29 October 1990 and 13 December 1991, the European Union has politically committed itself to stabilisation of CO_2 emissions by the year 2000, on the basis of levels in 1990. On 25 September 1991, the European Union presented a European Strategy for limiting CO_2 emissions and improving energy efficiency. The strategy's elements include a system for monitoring greenhouse gas emissions (Council decision regarding a system for monitoring emissions of CO_2 and other greenhouse gases in the Community), the Council directive on limitation of carbon dioxide emissions through more efficient energy use (SAVE directive) and an additional package of measures involving support, research and advising programmes.

Additional resolutions of the European Council (environment) on refinement of the EU's climate protection strategy were approved on 15 December 1994 (Doc. CONS/ENV/94/4), on 16 December 1994 (Doc. CONS/ENV/91/5), on 15 June 1995 (Doc. 8786/95, ENV 130), on 18 December 1995 (Doc. 13001/95, ENV 341), on 18 June 1996 (Doc. 8721/96, ENV 239) and on 3 March 1997 (Doc. 6450/97, ENV 74) These resolutions define the EU's guidelines for its negotiations relative to the Framework Convention on Climate Change – especially for negotiations on a climate protocol. In addition, they refine the EU's internal climate protection strategy. In both areas, Germany strongly supports effective EU climate protection policy, in terms of ambitious greenhouse gas reduction objectives and of policies and measures.

In many areas, a common EU approach is required, due to the constraints of international competition and due to the potential a common approach affords for achieving more significant greenhouse mitigation. For example, Germany has strongly supported CO_2 limits for automobiles, increases in minimum mineral-oil tax levels and taxation on aircraft fuels.

The Federal Government also supports efforts to introduce a CO_2/energy tax on the European level. For this reason, it supports the ECOFIN Counci's request, of March 1996, that the European Commission prepare a relevant proposal that would be binding for all EU countries and that would build on existing excise tax structures in the EU.

On 14 March 1996, the European Union presented a second progress report on the achievement of the Community's CO_2-stabilisation objective (Document COM (96) 91 final). This report is based on assessments made with the EU's monitoring system for CO_2 and other greenhouse gases.

The European Union is a Party to the Framework Convention on Climate Change. On 11 June 1996, it presented the "First report of the Commission pursuant to the Framework Convention of the United Nations" (Document (96) 217 final). Current plans call for the European Union's report to be submitted by the European Commission in April 1997, when the 2nd reports of the Member States are submitted. This EU report will contain a comprehensive description of the EU's climate protection strategy.

5.4.2 Climate protection programmes of the *Länder*

In keeping with the distribution of responsibilities between the Federal Government, the *Länder* and the local authorities (cf. Chapter 3.1), the *Länder* have a very important role to play in the development and implementation of the German climate protection strategy.

Many *Länder* are assuming special responsibility for climate protection. For example, on 31 March 1995 the *Länder* approved a resolution in the Bundesrat that underscored the need for development and implementation of measures to achieve the reduction target established for Germany. Pursuant to the resolution, the *Länder* support the Federal Government's objectives. The different situations in the various *Länder* should be noted in this context. CO_2 emissions differ as a result of differences in population, energy sources used, infrastructure etc. The following figures highlight the significance of the *Länder* in this context: the state (Land) of North Rhine-Westphalia (with a population of about 18 million, making it the most populous of all the *Länder)* has annual CO_2 emissions of about 200,000 Gg, or about the same as the annual CO_2 emissions of Spain or The Netherlands. Another example is the state of Berlin (population about 3.5 million), which annually emits about 25,000 Gg CO_2, or roughly half as much CO_2 as Denmark emits.

The relatively sparsely populated state of Mecklenburg-West Pomerania, which has an area of 23,559 km² and a population of about 2 million, has annual emissions of 30,000 Gg CO_2.

Tab. 5.4.2.1: Climate protection and energy programmes of the *Länder* (overview)

Land (state)	Population[1)] 10^6	CO_2 emissions[1)] Mt	Short overview/objectives
Baden-Württemberg	9,8	89	Baden-Württemberg's 1994 climate protection concept; report of the state of Baden-Württemberg on the status of planning and measures for climate protection; 1996 aim (orientation): since this *Land's* emissions amount to only 7 t of CO_2 per inhabitant and year, its climate protection concept is oriented to the aim of making an appropriate contribution, by the year 2005, to the Federal Government's objective of a 25% reduction in CO_2 emissions by the year 2005, based on the 1990 emissions level.
Bavaria	11,4	113	Report on the implementation of the Rio resolutions in Bavaria, June 1994; state parliament printed paper 13/5048 (last revision: 7 June 1996); "Energy Concept 2000" (planned for the end of fall 1996)
Berlin	3,5	25	Report of the state of Berlin on the status of planning and measures for climate protection; Reduction target: CO_2 reduction of at least 25% per inhabitant (last revision: 1995)
Brandenburg	2,6	58	1994 Climate protection report of the state of Brandenburg; Energy concept of 31 May 1996
Bremen	0,7	13	1994 state energy programme (last revision: 15 June 1994) Reduction target: decrease energy-related CO_2 emissions by 30% by the year 2005, in comparison with the 1987 emissions level
Hamburg	1,7	17	– Hamburg's contribution to the reduction of dangers to climate (last revision: 30 October 1990) – Status report on Hamburg's contribution to the reduction of dangers to climate (last revision: 30 May 1995) – Membership in the Alianza del Clima e.V. climate alliance, whose aim is to cut CO_2 emissions in half by the year 2010; Hamburg assumes that attainment of this objective will depend significantly on the federal policy framework. – Signed the Charter of European cities and local authorities on the way toward future sustainability (Charter of Aalborg); a Local Agenda 21 is being prepared
Hesse	5,8	74	Hesse's energy policy and climate protection, a 1994 report of the state government
Mecklenburg-West Pomerania	1,9	30	No information; the state's first climate protection concept is expected to be completed by the end of September 1996; the first energy concept is expected in mid-1997
Lower Saxony	7,4	92	1994 report on climate protection: "Climate protection begins with us!"
North Rhine-Westphalia	17,4	213	North Rhine-Westphalia climate report, January 1992
Rhineland-Palatinate	3,8	39	Climate protection in Rhineland-Palatinate (report by the state government, last revision: 16 December 94) Reduction target: CO_2 reduction of 30% by the year 2005 (reference year not specified)
Saarland	1,1	18	"Climate protection – no question about it!", June 1992 Reduction target: CO_2 reduction of 25–30% by the year 2005 (no reference year)

Land (state)	Population[1] 10^6	CO_2 emissions[1] Mt	Short overview/objectives
Saxony	4,8	81	1994 Climate protection report of the Free State of Saxony
Saxony-Anhalt	2,9	77	Report for the 42nd Conference of Environmental Ministers on 18/19 May 1994; climate protection programme being prepared (planned for the end of 1996)
Schleswig-Holstein	2,6	29	CO_2-reduction and climate protection programme for Schleswig Holstein (state parliament resolution of 27 May 1994; last revision: 25. October 1995) Aims: By the year 2010, 25% of electric power requirements are to be met by wind power, 25% of total final energy requirements are to be met by renewable energies, 30% of heating requirements are to be met through combined heat and power generation and 10% of primary energy requirements are to be met through biomass use – Greater consideration of environmental and climate protection aims in economic policy (intensified focus of Trade Supervisory Offices on climate protection measures in industry and commerce and on energy saving), pursuant to the Kiel environmental declaration of 12 June 1995
Thuringia	2,6	47	Study on the emissions situation for greenhouse-relevant gases and on reduction potential in Thuringia (last revision: 1994), as a preliminary step toward a “Thuringia climate protection concept and programme”, of which preparation is to begin in 1997.

[1] cf. Table 3.1.2.1

Tab. 5.4.2.2: An overview of sectoral measures of the *Länder*

	Energy	Transport	Construction, housing, settlement structures	Research, training, education in schools (higher education institutes)	Agriculture, silviculture, nature conservation and landscape management	Waste management
Baden-Württemberg	yes	yes	initiated	yes	initiated	initiated
Bavaria	yes	initiated	initiated	initiated	initiated	initiated
Berlin	yes	initiated	yes	initiated	no	no
Brandenburg	yes	yes	yes	yes	yes	yes
Bremen	yes	initiated	initiated	initiated	no	no
Hamburg	yes	yes	yes	yes	yes	yes
Hesse	yes	no	yes	initiated	no	initiated
Mecklenburg-West Pomerania	no information at present	no information at present	no information at present	no information at present	no information at present	no information at present
Lower Saxony	yes	yes	initiated	initiated	initiated	initiated
North Rhine-Westphalia	initiated	initiated	initiated	initiated	initiated	initiated
Rhineland-Palatinate	initiated	yes	initiated	initiated	yes	no
Saarland	yes	yes	initiated	initiated	initiated	initiated
Saxony	yes	yes	initiated	no	yes	initiated
Saxony-Anhalt	initiated	initiated	initiated	initiated	initiated	no
Schleswig-Holstein	yes	initiated	yes	initiated	initiated	yes
Thuringia	initiated	initiated	initiated	initiated	initiated	initiated

Note: for each sector and *Land*, the term "initiated" summarises individual measures in the relevant sector

There is great potential in the various *Länder* for reducing CO_2 emissions; this potential can be tapped by means of specific climate protection policies of the *Länder.* The following tables, which are based on information provided by the *Länder,* give an overview of the current status of *Länder* climate protection and energy programmes.

Tab. 5.4.2.3: Baden-Württemberg

Sector	Measures
Energy	– Support for municipal energy and climate protection concepts, testing of ecologically oriented urban models – Third-party financing/contracting, aimed at saving energy – Efforts to reduce use of oil, hard coal and lignite and to increase use of natural gas – Increasing use of combined heat and power generation and holding of workshops on combined heat and power generation – Support for small hydropower systems with outputs up to 1 MW; from 1989 to 1994, this support enabled development of a total of about 12.5 MW of hydropower – Broad-based support for solar collecting systems and photovoltaic systems – Support for municipal model projects to intensify use of solar energy, biogas, wood and combined heat and power generation in conjunction with small-scale district heating networks *(Nahwärme)* – Baden-Württemberg's solar energy and wind power atlas – Directive on the ecological assessment of wind power systems and treatment of such systems under construction law (20 April 95) – Within the framework of amendment of the Act on the Sale of Electricity to the Grid, support for clear and fair regulations for supply to the grid of power from small-scale combined heat and power stations – Energy Information Centre in the State Trade Agency *(Landesgewerbeamt)* and consumer advice centres, support provided for energy advising and relevant public relations aimed at households – 1 October 94: founding of the Klimaschutz- und Energieagentur Baden-Württemberg GmbH (Baden-Württemberg climate protection and energy agency)
Transport	– Support for shifting goods transports from roads to railways and waterways (about 70 million DM) – Expansion of the railway infrastructure (Pfullendorf container-handling centre, reactivation of decommissioned railway lines), support for industry main-lines and for networks of load-delivery systems and freight centres – Measures to expand and enhance local public transportation infrastructures and vehicle fleets of local public transportation systems (examples: support for acquisition of buses and tramway vehicles, and subsidies for tickets for regular users such as commuters and students – "environmental", "job" and "semester" tickets) – Submission to the state parliament (Landtag) of a draft of a local public transportation law – Expansion of "Park & Ride" facilities (currently, facilities have a total of about 13,500 parking spaces) and "Park and Share a Ride" *("Parken & Mitfahren")* (currently, about 2,700 parking spaces), – Bicycle concept of 23 August 1993 (Aim: increasing bicycle traffic, as a percentage of total city traffic, from 11% to 20%) in conjunction with the "Bike & Ride" support programme, which is receiving annual funding of 10 million DM from 1994 to 1996. – Increased priority for bicycle traffic as part of amendment of the state building code – Two studies on municipally compatible business traffic; a symposium entitled "Business traffic – vital artery of cities" – Model experiments: "Eliminating traffic jams and controlling traffic flow" (7 November 95) and "Stuttgart 21" (basis for connecting the Stuttgart airport to the high-speed railway network) – Public information on the topic of "environmentally compatible mobility" (commercials, films, pilot seminars, the "mobile Schopfheim" model test)
Construction, housing, settlement structures	– Integrated concept for improving the energy efficiency of older structures – Bonus system for modernisation of existing structures, with a focus on reducing energy consumption and emissions – Expansion of use of combined heat and power generation for supply of heat and power to state properties – Support for environmentally compatible construction methods and for housing modernisation – Support for energy-efficient designs and efforts to enshrine such methods in the law

Sector	Measures
	– Support programme for the preparation of municipal energy concepts and energy diagnoses, aimed at decreasing energy consumption in construction of public structures (7 measures implemented to date; 16 being prepared)
Research & training, education in schools(higher education institutes)	– Support for research, development and demonstration projects aimed at market placement of energy-efficient installations and processes (for example, awards of research projects to the universities of Hohenheim and Tübingen (biogas from organic waste) and testing of innovative technologies for wind power systems) – The “Climate-friendly and energy-saving school” campaign; a play entitled “Climate protection” – Training and continuing training for craftsmen, architects and structural engineers – Training programme for intensified energy management
Agriculture, silviculture, nature conservation and landscape management	– “Renewable raw materials” support programme (wood-chip power stations and associated local district heat networks, bio-fuels, heat generation and use of agricultural biomass to generate energy, use of biogas), 10 million DM; support for ecologically oriented agriculture – “Energy production and use” practical test on about 32 hectares of scrub forests cultivated for energy purposes, 1988–1992 – Support for ecologically appropriate initial afforestation; support for treatment of old open-pit-mining sites by means of afforestation and restoration to a natural condition – Studies on the optimisation of vegetable-oil fuels and suitable engines – Processing of rape into rape oil – “Nitrate-information” service aimed at efficient fertiliser use – Seminars of the Rural Academy (Akademie ländlicher Raum): “Using wood to generate energy” – MEKA programme
Waste management	– Increase of collection and use of landfill gas, with simultaneous substitution of such gas for fossil fuels

Tab. 5.4.2.4: Bavaria

Sector	Measures
Energy	**Aims:** By the year 2000, 13% of required primary energy is to come from renewable sources (current percentage: 9%), with 5% coming from biomass Minister-President’s government declarations of 21 July 1994, 8 December 1994 and 19 July 1995 **Measures** : – Study of the German Institute for Economic Research (DIW): “Reduction of CO_2 emissions in Bavaria”, 1994 – The “Energy Concept 2000”, a programme oriented to CO_2 reduction and involving efficient energy use, renewable energies and further development of innovative energy technologies, including hydrogen technology (planned for the end of 1996) – Support for municipal climate protection concepts (about 6 million DM for the period 1997–1999) – Support for municipal energy-saving concepts for properties of municipal regional authorities and for areas of new construction (about 3 million DM for 1995/96) – Measures to decrease energy requirements in state buildings, based on ongoing monitoring and assessment (state parliament resolution 10/3504) – Support programme: “More efficient energy production and use” (10 million DM for 1995/96) – Broad-based support programme to intensify use of renewable energies (acquisition, installation and start-up of solar collector systems and heat pumps available on the market; some 24 million DM for 1995/96)

Sector	Measures

	– Support programme for recommissioning, maintenance, expansion and new construction of small hydropower systems of up to 1 MW expanded output (6 million DM for 1995/96)
	– Risk cover of up to 75 % for geothermal drilling; partial assumption of the exploratory risk
	– Special support programme: “Conversion of solid-fuel heating systems to environmentally compatible fuels and solar components (max. of 6 million DM for 1996)”
	– Global concept for renewable raw materials; Support for processing of biomass and use for energy production (about 30 million DM annually beginning in 1995)
	– The C.A.R.M.E.N. e.V. co-ordination centre for renewable raw materials; supports use of biomass as a source of energy and materials
	– Revision of the existing “Bavaria Solar and Wind Power Atlas”
	– Model study: “The framework for landscape-compatible, co-ordinated and efficient use of wind power in Bavaria”, (12/96)
	– Report on further expansion of hydropower use in Bavaria (hydropower reserves), November 1995
	– Establishment of research alliances: research areas include
	  – solar energy; development of high-performance, cost-effective thin-film solar cellsor direct conversion of solar energy into electric power (28.5 million DM for 1995 – 1998),
	  – Solar-assisted energy systems for buildings. Aim: enhancing the cost-effectiveness and the popularity of solar heating systems; improvement of existing techniques and development of innovative processes
	– Installation of a photovoltaic solar facade on the building of the environmental ministry (output 52 kW)
	– Support for two solar “filling stations” (each with output of 20 kW)
	– Establishment of a “Bavaria Hydrogen Action Group”
	– 100 million DM programme package provided by Bayernwerk AG: “Bavaria’s Energy Future” (1996–2000), covering the topics
	  – Efficient energy use
	  – Heat pumps/solar collecting systems
	  – Photovoltaic systems/hydrogen
	  – Biomass
	– A programme of Bavarian power companies; “Sun in School”; construction of some 500 photovoltaic systems for schools (the majority have already been constructed)
	– Comprehensive programmes to provide information and advising on the topics: energy saving, efficient energy use and use of renewable energies; measures include brochures, and establishment of advising centres by state, municipal and private agencies and by power companies
	– Within the framework of the Act on the Sale of Electricity to the Grid, creation of means for providing cost-covering compensation (permissible increases of the electricity price for tariff customers of up to 0.15 Pfg/kWh)

Transport	– Support for model projects (transport bourses, freight centres) for the truck-transports sector – Shifting of automobile and air transports to environmentally compatible modes of transportation; improvements of service are to enable a larger percentage of traffic growth to be growth in rail traffic, local public transportation and inland shipping – Support for bicycling, an environmentally compatible mode of transportation – for example, through construction of bicycle paths – Installation of traffic-control systems to improve the continuity of traffic flow on federal autobahns (improvements in traffic safety and reductions in emissions) – Shifting of passenger traffic to railways, through gradual introduction of integrated-interval timetables (Aim in Bavaria: at any train station, departures at least once on the hour in every direction) – Shifting of goods traffic to railways (“Trailer train” pilot project, *Bayerische Trailerzug-Gesellschaft)* and to waterways (new construction and expansion, Rhine-Main-Danube Canal) – Gradual establishment of networks of freight centres, and pilot projects on city logistics – Model project and community of interests: “Auto-free spa and tourist sites in Bavaria (IAKF)”. Emissions and immissions are to be considerably reduced by means of traffic-reduction concepts that give clear priority to the “environmental network”, consisting of public transportation, pedestrian traffic and bicycle traffic.

Sector	Measures
	– Support of pilot projects using alternative power technologies to reduce pollutant emissions and energy consumption (for example, hybrid concepts, biogenic fuels) – Support of pilot and guideline projects for use of hydrogen in the transport sector (for example, Bavaria liquid hydrogen bus demonstration; planned: fuel cell buses) – “Recreation and relaxation” programme, 1996: 25 million DM, primarily for local recreation oriented to traffic reduction
Construction, housing, settlement structures	– Programme: “Settlement models – New approaches to reasonably priced, ecologically compatible and socially oriented housing in Bavaria”: 15% reduction of energy consumption in comparison with the new Heat Insulation Ordinance; 200 million DM in state funding appropriated to 12 model projects since 1995 – Support programme for municipal construction (195 million DM) – part of this effort is aimed at re-opening sealed land surfaces – Use of renewable fuels in state buildings – Model projects for use of wood as a building material – Voluntary commitment not to use insulation materials containing CFCs and HCFCs in state and state-supported construction (state parliament resolution 13/4373) – Intensified use of photovoltaic systems in state buildings – Use of energy-saving lighting systems in all state buildings (both old buildings and newly constructed ones) – Air quality control; energy-saving and environmentally compatible heating systems (OBBS 20 July 1989) – Initiative for the substitution of partially halogenated chlorofluorocarbons (HCFC) in air-conditioning and refrigeration systems (state parliament resolution 13/4392)
Research & training, education in schools (higher education institutes)	– Bavarian climate research programme of 1 January 1990; a study of expected regional climate changes in Bavaria and their impact on micro-organisms, plants, animals and people, to be used as a basis for decisions regarding state avoidance and adaptation strategies; from 1990–1996, some 25 million DM were provided for 75 projects – As a special emphasis, support for improvement of techniques for using biomass as a source of energy and materials
Agriculture, silviculture, nature conservation and landscape management	– Support for use of wood as a raw material – Measures in behalf of afforestation – Measures in behalf of environmentally compatible fertiliser use (soil studies, the “Nitrogen” fertiliser-use advising network, nitrogen-monitoring programme) – Measures to reduce nitrogen and methane emissions in agriculture (“Nitrogen 2000” support programme) – Support programmes in the areas of nature conservation and landscape management (including the Bavarian contract-based nature conservation programme, hindrance compensation *(Erschwernisausgleich)* for wetland areas), with the following aims: by means of extensive agricultural use, to protect and develop ecologically valuable habitats and support bases for wild floral and faunal species, and to preserve cultural landscapes and characteristic landscape areas – KULAP

Waste management	– Of 51 approved landfills for municipal waste,
	  – 48 have active gas-collection systems,
	  – 35 have facilities for using landfill gas (additional facilities are under construction)
	– Currently, 77% of municipal waste, which contains considerable amounts of substances of recent organic origin, undergoes thermal treatment in installations that produce electric power (and, in most cases, heat as well - for district heating, and for industrial and process steam) (currently, there are 19 such installations – soon, 20); this energy production reduces use of fossil fuels and reduces net CO_2 emissions
	– 5 installations for organic-waste fermentation, producing a total of 17,200 t/a (1995); the resulting energy is substituted for primary energy. Further expansion is planned.
	– Composting of 1.2 million t of cuttings and organic waste (1995); storage of CO_2 as an organic substance.

Tab. 5.4.2.5: Berlin

Sector	Measures
Energy	– Resolution on energy-saving for 1996: 6% of estimated energy costs are blocked and may be used only for additional energy-saving measures – Expansion of environmentally compatible line-bound types of energy, modernisation of gas networks in the eastern districts, conversion of gas networks from town gas to natural gas, modernisation of district-heating networks, expansion of combined heat and power generation – Development of a Berlin energy-saving system (BENSY), "BIZET" Impetus programme (Berlin impetus programme for transfer of energy savings), additional energy services involving the Berlin Energy Agency – By 1999: introduction of use-dependent billing for district heat – Pilot project for application of operator-oriented approaches to energy conversions in heating systems of public facilities, 1993; the "Energy-saving partnership" model project – Establishment of a budget item for "energy-saving marketing" in the 1995/96 double budget – Support of solar heating installations and other facilities for using renewable energies (1995: 5.5 million DM and 1996: 6.5 million DM), broad-based programme for retrofitting existing buildings with solar heating installations, primarily with installations for heating water for industrial use – Establishment of an advising and co-ordination office for solar energy – Special BEWAG programme for equipping Berlin schools with photovoltaic systems – Leasing of suitable roofs of public buildings and associated facilities, and of open areas belonging to the state, to operators of photovoltaic systems – Foundation of an international solar centre – Ordinance on solar systems (statutory requirement that part of the water in industrial heating systems be heated by solar power), September 1995 – Berlin's first project within the framework of the "solar heating 2000" federal programme is in place (home for senior citizens in Lichtenberg) – Award of the "Berlin Solar prize" – The "Solar School" campaign: financial support for projects that save energy and use renewable energies (Eurosolar regional group) – Support for in-company energy concepts (small and medium-sized companies) and for energy advising – Information campaigns with the chamber of commerce, and with the crafts chamber – Low-cost-loan programme for thermal insulation of production sites
Transport	– New housing developments that generate less traffic, the "Living without a car" concept (five areas for new construction remain to be selected), "The Environmental Lane" model experiment – Expansion of the bicycle-lane network – Introduction of parking-space management, support for leasing parking spaces for car-sharing – Establishment of a co-operative, integrated traffic-management system – Review of the possibility of procuring energy-saving vehicles for the public sector – Information campaign focusing on the environmental impacts of traffic
Construction, housing, settlement structures	– A focus on energy-saving in directives for programmes in support of modernisation and repair – Special support for use of solar energy, advising of tenants with regard to energy-oriented modernisation, energy advice as part of transitions to individual billing for heating – Municipal, ecologically oriented model project: 5.5 million DM in the 95/96 fiscal year – Preparation of a guide for energy concepts for optimal use of piped energy: district heating and natural gas for heating (for new construction) and modernisation – Revision, with respect to the energy sector, of regulations for subsidies of residential construction – The "Low-energy-house Standard" *(Niedrigenergiehausstandard)* in publicly subsidised housing construction – On-site checks and suitable sanctions for enforcement of the Heat Insulation Ordinance

Sector	Measures
Research & training, education in schools (higher education institutes)	– Provision of information on energy-saving and on climate protection, carried out in co-operation with schools/universities/adult evening schools, the subject of "energy" adopted in school curricula and in training/continuing training – Support for basic research, applied research and manufacturing technologies relative to solar energy and other renewable energy sources; testing of components for using solar energy and other renewable energy sources
Agriculture, silviculture, nature conservation and landscape management	– Market-adapted and site-adapted agriculture
Waste management	None

Tab. 5.4.2.6: Brandenburg

Sector	Measures

Energy	**Aim:**
	
	Decrease CO_2 emissions by 42% between 1990 and 2010.
	
	– "Report on the development of the energy supply in the state of Brandenburg" (qualification and quantification of energy savings and emissions reductions) and studies on potential for use of wind power and hydropower and for combined heat and power generation
	– Energy concept of 31 May 1996 for the state of Brandenburg
	– State planning law enshrining conservation of resources, energy-saving, use of renewable energies, sustainable waste management and use of combined heat and power generation as basic principles and aims of regional planning and state planning
	– Facilitation of construction of wind power systems – in part, through official decisions on treatment of such systems in regional planning, nature-conservation law and building law
	– Initiation of legislation that would provide appropriate compensation for electric power from combined heat and power generation systems of up to 5 MW_{el} when fed into the public grid
	– Establishment of the aim of having renewable energies supply 5% of the state's energy needs by 2010 (energy concept; currently, they supply 1%)
	– Preparation of a state law on energy-saving
	– Regular informational events on energy-saving and on use of renewable energies, for different target groups; for example, for industry and trade (in co-operation with the chamber of commerce)
	– Preparation of relevant guides, including guides on the preparation of energy concepts for local authorities and public buildings, for housing associations and industry and trade; and guides on construction of wind power systems
	– Preparation of a catalogue of energy indexes for industry and trade as a standard for assessing existing installations and for use in planning
	– Creation of a Brandenburg Energy Prize
	– Extensive support programmes for saving energy and for using renewable energies, for example,
	  – Preparation and implementation of local and regional concepts for relieving environmental stress and for using energy
	  – In-company energy concepts and energy-saving investments
	  – Combined heat and power generation using fossil fuels and renewable raw materials (over 40 small-scale combined heat and power generation systems)
	  – Modernisation and expansion of district heating systems (expired)
	  – Enhancement of energy efficiency of buildings (including modernisation of over 40,000 heating systems and conversions to fuels with lower emissions); energy efficient ("low-energy") houses
	  – Solar systems (over 100 photovoltaic systems, 1,500 solar heating systems)
	  – Wind power systems (over 160 systems in operation) and hydropower systems

Sector	Measures
	– Biomass use (especially wood and biogas) – Heat pumps (over 800 systems) – Rheinsberg, a model city for energy use (modernisation and expansion of the district heating network – now reaching 85% of all consumers - extensive building modernisations, construction of a small-scale combined heat and power generation system and of boiler systems for wood chips) – Geothermal projects – Energy officers for local authorities – Establishment of the state's own Brandenburg energy-saving agency in 1991: the agency provides advising, co-ordination and support to local authorities, housing associations and industry and trade, and initiates and supports projects oriented to energy-saving and use of renewable energies – Establishment of the Brandenburg Technology and Innovation Agency in 1991, with significant state participation; the agency supports industry and trade in implementing innovative product and production processes, and support includes consideration of efficient energy use and renewable energies
Transport	– Socially compatible fares, design of an efficient timetable as part of the pending regionalisation of local rail transportation and the establishment of traffic associations/co-operatives – State planning law that defines the priority of railway traffic and ship traffic with respect to road traffic, and that creates traffic-limiting structures as basic principles and aims for regional planning and state planning – Integrated traffic concept (based on traffic-policy guidelines), including consideration of – Priority for the creation of requirements-oriented, cost-effective alternatives to road traffic – Giving public transportation a greater share of local and regional travel – Shifting freight traffic to trains and ships, in part through use of freight centres and concepts for regional rail transports of goods, giving special consideration to problems of cross-border traffic – Systematic expansion of an efficient local public transportation system, on the basis of the – "Target Network 2000" *("Zielnetz 2000")* programme for expansion of regional railway systems – Law on local public transportation – Influence on traffic-generating sitings of companies and traffic-generating settlement structures – Priority for investments in the local public transportation infrastructure and railway network and for complementary infrastructure measures such as construction of freight centres with connections to rail and ship traffic – Use of possibilities for influencing traffic patterns – State studies on – The environmental impacts of traffic in Brandenburg – Regional railway goods transports between Barnim and Uckermark – The auto-free spa (also a model experiment in the Belzig spa) – Model projects – Model cities with environmentally compatible traffic (in Neuruppin, Oranienburg, Senftenberg) – Tax models for reducing traffic in Lübben – Lübbenau (supported by the EU within the framework of the "LIFE" programme) – Support for – Projects to enhance the attractiveness of train travel – Construction of bicycle paths
Construction, housing, settlement structures	– Orientation of developments to the aim of energy-saving and traffic-reducing structures (including use of planning law, support mechanisms) – Efforts to ensure that consideration is given, in development plans, to aims of and needs for conservation of resources, energy-saving and use of combined heat and power generation and of renewable energies – Guides for the preparation of energy concepts for local authorities and public buildings, for housing associations (now available) and for energy-efficiency improvements and modernisation of one and two-family homes (in preparation)

Sector	Measures

	– Technical courses for architects and craftsmen, in co-operation with the relevant chambers and guilds
	– Advising offered by the consumer advice centre (for private owners, 13 locations), by the Brandenburg energy-saving agency (for housing associations, local authorities) and by the power companies
	– Energy-oriented specifications in subsidies for housing construction
	– Support programme and sample projects with aims that include energy-efficiency renovation of old buildings
	– Support for
	  – Ecologically exemplary buildings with energy-efficient designs
	  – Use of solar systems, heat pumps and renewable energies
	  – Conversion/replacement of heating systems, for renovation and expansion of district heating systems and for connection to district heating (expired)

Research & training, education in schools (higher education institutes)	– Development of future-oriented, innovative energy technologies on the basis of the state of Brandenburg's technology concept, and in co-operation with science and industry
	– Establishment of the Energy Resources Institute, at the Brandenburg Technical University (BTU) in Cottbus, in 1995. The Institute has the following focuses:
	  – Future-oriented energy technologies (especially clean combustion and gasification of solid fossil fuels and biomass, hot-gas purifying, efficiency improvement)
	  – Efficient energy use
	  – Energy management
	  – Socio-economic aspects of technological innovation
	– Establishment of the Potsdam Institute for Research into the Consequences of Climate Change (PIK) in 1992; the PIK is a nationally and internationally active scientific institution for research into climatic effects and earth-system analysis
	– Development of university resources with focuses on the areas of energy, eco-technology and biotechnology; for example:
	  – Energy technology and economics, environmental sciences and process technology, management of raw materials and resources, environmental and energy law (BTU Cottbus)
	  – Environmental sciences/eco-technology/biotechnology (University of Potsdam)
	  – Biotechnology and genetic engineering (Technical Fachhochschule (TFHS) Wildau)
	  – Wood use/wood gasification (Fachhochschule Eberswalde)
	– A focus on research and development of solar technology in Frankfurt/Oder (Society for the promotion of solar energy use *(Gesellschaft zur Förderung der Solarenergienutzung), Institute for Solar Technologies)*
	– Numerous developments and studies, including
	  – Development of innovative photovoltaic modules
	  – Cultivation of renewable raw materials and use of such materials for energy production
	  – Improvement of energy efficiency and energy technologies in various areas
	  – Pilot study of the PIK: "Possible consequences of climate changes on the State of Brandenburg"

Agriculture, silviculture, nature conservation and landscape management	– Development of a network of nature parks, large conservation areas and biosphere reserves; measures in biotope and landscape management, forest management and forest conservation
	– Organic farming (without any use of chemical pesticides and nitrogen fertilisers) on 32,400 hectares
	– The "environmentally oriented agriculture" support programme
	– Optimisation of fertiliser use
	– Emphasis on biomass in expanding use of renewable energies, including the following efforts
	  – Renewable raw materials support programme, 1991 to 1995
	  – Support for use of biomass as a source of energy, with an emphasis on wood and biogas
	  – A concept entitled "Possibilities and opportunities for developing and using renewable raw materials during the period from 1996 to 2000" – especially the section on "using renewable raw materials for energy production"
	  – Establishment of a "Bioenergy Brandenburg" working group in 1992; completion of a study on the potential for using biomass available in agriculture and silviculture for energy production
	  – A brochure entitled "Energy from Biomass" and intended for practical application

Sector	Measures
	– A state "biodiesel" filling station programme, and gradual phase-in by state silvicultural authorities of biodiesel and bio-hydraulic fluids; preparation for construction of the Wittenberge biodiesel facility, which will have a production capacity of 60,000 t – Construction of over 420 wood-firing plants, some of them large-scale installations, and 8 biogas plants; the latter currently supply 25% of the electric power generated in German biogas installations; one of them is the largest biogas plant in Germany – Planning and preparation (for construction) of a major wood-gasification power station in Elsterwerd – Implementation of 3 research projects in the area of renewable raw materials; in particular, projects on decentralised energy production from renewable raw materials, within the framework of closed-substance-cycle waste management – Market-adapted and site-adapted agriculture
Waste management	– Use of semi-liquid manure and other organic residual materials in the state's large biogas plants – 4 small-scale combined heat and power generation systems that use sewage gas – 2 small-scale combined heat and power generation systems that use landfill gas (planned) – Use of residual materials for energy production in 2 hazardous-waste incineration plants, 3 combined heating and power stations and one cement plant – Use of landfill gas in a hazardous-waste incineration plant

Tab. 5.4.2.7: Bremen

Sector	Measures
	Aim: To decrease energy-related CO_2 emissions by 30% by the year 2005, in comparison with the 1987 emissions level
Energy	– Support for initial marketing of condensing-boiler systems: 1.2 million DM in 1993/94 – Investment subsidy for the Bremerhaven – Leherheide waste-heat project: 3 million DM – The "Replacement of electric heating systems" support guideline of 27 April 1995; support is provided for replacement of electrical room-heating systems with central building-heating systems with integrated water-heating systems – Support for efficient energy production and combined heat and power generation – Development of a district heating network – New construction of a hydropower station – Implementation of the Federal-*Länder* "250-MW wind" programme (with the aim of developing the capacity to generate 3% of Bremen's power needs) – Smaller programmes that subsidise solar systems
Transport	none
Construction, housing, settlement structures	– Subsidies for thermal insulation in existing residential buildings and in new "low-energy houses"; 2 million DM in 1993/94 – 1984 programme of investments for reducing energy costs in buildings (26 million DM worth of reductions in energy costs)
Research & training, education in schools (higher education institutes)	– Economic policy action programmes (WAP) for development projects in the area of energy technology (small-scale combined heat and power stations, wind power systems) carried out by Bremen companies; 1 million DM since 1988
Agriculture, silviculture, nature conservation and landscape management	none
Waste management	none

Tab. 5.4.2.8: Hamburg

Sector	Measures

Energy	– Preparation of a Hamburg law on climate protection through saving energy (Hamburg climate protection law)
	– Provision of electric power generated from a renewable energy source – hydropower – via a cable connection to Norway (as of 2003) (import of electricity)
	– Extensive linearisation of tariffs for electricity and gas
	– Support for energy-saving and use of renewable energies; a total of some 100 million DM provided from 1995 to 1999
	– Expansion of the district heating network: from currently 330,000 residential units to 450,000 units; in addition:
	  – Integrated supply concept, in co-operation with power companies
	  – Programme of subsidies for connections to the district heating network
	– Expansion of decentralised combined heat and power generation:
	  – Programme of support for small-scale combined heat and power stations and for industrial and commercial combined heat and power generation
	  – Compensation paid for electricity fed into the grid from small-scale combined heat and power generation systems: in the amount of 75% of the average price for electricity supplied to all end consumers
	  – Programme of support for very small-scale combined heat and power generation systems with a thermal output of 11 kW and an electrical output of 5 kW
	  – Model project involving a fuel-cell-based small-scale combined heat and power generation system
	– Energy advice for small and medium-sized companies (1990 to 1992)
	– Expansion of use of renewable energies:
	  – Expansion of use of wind power in Hamburg (13.4 MW installed to date), planning for generation sites that will bring total capacity to about 25 MW
	  – Programme of support for photovoltaic systems (since 1990, a total of some 160 systems); now supplanted by cost-oriented compensation from Hamburgische Elektrizitäts-Werke AG (HEW) (up to 2.20 DM per generated kWh)
	  – Programme of support for solar heating systems (500 systems to date)
	  – The “Nord” (“north”) solar initiative (information for the public, marketing, qualification and other supporting measures)
	  – Report on the use of hydropower capacities in the city area
	– A co-operation contract between the city and HEW: from 1997 to the year 2014, HEW will provide, each year, about 1% of its electricity revenue for support of energy-saving measures and of renewable energies. Some 24 million DM will be provided each year for:
	  – Energy advice (7.8 million DM),
	  – Information for the public (4.0 million DM)
	  – Renewable energies (4.4 million DM)
	  – Efficient technologies (3.8 million DM)
	  – Promising new technologies and products that are still in the experimental phase (4.0 million DM).
	For example, with these funds, HEW will pay
	  – a bonus of 10 pfennigs per kWh for renewably generated electricity, in addition to the compensation paid under the Act on the Sale of Electricity to the Grid
	  – From 1.5 to 2.20 DM per kWh for photovoltaically generated electricity, or a subsidy of 7,000 DM per kWh as an option with reduced compensation for electricity fed into the grid
	  – Increased compensation of 12.8 pfennigs per kWh for electricity fed into the grid from small-scale combined heat and power stations with up to 1.5 MW electrical output, beginning on 1 January 1997
	– The Hamburg Chamber of Crafts’ Centre for Energy, Water and Environmental Technology (ZEWU, Hamburg)
	– Energy advice provided by Hamburgische Elektrizitätswerke (power company), Hamburger Gaswerke (gas company) and consumer advice centres
	– Following the elimination of the “Kohlepfennig” electricity surcharge: Collection of donations, by the Hamburg Climate Protection Fund, and with the support of HEW and the city, in order to equip schools with photovoltaic systems

Transport	– Shifting of passenger traffic to modes of transportation within the “environmental network” – Shifting of goods transports from roads to railways and waterways – Joint state planning, carried out with the states of Lower Saxony and Schleswig-Holstein, with aims that include preservation of regional structures that tend to reduce traffic

Sector	Measures
	– Planning for two freight centres – Extensive designation of 30 kph zones in residential areas (which reduce fuel consumption when respected by drivers) – Amendment of parking-space requirements in the Hamburg Building Code (bicycle parking, use for local public transportation of money saved in changing types of parking) – Measures for management of publicly accessible parking spaces – Expansion of the railway infrastructure – The "bus-acceleration" programme – Improvement of the quality of service in local public transportation (25-point programme) – Season tickets for large customers, "semester" ticket, "job" ticket – Public information on the topic of "environmentally compatible mobility" – Preparation of a concept for bicycle traffic – The "Car-free living" model development – Car-sharing – Programme for support of solar cars used within a network – Expansion of "park and ride" facilities
Construction, housing, settlement structures	– Reduction of consumption of heating energy, electricity and water in public buildings (savings of 130 million DM between 1979 and 1994); 45 million DM earmarked for additional measures between 1995 and 1999 – Energy management in public buildings (monitoring of energy consumption, special training for custodians) – Agreement between the city and the Hamburgische Elektrizitätswerke AG (HEW; power company): HEW will prefinance investments aimed at reducing electricity use; the city will reimburse HEW through savings on its electricity bills (investments amounting to 40 million DM) – Employees of the Free and Hanseatic City of Hamburg receive energy-saving tips along with their salary statements – Subsidies for housing modernisation costing a total of 80 million DM annually. The subsidies are tied to energy requirements. The exact percentage of the investments that are aimed at energy-saving cannot be calculated, however. – The Bramfeld solar development, comprising 124 solar-heated row houses – Programme of support for heating-system modernisations: for boilers meeting the "Hamburg norm"; 16 million DM from 1988 to 1994, 7.5 million DM from 1995 to 1999 – More stringent requirements, since 1992, for thermal insulation of buildings (Hamburg Heat Insulation Ordinance), rescinded following the amendment of the Federal Heat Insulation Ordinance in 1995 – Introduction of a Hamburg thermal certification *(Wärmepaß)*; certification is on a voluntary basis – Programme of support for "low-energy" (energy efficient) house construction (2 million DM from 1991 to 1996, 148 residential units) – Programme of support for thermal insulation in one-family and two-family homes – Energy-oriented recommendations for planning of housing developments and building (EESG 95); used in development-plan procedures and in urban-planning competitions – Inclusion of district-heating and small-scale combined heat and power generation systems in development plans – Solar systems have been exempted from building-permit requirements
Research & training, education in schools (higher education institutes)	– Hamburg-based climate research at the Max Planck Institute for Meteorology, at the German Climate Computing Centre and at the University of Hamburg's Centre for Oceanic and Climate Research – Planned: Establishment of a Centre for Atmospheric and Marine Sciences – Planning for a special research area, "Climate-relevant processes in the system consisting of the ocean, the atmosphere and the cryosphere", will soon be completed – A special research area, "The Climate system in north-Atlantic low-pressure zones", is being prepared – Research projects focusing on the effects of climate change – Research projects within the framework of the international programme "Human Dimensions of Global Environmental Change" – Research projects focusing on efficient energy use and use of renewable energies (for example, use of biogas) – The "Fifty-Fifty" project at over 40 Hamburg schools: 50% of saved energy costs are made available to the schools to use as they see fit (savings in 1995/96 alone: 725,000 DM); the project is to be expanded to 80 schools

Sector	Measures
Agriculture, silviculture, nature conservation and landscape management	
Waste management	

Tab. 5.4.2.9: Hesse

Sector	Measures
Energy	– An average of 10 million DM available annually for measures to save energy – Appointment of energy officers for state properties, employment of energy experts in every one of Hesse's state building authorities – In 1993: sample studies of public buildings aimed at producing detailed consumption measurements and identifying possibilities for saving electricity; preparation of the guide "Energy in construction – energy-aware building planning"; a programme of support for technical measures aimed at making electricity use in municipal buildings more efficient – Energy advice for small and medium-sized companies, pursuant to Article 8 of the Hesse Energy Act (HEnG) – A special programme of energy certifications *(Energiepaß)*, in place in Frankfurt, is to be extended throughout the state – 1991–1993: A total of 1.456 million DM invested to support 38 energy concepts – The Brundtlandstadt/Hesse Energy-saving city model project (the state's integrated energy and climate protection concept is to be put to a practical test in the city of Viernheim) – The Landes-Energie-Agentur-Hessen-Energie-GmbH (approx: Hesse State Energy Agency), a consulting and agency company, established on 2 October 1991 for the purpose of supporting the state's energy policy (funding in 1993: 2.5 million DM; 4,838,500 DM also provided by the state's environmental ministry to help finance relevant loans) – Interest subsidies for construction of small-scale combined heat and power generation systems in Fulda for production of heat, refrigeration and electricity (cash value about 1.9 million DM), subsidy of 840,000 DM for new construction in Wetter of a small-scale combined heat and power generation system with heat-supply network; the model project "standard small-scale combined heat and power generation system" – Subsidy of 3.2 million DM for construction, in Arheiligen, of a natural-gas-fired gas-turbine plant with waste-heat boiler – A low-cost loan of some 11.7 million DM provided for expansion of Kassel's district heating system – 1991-1993: subsidies totalling 57.3 million DM for 80 projects including installations with combined heat and power generation; installation and expansion of small and large-scale district heating networks – "Solar-thermal support programme" – began in 1992

Sector	Measures
	– 4.4 million DM worth of support in 1993 for 1,420 solar systems in residential buildings – State subsidies for 16 small hydropower systems – Construction of 19 wind power systems with a total output of 2,530 kW; the environmental ministry has issued 1193 statements of support *(Förderbescheide)* for 26 installations with a total output of 6,225 kW (as of January 1994; by the end of 1994 64 installations with a total output of 18,000 kW are expected to be in operation); from 1991–1993, some 7.8 million DM worth of support for wind power was approved – From 1991–1993, the state programme for support of photovoltaic systems provided 6.6 million DM in subsidies for 291 projects – In 1993, some 2 million DM in subsidies was provided for three projects for construction of biogas systems in conjunction with small-scale combined heat and power generation systems – 1.15 million DM worth of subsidies for a phosphoric-acid fuel-cell heating station of the HEAG company
Transport	none
Construction, housing, settlement structures	– Structurally oriented directives aimed at reducing energy use in state buildings (1992) – Continuation of a systematic programme of connecting state buildings to the district heating network (only energy-efficient, environmentally optimised heating systems); construction of municipal buildings with energy-efficient designs has been subsidised since 1992 – Energy efficiency standards as a prerequisite for subsidies for construction of social (low-cost) housing – Directive on reducing energy use in buildings for which state subsidies are provided (1993) – Financial support for new development consisting of energy efficient houses in Fulda-Johannesberg (additional project: Rothenburg/Fulda); support for the construction of the Darmstadt-Kranichstein passive house – The “Energy Efficient Construction” information service of Hessen Energie GmbH – State programme of subsidies to support energy efficiency and modernisation in residential buildings – From 1991–1993, a total of 2.5 million DM in subsidies were paid to modernise the thermal efficiency of four schools to “low-energy” standards *(Niedrigenergiestandard)* – Establishment of a new category for subsidies: “Thermal efficiency modernisation in municipal buildings” – Training events for architects, engineers, housing associations, building contractors (“Ecologically oriented construction”)
Research & training, education in schools (higher education institutes)	– Planning of a multi-year (vocational) qualification programme for the areas “Energy efficient construction” and “Efficient design of electrical systems” – In 1992, support for a research project at the wind power park test field: mechanical stresses on variable-speed wind power systems under conditions prevailing in Germany’s central mountains
Agriculture, silviculture, nature conservation and landscape management	– HEKUL, HELP
Waste management	– Total subsidies of 0.8 million DM for six sewage gas projects, from 1991–1993; a 1.378 million DM subsidy for a project for use of landfill methane; and 2 million DM worth of support for three projects for construction of biogas systems, in conjunction with small-scale combined heat and power stations, in 1993

Tab. 5.4.2.10: Mecklenburg-West Pomerania

Sector	Measures
Energy	no information at present
Transport	no information at present
Construction, housing, settlement structures	no information at present
Research & training, education in schools (higher education institutes)	no information at present
Agriculture, silviculture, nature conservation and landscape management	no information at present[1)]
Waste management	no information at present

[1)]According to information available to the Federal Government, Mecklenburg-West Pomerania is carrying out measures involving grassland management in accordance with nature conservation principles

Tab. 5.4.2.11: Lower Saxony

Sector	Measures
Energy	– 1300 MW of installed wind-power capacity as a target for the year 2005 – Report on selection of suitable areas, as a basis for obtaining sites for wind power parks, 1992 and 1995 – As part of state area planning, selection of priority sites for wind power systems with a total wind power output of 2060 MW – Guideline on the application of Lower Saxony's nature conservation law's intervention regulations to construction of wind power systems – Programme for non-nuclear electric power in Lower Saxony, 1994 (pursuant to information provided by Lower Saxony) – Report on the "Ecological and economic consequences of opting not to use nuclear energy in electricity generation, and energy-policy alternatives in Lower Saxony", November 1992 – Report on "Possibilities for CO_2 reduction through energy-saving, fuel substitution and intensified use of renewable energies, illustrated with the example of the Greater Hannover Area", February 1992 – Support provided, from 1991 to 1995, from the state's economic development fund – the "Ecological area (eco-fund), energy directive" – for energy efficiency and renewable energies: 497 wind power systems (both single systems and wind parks): 65.0 million DM of support 2,737 solar heating systems (collectors for heating service water): 9.8 million DM of support 22 hydropower systems: about 2.3 million DM of support 218 photovoltaic systems: about 8 million DM of support 217 small-scale combined heat and power stations (including biogas): about 0.6 million DM of support 2,700 condensing-boiler systems: about 0.6 million DM of support 40 "low-energy" houses: about 2.5 million DM of support

Sector	Measures
	9 projects to enhance energy efficiency (gas/steam and others): about 14 million DM of support
Transport	– Support from 1990–1995: – 260.3 million DM for construction of bicycle paths along state roads (provided by the Federal Government, the state, local authorities) – 183 million DM for buses for local public networks; 200 million DM for tramcars for local public tramway networks – 335 million DM in subsidies for municipal railway construction in Braunschweig and Hannover – 63 million DM for non-federal railways (in particular, for modernisation of the superstructure) and for German Federal Railways (DB) – 970,000 DM for expert consultation as part of the development of a "co-operative" traffic management system in the Hannover area – Motorised traffic in Lower Saxony in 1990 and 2010 – traffic volume, total mileage, energy consumption and pollutant emissions – Study on reducing CO_2 generated by traffic in the greater Hannover area – Commissioning of the preparation of an action concept for reducing traffic-related environmental stresses in Lower Saxony, especially for achieving CO_2-reduction targets – "Job" tickets for some 40,000 state employees in the greater Hannover area, available since early 1993 – Application submitted to the EU by the Aurich rural district for the project "Traffic reduction in tourism on the North Sea coast"
Construction, housing, settlement structures	– Ecologically oriented recommendations (as well as energy-related requirements) and terms for support included in the technical provisions for Lower Saxony's construction of social (low-cost) housing, January 1995 – "Environmental guidelines for public procurement" (set standards for energy efficiency of state-owned buildings), May 1992 – Energy saving and efficient energy use in state buildings, December 1994; target: achievement of higher standards of thermal insulation than those established by the 1995 Heat Insulation Ordinance
Research & training, education in schools (higher education institutes)	– About 32 million DM of support provided for 39 projects from the "New environmental technologies" eco-fund directive, aimed at development and testing of innovative products and production processes – About 45 million DM of support provided for 44 projects from the "Business and the environment" *("Wirtschaft und Umwelt")* eco-fund directive, aimed at reducing pollutant emissions
Agriculture, silviculture, nature conservation and landscape management	– Over 3 million DM of support provided from 1991 to 1994 for cultivation and use of renewable raw materials – Concept for additional support for renewable raw materials (April 1993) – "Base" programme: a programme oriented to actual problems
Waste management	– Of the state's 46 approved landfills for municipal waste, 35 have gas-collection systems and 23 have systems for using landfill gas – Use of double-refined products (recycled motor oils) in state motor vehicles (automobiles), March 1995

[2] The Federal Government does not consider this to be a measure for reducing greenhouse gas emissions.

Tab. 5.4.2.12: North Rhine-Westphalia

Sector	Measures
Energy	– 1987 programme: "Efficient energy use and use of inexhaustible energy sources" (subsidies of 92 million DM until the end of the first half of 1991) – Subsidies for the preparation of some 180 municipal energy concepts – Establishment of the North Rhine-Westphalian energy agency and the "North Rhine-Westphalia solar working group" *("Arbeitsgemeinschaft Solar NRW")* – Rates structures – including those for gas prices – are to be made as linear as possible
Transport	– Support for municipal concepts for control of traffic development and for parking-space management, for expansion and improvement of local public transportation, for traffic abatement and for construction of bicycle paths (for example: infrastructure assistance for the Rhein-Ruhr transport association *(Verkehrsverband)*; the "ticket instead of a parking space" concept, with season tickets for major customers in connection with parking-space management; "semester" tickets; shorter intervals in timetables; greater convenience and better service and security in local public transportation) – Support provided for extensive traffic abatement in cities and local authorities (since the early 1980s) – Support for local authorities in designating 30-kph speed zones – Making development of traffic-reducing residential and commercial zoning structures an emphasis of state policy
Construction, housing, settlement structures	– Subsidies for energy efficient houses and environmentally compatible new social (low-cost) housing projects within the framework of North Rhine-Westphalia's housing-construction programme – Early 1980s-1990: about 500 million DM for modernisation of existing heating systems and for improvement of thermal insulation in state buildings – Simplified licensing procedures for installation of hot-water systems, water-heating systems, solar collectors and other types of solar systems, heat pumps and combustion systems with up to 1 MW rated thermal output – Training courses on "Ecologically oriented construction" – Stop to use of fully halogenated CFC and polystyrene-foam foil in food packaging and of throwaway utensils in state-owned institutions – Directive on reduction of CFC and halons in refrigeration and air-conditioning systems, on halon reduction in fire-extinguishing systems and on obligations to use CFC-free building materials on state properties
Research & training, education in schools (higher education institutes)	– Mid-1991: Establishment of the Wuppertal Institute for Climate, Environment and Energy *(Wuppertaler Institut für Klima, Umwelt, Energie GmbH)* – Establishment of academic chairs: Climate-adapted architecture and structural engineering, ecologically compatible energy industry – A study on the "Coal-fired power station of the future" (1990) – Commissioned research: "Standards for energy indexes in the framework of future subsidy guidelines for construction of social (low-cost) housing (in order to support the establishment of an energy "passport" certification)"
Agriculture, silviculture, nature conservation and landscape management	– The state government is pursuing an agricultural policy, throughout the state, of agricultural extensification involving programmes for nature conservation, protection of water resources and expansion of ecologically oriented farming; priority for extensification over land set-asides – Since 1984, some 250 million DM has been spent on forest management and expansion of forested areas – The "Forest 2000" concept (use of ecologically appropriate forest species, preservation of genetic diversity, creation of stable, layered mixed stands)
Waste management	– Use of landfill gas in 18 installations (about 30 %); additional gas-use systems are under construction and are being planned

Tab. 5.4.2.13: Rhineland-Palatinate

Sector	Measures
Energy	– Programme to support use of renewable fuels – Expansion and improvement of advising in the area of thrifty and efficient energy use – “Renewable Energy” Palatinate Working Group (including the ministries for the environment and economics, and Palatinate power companies)
Transport	Aim: 10% CO_2 reduction in city traffic – In the 1994/95 dual budget: about 750 million DM for local public railway and bus transportation – Creation of links between modes of transportation: for example, subsidies for park and ride facilities, covering up to 85% of the construction costs; the “Traffic management 1992/93” pilot project, with specific project proposals for certain cities – A considerable increase in funding for bicycle paths away from certain, classified roads – Preparation of regional goods-transport concepts by the state government and German Railways (DB) (spring 1993) – Concepts for construction of freight centres as freight-handling nodes – Modern traffic-control systems; support for improvement of existing traffic-radio systems – Preparation of a “Report on decreasing traffic emissions” (in the Coblence-Neuwied area) – Administrative provision on the procurement and use of state vehicles (with binding standards for maximum fuel consumption)
Construction, housing, settlement structures	– Amendment of the state building code (inclusion of a general clause on protection of the natural basis for life, etc.) – Planning assistance: “Energy efficient construction” and “environmental protection in the construction sector” – Inclusion of environmental protection criteria in state support for construction of rental and privately owned housing – Model projects for promotion of environmentally compatible, energy efficient types of construction – An administrative provision of 22 March 93 entitled “Landscape planning in overall development planning”
Research & training, education in schools (higher education institutes)	– Since 1989, there has been a State centre for environmental awareness (exhibitions, poster campaigns, competitions, quarterly *“Umweltjournal”* (“Environment Journal”) – Scientific projects in the area of climate protection at several of the state's universities and Fachhochschulen – “Practical environmental education”: Events sponsored by the State institute for continuing teacher training *(Staatliches Institut für Lehrerfort- und weiterbildung)* that focus on problems related to energy and the environment and on environmental education – Promotion of co-operation between science and industry and between science and local authorities (for example: transfer agency for regenerative energy systems, new materials and new procedures at the Bingen campus of the Rhineland-Palatinate Fachhochschule) – A programme for introducing innovations and technology (in 1993, the programme provided total funding of 7.9 million DM for 30 projects in significant areas of environmental protection)
Agriculture, silviculture, nature conservation and landscape management	– The “nitrogen-dynamics programme” in the area of agriculture and horticulture – “Cultivation-supporting N_{min} Standards System” for cultivation of vegetables and fruit (efficient nitrogen fertilisation) – “Working groups for integrated agriculture” – “Environmentally compatible farming” support programme – The “Dunginfo” (“fertilisation info”) computer programme – Subsidy programme for 20-year ecologically oriented land set-asides – Support for research projects in the area of renewable raw materials – Budget funds for purchase of land for land-care measures – The “More green through land consolidation” campaign (since 1987) – Payments for special services provided by the agricultural sector
Waste management	none

Tab. 5.4.2.14: Saarland

Sector	Measures
Energy	– Saarland will have a climate protection concept by early 1997 – Small-scale CHP concept employing landfill gas, for development of a district heating network – Reorganisation of the Saarland's power-generation sector – Pilot project of Saarbergwerke AG: "FRAC treatment" for production of methane gas – Future-energy programme for the Saarland (DM 10 million annually) a) Programme for placement of renewable energies on the market (MEP) b) Support provided for demonstration projects (large-scale systems) c) Subsidies for efficient energy use d) Subsidies for expansions of the district heating network: DM 105 million since 1985 (including federal share) – The Saarland solar "pact" to promote PV systems (increased compensation for solar-generated electricity fed into the grid) – Linear electricity rates in the tariff-customer sector – Approval under tariff law of ICP measures in the tariff-customer sector – Establishment of the Saarländische Energie-Agentur GmbH, the first German energy agency – Establishment of the "Solar" e.V. solar working group (processing of applications for support, advising, evaluation)
Transport	– Climate protection study, transport section, preparation phase – Study on perspectives for restructuring the energy system in light of the CO_2 problem: Renewable fuels in automobile traffic (1992) – Emissions cadastre for the traffic/transport sector (continuation) – "Saarland future transport concept": overarching guideline concept for all modes of transportation, draft – Development plan for local public transportation (state-wide local public transportation network, integrated timetable, network and infrastructure expansion; in this connection, execution of the most important project: the SaarBahn railway (under construction) – Establishment of a Saarland traffic association (currently being established), establishment of a state-wide integrated network of timetables and rates (being planned) – Introduction of a "semester" ticket (1994) – Administrative provisions relative to the Act on Financing of Community Transport (GVFG); funding reappropriation, with an investment emphasis on public transportation; expansion of support criteria, with priority placed on transportation within the "environmental network"; draft for continuation of the programme – State GVFG supplementary programme on local public transportation (since 1995) – Integration of the Saarland within the European high-speed railway network (TGV/ICE) through implementation of a railway link connecting Paris – Saarbrücken – Frankfurt/Main – Berlin; the aim is for high-speed railway transports to reduce numbers of short flights (currently being planned) – Subsidies for bicycle traffic: a programme providing support for municipal concepts for bicycle traffic (two thirds of all Saarland local authorities received subsidies covering 75% of planning costs); a programme to permit use of service paths in forests and fields for bicycle traffic; a Saarland concept for bicycle tours; directives for designation of bicycle paths are currently being drafted – Exemplary development of municipal traffic-development plans; exemplary cities are Ottweiler and Merzig (ways to achieve environmentally relevant and climate-relevant improvements, with the aim of passing a draft of a directive) – Support of a pilot project for "mobility advice"/mobility management ("Mobile in the Saarpfalz District") – Development of a cross-border logistical services centre with locations in Saarbrücken and St. Avold/France (optimisation of commercial traffic, with an emphasis on combined transports) – A "parking for car-poolers" programme – Priority given to construction of single-lane traffic roundabouts, the preferred type of node for harmonising traffic cycles in an energy-efficient manner – Expansion of the Saar River into a major waterway for shipping, in order to create an attractive alternative to goods traffic on roads – "Settlements and the environment" state development plans (continuation): development of residentially and commercially zoned areas in ways that generate little traffic; priority for structures that complement public transports

Sector	Measures
	– State building code (amendment procedure): expansion of earmarking of redemption payments to include “environmental network” traffic, introduction of requirements to provide bicycle parking
Construction, housing, settlement structures	– Priority given to district heating and gas for heating of state buildings – “Ecologisation” of the state building code (LBO) – Award of a “Green House Number” for residential buildings with especially low consumption of energy and resources – Support for small-scale district heating systems using solar energy (exemplary development)
Research & training, education in schools (higher education institutes)	– Study on the efficiency of parking for car-poolers, Saarland University for Technology and Industry (Hochschule für Technik und Wirtschaft), 1994 – An institute for future energy systems (systematic development and testing of renewable energies and energy-saving technologies) is currently being established – Wehrden Centre of competence for energy technology (demonstration and testing centre being established)
Agriculture, silviculture, nature conservation and landscape management	– Since 1988, public forest holdings have been subject to principles of near-natural silviculture – Subsidy programmes for environmentally compatible agriculture; programmes and informational events relative to plant protection in agriculture – Compensation payments for farmers who adapt their agricultural methods to soil characteristics, throughout their entire farms
Waste management	– Aim: reduce waste production by 30% – Establishment of an institute for management of industrial residual materials and waste – The Merzig-Fritten landfill has a gas-collection system in place, and test operations at the Ornesheim landfill are to begin in 1992 – The state government now requires local authorities to install composting systems for municipal green waste – Environmentally compatible disposal of appliances containing CFC

Tab. 5.4.2.15: Saxony

Sector	Measures
Energy	– Support for the preparation of municipal energy concepts (about 1 million DM by 1993) – About 82 million DM provided, through the immissions protection programme, for fuel conversions in municipal facilities and facilities of non-profit organisations in the Erzgebirge mountains (last revision: mid-1996) – From 1991 to 1993, 17 million DM in subsidies were provided in rural areas through the Joint Task "Improvement of the agricultural structure and of coastal protection", for the following: 476 fuel conversions, thermal insulation, control systems, heat recovery – Model project for obtaining heat from pit water (Ehrenfriedersdorf) – From 1991 to 1993, 160 million DM in subsidies were provided for 232 projects involving modernisations of district heating systems – Subsidies provided in 14 cases for energy advice in the commercial sector – The subsidy programme "Efficient energy use and use of renewable energy sources", and the supplementary programmes "Small hydropower systems" and "Wind power systems" provided a total of some 390 million DM in subsidies, from 1991 to 1995, for some 9851 projects – Subsidies for 150 systems (as of the end of 1994) from the "1000-roofs photovoltaics programme" – Energy efficient development *(Niedriegenergiehaussiedlung)* with solar heating systems
Transport	– Establishment of three freight centres with terminals for combined (road/rail) load-delivery traffic (Dresden, Leipzig, Glauchau) – From 1991 to 1994, 2.6 billion DM in funding was earmarked for local public transportation (emphases: modernisation and procurement of trams and buses, purchase of 1391 low-emissions vehicles) – Concept for a closed network of bicycle paths – Participation of the cities Plauen, Pirna and Aue in research projects of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety under the heading "Environmentally compatible urban traffic"; participation of the city of Gallen/Delitzsch district in the "Neighbourhood store 2000" project of the German Federal Ministry for Regional Planning, Building and Urban Development (traffic reduction)
Construction, housing, settlement structures	– Subsidies of some 2.1 billion DM, by August 1994, for about 160,000 apartments (this programme did not provide for separate listing of costs for heating-systems modernisation and measures to reduce energy consumption) – Exemplary renovation in Coswig of structures with WBS 70 slab construction, through a "climate protection programme" – The "Ecologically oriented construction" transfer agency
Research & training, education in schools (higher	– Subsidy for development of the "Eco-refrigerator" (CFC-free)
Agriculture, silviculture, nature conservation and landscape management	– Subsidies for organic farming (about 6,600 hectares of farmland by mid-1994) and for measures of biotope conservation and landscape management (about 10 million DM in 1994) – In 1993, industrial rape *(Raps)* cultivated nearly exclusively on about 6,350 hectares of set-aside land; land set-asides (by Jan. 1994, some 100,000 hectares of farmland) – Programme to provide advice about nitrogen; supplementary subsidies provided under the "Measures to relieve the burden on the environment" programme – Subsidy of a pilot facility (beginning of operations planned for the end of 1994) for producing biogas through fermentation of semi-liquid manure – The "Near-natural silviculture by means of forest conversion" and "Forest management principles for the municipal forest" programmes – Initial afforestation of about 900 hectares, 1991–1994 – Some 3 million DM in support for a total of some 200 projects involving conversion to modern wood-fired heating systems – Special subsidy programme: "Wood as a raw material" – Subsidy programme: "Environmentally compatible agriculture" Aim within the state's development plan (medium-term): expansion of the state's forested area from 27 to 30 % of the state's total area
Waste management	– Landfill-gas collection systems planned for new landfills – Requirements for preparation of waste life-cycle analyses, advice on waste – Study on transports within the waste-management association

Tab. 5.4.2.16: Saxony-Anhalt

Sector	Measures
Energy	– Support for combined heat and power generation; expansion of district heating networks, use of heat-controlled small-scale combined heat and power stations – Recovery of energy in waste (landfill gas) – Provision of municipal services packages for saving energy; establishment of energy agencies – Substitution of low-carbon fuels for high-carbon fuels, in keeping with available resources – Programme to provide support for market placement of technologies for using wind power; some support for hydropower systems
Transport	– Enshrinement of traffic-reducing structures in building and planning laws – Support for differentiated public transportation concepts, for combined traffic (road/rail) and for pedestrian and bicycle traffic – Draft of a law on local public transportation for the state of Saxony-Anhalt – Efforts to reduce distances between residences, places of work and shopping areas
Construction, housing, settlement structures	– 70 million DM for modernisation of existing buildings by means of conversion of heating systems – for systems larger than 100 kW – Issuance of state-specific provisions for execution of the Heat Insulation Ordinance and of subsidy programmes for old buildings
Research & training, education in schools (higher education institutes)	– Subsidies for research-sector studies that consider the transition from end-of-pipe technologies to integrated ones – Status-quo analyses on climate protection in Saxony-Anhalt, inventories of climate-relevant substances within the framework of an air-quality-control plan for individual areas studied
Agriculture, silviculture, nature conservation and landscape management	– Land-use conversions to create CO_2 sinks – Optimisation of fertiliser use – The “Environmentally compatible farming” subsidy programme
Waste management	none

Tab. 5.4.2.17: Schleswig-Holstein

Sector	Measures
Energy	**Aims:** By 2010, 25% of the state’s power requirements are to be met through wind power, 25% of its total final energy requirements are to come from renewable energies, 30% of its heating requirements are to be covered by combined heat and power stations and 10% of its primary energy requirements are to be met through use of biomass – Tests involving efficient and thrifty energy use on all levels of energy production and consumption – Wind power programme: by the year 2005, 1,000 MW of electricity are to come from wind power; by 2010, 1,200 MW – Expansion of combined heat and power generation: by the year 2005, 25% of the state’s heating requirements are to be met through district heating and combined heat and power generation – Use of biomass (scrap wood, straw, semi-liquid manure): by the year 2005, 7% of the state’s primary energy requirements are to be met through biomass use – The earliest possible stoppage to use of nuclear energy, which blocks innovation and investment[1)] – Efforts to prepare a concept for support of contracting in the areas of industry, trade and public administration

[1)] The Federal Government does not consider this to be a measure for reducing greenhouse gas emissions

Sector	Measures
	– Preparations for award of a contract for preparation of a catalogue of building types, as well as for development of a concept for building renovations oriented to thermal efficiency – Efforts to amend the directive for subsidised construction
Transport	– The “traffic concept” 1990 – Efforts to change the “modal split” in favour of local public transportation – Tests of shifts of transports to modes of transportation with lower emissions – The tourism concept has been updated with the “Tourism concept 1996” of April 1996 – A concept entitled “Local public rail transportation (SPNV) 2010 for the first state-wide local public transportation plan for Schleswig-Holstein” (September 1996) – Efforts to establish a mobility centre, and support provided for training of “mobility advisors”
Construction, housing, settlement structures	– Amendment of the directive on housing construction, to promote renovation oriented to energy efficiency – Subsidies for over 2,200 rented and owned flats meeting the “low-energy-house” standard
Research & training, education in schools (higher education institutes)	– Initiative in the area of continuing training entitled “Climate protection/energy-saving” – Preparation of a concept for “Community climate protection in Schleswig-Holstein” – Commissioning of the energy foundation to identify potential for reducing CO_2 emissions, to derive a list of priorities and to initiate pilot projects – Emphasis on “climate protection” in educational events offered by the Academy for Nature and the Environment of the state of Schleswig-Holstein in 1995
Agriculture, silviculture, nature conservation and landscape management	– Over 22 million DM in subsidies for ecological farming since 1989 – Promotion of extensive agricultural production; promotion methods include contract-based nature conservation – The 1989 ordinance on semi-liquid manure – Support for renewable raw materials – The Fertiliser ordinance of 26 January 1996, which has been in force since 1 July 1996 – Between 1988 and 1995, an initial afforestation programme covering about 6700 hectares of land, aimed at increasing the stability of forest ecosystems – Reduction of climate-relevant emissions through rewetting of low moors (independently from the priority for nature conservation pursuant to Article 11, para. 2, No. 13 of the state’s nature conservation act)
Waste management	– Waste management programme to reduce methane emissions through waste avoidance – Collection of methane gas at selected landfills – Measures to avoid and reuse/recycle waste, in all relevant areas – Branch-specific concepts for waste avoidance and reuse/recycling in the crafts sector – Completion of an interim report within a report on identification of potential for waste avoidance and reuse/recycling in Schleswig-Holstein’s large-scale industry (with ongoing implementation of results) by the end of 1996 – Expansion of mechanical and biological treatment of municipal waste

Tab. 5.4.2.18: Thuringia

Sector	Measures
Energy	– Conversion of heating systems to fuels with high energy density – State support for intensified use of renewable fuels, for research into new energy technologies and for refinement of existing energy technologies – Support programmes for energy production from renewable raw materials – Subsidies for combined heat and power generation; renovation and expansion of the district heating network – Promotion of use of renewable energies
Transport	– Conversion of local public transportation to environmentally compatible fuels – Subsidies for natural gas and bio-fuel filling stations
Construction, housing, settlement structures	– Subsidies for installation of thermal insulation and for conversions to environmentally compatible fuels in old buildings
Research & training, education in schools (higher education institutes)	– Study on the emissions situation for greenhouse-relevant gases and on potential for reductions in Thuringia (Last revision 1994)
Agriculture, silviculture, nature conservation and landscape management	– Support programme to promote direct use (i.e. not for energy) of renewable raw materials – Establishment of a "Renewable raw materials" technical advisory board – Subsidies for ecologically oriented agriculture – Enhancement of the stability of forest ecosystems – KULAP
Waste management	– Collection and use of landfill gas to obtain heat

5.4.3 Climate protection programmes on the local level

The local level – cities and communities – holds considerable potential for action to reduce emissions of CO_2 and other greenhouse gases.

This considerable potential results from the various functions and tasks of local authorities:

– They are the administrative level that carries out federal and *Länder* laws,

– They establish standards for their local communities,

– They function as entrepreneurs in cases where the power supply is provided by a municipal power company,

– They own municipal properties such as administrative buildings, schools, kindergartens and swimming pools,

– They provide relevant support through municipal support programmes for CO_2 reduction, especially programmes to save energy and use renewable energies.

Part of the measures approved by the Federal Government in a total of 4 resolutions on reduction of CO_2 emissions, and other greenhouse gas emissions, are implemented on the local level.

The areas in which local authorities contribute to climate protection are as diverse as local authorities' functions. Local authorities have numerous possibilities for direct action, such as saving energy in their buildings, pursuing aims of climate protection in their procurements or choosing vehicles with low fuel consumption for their fleets. In addition, local authorities can contribute substantially to climate protection in their planning and in their tasks on behalf of the public interest. Relevant areas in this context include especially the municipal power supply, local public transportation and energy efficiency in municipal waste treatment and wastewater disposal. In municipal centres for advice on the environment and energy use, for example, local citizens can be inspired to save energy, opt for environmentally compatible types of mobility and reduce waste production. By means of participatory instruments such as round tables or climate protection forums, new local players (associations, various branches of industry and commerce, young people etc.) can be persuaded to become involved in joint activities (cf. Table 5.4.3.1).

After 1990, many cities and local authorities in Germany began to develop and implement municipal climate protection concepts (often on the basis of existing energy supply concepts). To date, far more than 100 such concepts have been prepared. Cities such as Düsseldorf, Frankfurt, Freiburg, Hannover, Heidelberg, Kassel, Rheinsberg and Saarbrücken have made substantial efforts in climate protection and are now considered examples to follow – and many have international reputations. Table 5.4.3.2 contains a selection of cities with specific climate protection programmes.

The local authorities' climate protection activities are increasingly being supported by municipal leading associations. For example, in 1995 the Association of German

Tab. 5.4.3.1: Important areas for municipal action in support of climate protection

Sector	measure
Ecologically oriented urban development planning and regional planning	– Implementation of urban-development planning, construction planning and building permits oriented to climate protection and energy efficiency – Implementation of urban structures that tend to reduce generation of CO_2 (mixtures of functions, the "city of short distances" etc.) – More green and open areas in cities / opening-up (unsealing) of paved areas (carbon binding; CO_2 sinks); use of additional potential green areas (roofs, facades)
Information, advising and public information	– Establishment of a local or regional energy advice centre – Provision of climate-relevant information as part of environmental advice
Local procurement	– Environmentally compatible procurement – Waste avoidance in administrations
Energy-saving in consumption sectors	– Improvement of energy efficiency in municipal buildings by means of structural improvements in thermal insulation, efficiency-enhancing measures in heating, measurement and control systems, implementation of municipal energy management and of other measures to save heat and electricity – Support for efficient use of heat and power in other consumption sectors: households, small consumers (retail, crafts, services), manufacturing/industry and other public institutions/authorities (by means of information, planning and other supporting measures)
Environmentally compatible energy infrastructure	– Expansion of the line-bound energy supply (including energy for heating buildings: gas networks, small-scale / large-scale district heating networks) – Fuel conversions (for example, from coal to gas) – Conversion of the energy infrastructure to allow greater use of combined heat and power generation/small-scale CHP stations – Use of renewable and local energy sources (wind power, hydropower, solar energy, biomass, waste heat etc.)
Environmentally compatible development of the transport sector	– Reduced use of private automobiles, coupled with greater use of local public transportation and environmentally compatible, low-emissions modes of transportation – Improvement of the quality of the public transportation infrastructure, especially of local public transportation and other, less energy-intensive modes of transportation (bicycle paths/lanes, pedestrian zones etc.) – Environmentally compatible development of goods transports (expansion of the portion of the city's supply that comes from the surrounding region etc.)
Municipal waste and wastewater treatment	– Waste avoidance, waste separation, re-use and recycling of substances in waste – Waste treatment (as part of a systematic policy of avoidance, re-use and recycling): use of waste and landfill gas for generation of heat and energy; recycling of biomass waste within biogas systems; composting systems – Wastewater treatment: use of sewage gas, process-energy reductions

Source: German Institute for Urban Studies (Difu) 1996.

Cities and Communities (Deutscher Städte und Gemeindebund) – in co-operation with another municipal association, Kommunale Umwelt-AktioN U.A.N., published the guide "City hall and climate protection – tips for municipal practice (Local Agenda 21)", listing 99 examples of possibilities for municipal action in behalf of climate protection. The German Institute for Urban Studies (Deutsches Institut für Urbanistik) is available to German local authorities throughout the country as an authority on issues of municipal climate protection. Its series "Environmental consulting for local authorities" *("Umweltberatung für Kommunen")*, supported by the Federal Environmental Agency, provides additional resource materials regarding municipal energy management and preparation of municipal environmental and climate-protection reports. Since 1995, the German Institute for Urban Studies, in co-operation with state energy agencies, local authorities, the Alianza del Clima e.V. climate alliance and the Institute for Municipal Economic and Environmental Planning *(Institut für kommunale Wirtschafts- und Umweltplanung; Darmstadt)* have held the "Federal congress of municipal energy commissioners" each year. The first such congress was held in 1995 in Frankfurt, with the co-operation of that city's authorities, Hesse's ministry for the environment, and the Hesse Energie GmbH. The second was held in Potsdam, with the co-operation of that city's authorities, the state of Brandenburg's economics ministry and the state's Agency for energy-saving (BEA). Both events were attended by over

200 municipal energy commissioners. The third congress will take place in fall 1997 in Saarbrücken. In its guide “Cities for environmentally compatible development – materials for a “Local Agenda 21”, which was first published in 1995, the Association of German Cities *(Deutscher Städtetag)* has defined energy efficiency and climate protection an additional field for municipal action.

In March 1996, the association of municipal companies *(Verband kommunaler Unternehmen* – VKU) issued a vol-

Tab. 5.4.3.2: CO_2-reduction concepts of German cities (selection)

City	Population	Measures
Aachen[1)]	245627	– Various energy concepts already prepared – New energy supply concept being prepared (completion: expected by the end of 1992)
Augsburg	264852	– Study “Energy indexes of Augsburg schools” (indirectly, this is an analysis of CO_2 immissions) – An environmental report entitled “Air quality control and climate protection”, 1993/94
Aschaffenburg[1)]	65650	– Aschaffenburg energy atlas, 1992
Bautzen	46247	– “Action-oriented energy concept for the city of Bautzen, including potential for reducing CO_2 emissions”, 1993
Bayreuth[1)]	73296	– “Emissions cadastre of the city of Bayreuth”, 1989, updated 1993
Beckum	37075	– Energy supply concept of the city of Beckum, 1988 – Energy report, 1988–93
Bensheim	35535	– “Energy table” on the topic of “building and renovating”, 1996 – Energy concept (including CO_2), 1995
Berlin[1)]	3,4 million	cf. Chap. 5.4.2
Bielefeld[1)]	324287	– Report on “Tapping potential for CO_2 reduction” in the city of Bielefeld – Internal administrative concept for climate protection
Bochum[1)]	400356	– Study being planned (resolution of the city council’s committee for environmental protection)
Bottrop	119377	– Energy concept of the city of Bottrop of November 1991 – Currently, an “Integrated transport development plan”, including a CO_2-emissions analysis, is being prepared – Concept for use of renewable energies – Internal administrative preparation of a climate protection programme (1992)
Bredstedt	4807	– Energy concept in the framework of the Brundtland city project
Bremen[1)]	554377	cf. Chap. 5.4.2
Bremerhaven[1)]	131492	– CO_2-reduction concept, 1995
Butzbach	22772	– Climate protection concept (being prepared)

City	Population	Measures
Dessau	93 855	– CO_2-emissions analysis completed within the city administration – “Energy table” on the topic of “saving energy in households”, 1996 – Energy concept (being prepared)
Detmold	70 970	– Energy and traffic concept relative to climate protection – CO_2-reduction concept approved by the council, but not yet implemented – Concept for support of energy-efficient designs and measures to save energy in old buildings
Donaueschingen[1)]	19 805	– Climate concept of the city of Donaueschingen (catalogue of measures), 1992 – Climate protection report 1995
Dresden[1)]	481 676	– Study on potential for CO_2 reduction (commissioned) – Energy concept (including CO_2), 1990/92 – CO_2 analysis for Dresden, 1993 – Programme of municipal measures for reduction of emissions of CO_2 and other greenhouse gases – Study on the relationship between urban structures and CO_2 emissions, 1995 – Climate protection report 1995
Duisburg	536 797	– Conference on “Municipal climate protection” held as part of Duisburg’s 1996 "Environment Days"
Düsseldorf	578 135	– Report on reducing traffic-related air pollution – Report on “Efficient energy use and CO_2 reduction” (1992) – Pilot project on saving energy saving in craft industries (1994)
Eberswalde[1)]	50 730	– Preparation of a climate protection concept (in co-operation with the energy advisory board), 1996
Erfurt	203 134	– Least-cost planning study (SAVE programme, including emissions reduction), 1993
Erlangen[1)]	102 794	– Report: development of energy use in the household sector in the city of Erlangen (Last revision: 30 August 91) – CO_2-reduction concept for the household sector, 1992 – Energy supply concept, 1993
Essen[1)]	627 269	– “Energy concept Essen: Action concept for efficient energy use and reducing the burden on the environment” (1993)
Frankenthal/Pfalz	47 699	– The city of Frankenthal’s public utilities’ energy supply and traffic concepts in behalf of climate protection
Frankfurt am Main[1)]	663 952	– Measures for efficient energy use in different action areas for the city of Frankfurt – Concept for a CO_2-reduction strategy being prepared (1991 climate initiative) – “Energy and CO_2 analysis for Frankfurt a.M.”, 1992 – “Energy table” on the topic of “modernisation of heating systems”

City	Population	Measures
Frankfurt am Main (greater metro aera): Franfurt regioal association *(Umlandverband)*	n. a.	– Environmental protection report, part VI: climate protection – CO_2 cadastre/maps for the greater metropolitan area
Frankfurt/Oder	83850	– CO_2-reduction concept (being prepared, 1996)
Freiburg im Breisgau[1)]	195789	– Resolution on the development of an overall transport concept (1989) – “Freiburg energy supply concept”; planned update of the concept in 1992/93 (including CO_2) – Integrated climate protection concept (including transport), 1996
Gießen[1)]	74029	– “Energy supply in Gießen – A contribution to the solution of the climate problem” – “1992 energy report: energy-saving and emissions reductions by the public utilities”
Göttingen[1)]	128299	– Energy concept for the city of Göttingen (including CO_2) – “Göttingen 2000” transport-development concept; commissioned – Climate protection report 1991–95
Groß-Umstadt[1)]	19537	– Climate protection concept (being prepared)
Hagen[1)]	214912	– CO_2-reduction and implementation concept within the framework of an overall city energy supply concept (framework concept completed in 1993; detailed concepts in 1994 and following years; for example, energy-optimised urban development planning, 1995) – Report on “climate protection in Hagen”, 1993 – “Climate in brief” (guide to available local advice on climate protection), 1996
Hamburg[1)]	1,6 Mio	cf. Chap. 5.4.2
Hamm[1)]	174700	– 1989 energy supply concept of the city of Hamm
Hannover[1)]	523627	– Proposal for a model project entitled “Municipal CO_2-minimisation programmes”, 1990 – Energy concept and transport-development plan – Waste-management programme – Establishment of a central office for energy + climate within the environmental protection agency – “Climate-relevant emissions in Hannover. Inventory of data on greenhouse gases with ozone-depleting substances” (1993) – Least-cost-planning case study for Hannover, carried out by the Hannover AG public utility (1995) – “Guidelines for ecologically oriented construction” (1994) – Integrated climate protection programme (resolution of 1996) – Concepts for subsidising energy-efficient houses – The THERMIE model project for enhancing the energy efficiency of old buildings – Over 60 Hannover schools save energy through changed usage patterns

City	Population	Measures
Hannover (greater Metro area) – association of local authorities	n. a.	– Study on CO_2 reduction in the Hannover greater metropolitan area, carried out in 1992 by the association of local authorities for the Hannover greater metropolitan area and Lower Saxony's ministry for the environment, 1992
Heidelberg[1)]	140 282	– CO_2-action concept, completed in 1992 – Energy concept, 1992 – The Transport forum's catalogue of immediate measures (resolution of 1993) – Reports on implementation of measures to reduce CO_2 (since 1994) – "Energy table" on the topics of building and renovation, 1996 – Heidelberg thermal efficiency certification *(Wärmepaß)*, 1996
Herford	65 368	– Being prepared: design of an energy concept
Hersfeld-Rotenburg (rural district)	132 600	– "Energy table" on the topic of "Energy advice in the district", 1997
Herten	69 374	– "Energy concept 2000. Safeguarding the quality of life – conserving the basis for life", 1991
Hünfeld	14 219	– Climate protection concept (being prepared)
Jena	100 390	– "Energy concept for the city of Jena" (including CO_2), 1992 – Climate protection concept (being prepared within the city's administration)
Karlsruhe	277 998	– Study of CO_2 emissions in the Karlsruhe administrative district (Baden-Württemberg's State office for environmental protection, 1993)
Kassel	199 935	– New Kassel energy concept of the city's public utilities *(Städtische Werke AG)* – Study entitled "Concept for execution and support of electricity-saving programmes by power companies and for least-cost planning in Hesse, using the example of Kassel's public utilities *(Städtische Werke)*" – General transport plan of the city of Kassel of 1990
Kiel	249 199	– The city council has commissioned a study to identify potential for reduction in transports and energy consumption in Kiel – The "Kiel: city of climate protection" project, 1995/96 – A climate protection co-ordination agency, established 1995 – Internal administrative concept for CO_2 reduction, 1995
Cologne (Köln)[1)]	960 631	– Operation of a measuring network that keeps track of climate-relevant substances and pollutants in the air – The "Energy for Cologne 1985–2000" concept – Administrative contract: development of further possibilities for CO_2 reduction – "An energy-saving, environmentally compatible energy supply in Cologne. Status report 1993" (and 1995) (GEW)
Langenhagen[1)]	47 428	– "Possibilities for reducing amount of heat energy required in residential buildings in Langenhagen", 1991 – Energy concept (including CO_2; completed in 1992)

City	Population	Measures
Langenhagen		– Supplementary study: “First Langenhagen climate protection campaign: energy-saving lighting systems”, 1993
Langgöns	10596	– Climate protection concept (being prepared)
Leipzig	496647	– Energy concept (including CO_2; completed in 1992) – Concept for measures, requiring only minor investments, to save energy in municipal buildings – Concept for modernisation of heating systems in 69 schools (Oct. 93); implementation by 1996
Leverkusen[1)]	162011	– Various measures for CO_2 reduction, such as afforestation, adding greenery to facades, energy-saving in municipal buildings – Energy concept (including CO_2), 1993
Lübeck[1)]	217269	– Report on the environment and saving energy, 1994 – CO_2 analysis, 1995 – “Energy table” on renovation of old buildings in a specific section of the city, 1997
Ludwigshafen[1)]	167541	– Air quality control plans for 1976/84 and 1985/91 – “Energy table” on the topic of “Saving energy in households and schools”, 1996/97
Lüdenscheid[1)]	80059	– Smaller measures in behalf of CO_2 reduction
Lüneburg[1)]	63557	– Energy supply concept (including CO_2 reduction, completed in 1993)
Lützschena b. Leipzig	2854	– Local climate protection concept, 1994
Magdeburg[1)]	272516	– “Local policy guidelines: climate protection in Magdeburg”, 1993 – Annual measures plans for implementation (beginning in 1993) – Energy and CO_2 summary for Magdeburg, the state capital, 1995
Mainz[1)]	184646	– “Environmental protection in the administration – the 1993 environment report” – “Energy concept for the city of Mainz (including CO_2)”, 1993 – “Mainz energy concept: analysis, evaluation, scenarios and measures relative to CO_2 reduction” (1994) – Internal administrative study on the transport sector
Marburg	76406	– Resolution for the development and implementation of a climate protection programme (9/92)
Mönchengladbach	265069	– “Municipal energy concept”
Mülheim a.d.Ruhr	177175	– Climate protection concept (being prepared, 1996)
München[1)]	1,2 Mio	– Two studies on potential for reducing CO_2 emissions and on the costs of CO_2 reduction – “Energy-saving concept for Munich, the state capital” (1991) – CO_2-reduction concept for Munich, the state capital, 1996

City	Population	Measures
Münster[1)]	267072	– Energy concept of Stadtwerke Münster GmbH (public utility) of 1985 – Local transportation concept 2000 – Waste-management concept – Report on CO_2 reduction, prepared by the Energy and climate advisory board (final report 1995) – Establishment of a co-ordination agency for climate protection and energy (KLENKO), 1995
Nordhausen	45502	– Energy concept 1992 (including CO_2) – Expansion and updating of the municipal energy concept to include climate protection (being prepared)
Nuremberg[1)]	500198	– Measures in behalf of CO_2 reduction in the transport sector – Energy-saving concept of the city of Nuremberg – First climate protection report of the central Franconian “axis” of cities (Nuremberg-Fürth-Erlangen-Schwabach-Ansbach) to include a CO_2 analysis, 1994 – “Heating-related CO_2 emissions in Nuremberg and assessment of the potential for emissions reduction”, 1994 – Nuremberg’s CO_2-reduction programme, 1996 – “Energy table” on the topic of "Renovation of old buildings in the city’s southern district", 1999/97
Oberhausen	226025	– CO_2 reduction: catalogue of measures for 1992
Offenbach/Main	117000	– Study: Part V of the materials for an energy concept of the city of Offenbach: “Identification of potential for saving energy in construction of non-profit housing, and development of a climate protection programme”
Offenburg[1)]	54506	– Air quality control plan for the Strasbourg/Ortenau area – Planning: preparation of an energy concept; currently, UMEC, an environmental measurement and survey company (located in Karlsruhe), is preparing an emissions and immissions cadastre for the Ortenau area – “Energy table” on the topic of “Renovation of old buildings”
Osnabrück[1)]	166837	– Energy supply concept including aims of environmental protection (1992) – Preparation of a transport-development plan that includes aims of environmental protection (completed in 1992) – Internal administrative concept for CO_2 reduction (1995)
Paderborn	125730	– Energy supply concept; completed in 1990
Pforzheim	116733	– “Pforzheim energy concept” (including CO_2), 1992
Potsdam[1)]	138618	– “Efficient energy use and use of renewable energies in Potsdam” (1993)
Ravensburg[1)]	46822	– Energy consumption of the city of Ravensburg based on comparisons of different fuels
Recklinghausen	126647	– Measures to reduce CO_2 in the energy and transport sectors
Rheinsberg	5560	– Energy and traffic concepts in behalf of climate protection

City	Population	Measures
Rheinsberg		– Ecological considerations applied to the district heating network of the city of Rheinsberg
Rostock[1)]	237307	– Energy study (including CO_2), 1991
Rottweil[1)]	24515	– Model for decentralised use of renewable energy – Energy supply concept – Direct-energy-conversion and available-heat concept of the city's public utility
Saarbrücken	192322	– Future-oriented energy concept, with environmental protection aims – A project entitled "Development of instruments for cost-optimised planning in a municipal energy services company" (Application for support by the EC's SAVE support programme) – Participation of Stadtwerke Saarbrücken AG (public utility) and the city of Saarbrücken in the ICLEI "Urban CO_2 Project" – Member in the OECD project group "Environmental improvement through urban energy management" – In the last 10 years, CO_2 emissions from municipal heating systems reduced by an average of 15 % – Integrated climate protection programme (resolution 6/93) – The Saarbrücken Energy Study 2005. Definition of a framework for active implementation of recommendations for a municipal services company, 1994
Saarlouis	38265	– Preparation of an energy concept with environmental protection aims; completed in 1991
Schwabach[1)]	36853	– CO_2-reduction concept (being prepared) – "Energy 2005: Think globally – act in Schwabach", 1992
Schwerin	124084	– Development of an overarching energy and environmental concept commissioned
Schwerte	50673	– CO_2-reduction concept and development of a concept for the "ecological city of the future" – Energy supply concept – Catalogue of measures: transport-development plan; waste-management concept; co-operation model for wastewater management; and the youth welfare office's environment protection project – Reports on the CO_2-reduction concept (since 1992)
Solingen[1)]	167112	– Preparation of a regional CO_2-reduction study, in co-operation with the cities of Remscheid and Wuppertal – CO_2-reduction programme for the energy sector (resolution 6/93) – Transport-development concept commissioned
Speyer	49310	– "Energy table" on the topic of "Co-operation of business enterprises"
Stendal	48177	– Energy concept for the city of Stendal, with environmental protection aims – Energy and CO_2 analysis, interim report 1994

City	Population	Measures
Stuttgart[1)]	599 415	– A measure called “Campaign to save energy” – Estimate of the environmental protection agency (within the municipal climatology department): Total emissions of some 5,5 million t per year – Exemplary modernisation of a school (building systems and the building’s exterior), 1996 – Climate protection concept (currently being prepared) – “Energy table” (to support preparation of a climate protection concept)
Sulzbach/Taunus	8 211	– “Energy table” on the topic of “CO_2 reduction in the transport sector”, 1997
Tübingen[1)]	83 175	– Currently being prepared: Report on “energy-saving and on expansion of combined heat and power generation in Tübingen” (being worked on since fall 1990) – Programme to save energy in 150 municipal buildings – Tübingen’s heat-energy certification *(Wärmepaß)*
Ulm[1)]	114 066	– The city of Ulm’s policy of support for solar energy use – Preparation of a transport-development plan; has been commissioned
Velten	10 423	– “Energy and your world” concept (with participation of young people), 1995
Viernheim	30 884	– Brundlandt urban projects – Integrated climate protection concept, 1996
Wardenburg	1 199	– Energy efficiency investments in the framework of local environmentally oriented estimates *(Öko-Gemeindeansatz)*
Wiesbaden[1)]	270 373	– Internal administrative climate protection concept, 1995
Witzenhausen	16 713	– Indirect measures to reduce CO_2 in the energy sector
Wuppertal[1)]	388 102	– Various environmentally compatible detailed energy supply concepts – Integrated CO_2-reduction concept, 1994 (including transport)

Source: First report of the “CO_2-Reduction” Interministerial Working Group (IMA); updated by Difu (no claim to completeness; last revision: December 1996).

[1)] Member in the climate alliance of European cities for protecting the earth’s atmosphere.

untary commitment in behalf of climate protection: by the year 2005, it plans to reduce CO_2 emissions by 34 million tonnes. Such a reduction would amount to more than 25 %, based on the level in 1990, the reference year.

In addition, the local authorities are increasingly organising themselves on the international and European levels by joining the relevant institutions.

The Alianza Del Clima e.V. climate alliance, with headquarters in Frankfurt (European office), currently has over 550 European members, including 326 German cities, local authorities and rural districts, making it the largest network of cities in behalf of climate protection. The Alianza has set itself the very ambitious goal of reducing CO_2 emissions by 50 % in its member cities and communities by the year 2010, based on levels in 1987.

The International Council for Local Environmental Initiatives (ICLEI), which was founded in 1990, is an international association of cities and communities. In early 1991, the ICLEI established its European office in Freiburg. The organisation is now leading an international campaign entitled “Cities for climate protection”, which to date has been joined by over 160 cities around the world, including 18 German cities. The campaign is open to any city or community that makes a commitment to prepare a municipal plan of action for reducing CO_2 emissions by at least 20 %.

Apart from any assessment of the various reduction targets that have been made, the Federal Government strongly welcomes joint efforts on the municipal level that are aimed at exchanging information regarding the most economical ways of reducing municipal contributions to the greenhouse effect.

Due to the major importance of the municipal sector for the implementation of national and international climate protection policy, the Federal Government is supporting a range of activities aimed at reducing CO_2 emissions on the local level. For example, as part of the OECD project "Environmental Improvement through Urban Energy Management", in which the German cities Saarbrücken and Heidelberg took part, the 1993 conference "The role of local energy advisors and energy services" in Saarbrücken and the 1994 conference "How to combat global warming at the local level" received financial support from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. In addition, the "Second World Mayors' Summit on Climate Protection", which was held in March 1995 in Berlin-Köpenick, and the follow-up workshop for the Heidelberg conference, held in September 1996 in Heidelberg, were supported by the German Ministry for the Environment.

The German Ministry for the Environment has also commissioned the German Institute for Urban Studies (Difu) in Berlin to carry out a research project entitled "Guide to the preparation and implementation of municipal climate protection concepts", which is to be completed by the end of 1996. The first publication in the framework of this research project, "Municipal climate protection in the Federal Republic of Germany", appeared in March 1995 in English and German in a publication series of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety entitled "Environmental policy". The second publication, "Climate protection in municipalities – guide to the preparation and implementation of municipal climate protection concepts" will give German local authorities an instrument for initiating all activities necessary for preparing municipal strategies for CO_2 reduction, for implementing such strategies and for carrying out the necessary accounting. Such activities include setting up the necessary administrative organisations, integrating local "players", preparing analyses and sub-concepts and numerous other individual measures. The guide will appear in early 1997 (Available from: German Institute for Urban Studies, Straße des 17 Juni 110/112, 10623 Berlin).

The Federal Government intends to support the implementation and application of this guide, in order to further intensify preparation of climate protection concepts on the municipal level.

The aim of the research area "Reducing pollution in urban development" *("Schadstoffminderung im Städtebau")* of the Federal Ministry for Regional Planning, Building and Urban Development is to apply experience gained from research to bring about changes in existing urban development policy: to use urban development policy as a means for action and strategies for avoidance and reduction of pollutant emissions in urban development; to enshrine climate protection within urban development. 12 model projects are currently being carried out within the framework of this research field, in different cities and communities, and with different emphases in the areas of urban development, transport and energy.

In another project in support of climate protection activities on the municipal level, the German Federal Environment Foundation (DBU) is establishing "Energy Tables". These tables are forums for discussion – established through initiatives of various municipal participants, and drawing on scientific experts – on improving energy efficiency and climate protection, with the aim of bringing about concrete decisions. The project gives local authorities an efficient vehicle for imparting scientific findings to local participants and for encouraging citizens to participate in climate protection policy. The aim is to support citizens in preparing and implementing their own specific action concepts for saving energy in selected municipal emphasis areas.

5.4.4 Measures within the framework of international organisations

In 1989, the 7 leading industrial countries (G 7) announced their intention to contribute to the solution of the climate problem. Germany has a significant role in the G 7's initiatives in the area of climate-protection policy.

At its 4th meeting in 1996, the UN Commission for Sustainable Development (CSD) – whose task is to supervise the implementation of Agenda 21 (approved at Rio 1992) – concerned itself inter alia with Chapter 9 (protection of the earth's atmosphere) of Agenda 21.

The Committee's deliberations were focused on the sectors of climate, energy and transport.

The CSD

– Recommends that the precautionary principle be applied, taking into account existing uncertainties and risks,

– Welcomes the 2nd Assessment Report of the IPCC, which contains the conclusion, inter alia, that scientific findings a suggest discernible human influence on global climate,

– Calls on all countries to sign, ratify and implement the relevant conventions, and to take additional relevant measures, especially in the areas of climate protection, protection of the ozone layer, trans-boundary and local air pollution, energy and transport,

– Requests the UN Secretary General to submit a report, by its 5th meeting 1997, describing the UN's existing energy-related activities and making proposals for further treatment of these activities within the context of sustainable development.

A number of measures have been taken within the ECE framework to reduce or stabilise climate-relevant emissions. The follow-up agreements to the Geneva Convention on Long-range Trans-boundary Air Pollution, of 13 November 1979, include the "Sofia Protocol of 31 October 1988 on the Reduction of Emissions of Nitrogen Oxides (NOx) or their Trans-boundary Fluxes" and the "Geneva Protocol of 19 November 1991 on the Reduction of Emissions of Volatile Organic Compounds (VOC) or their Trans-boundary Fluxes".

In the main, the Geneva Protocol sets forth obligations, under international law, to reduce annual emissions of volatile organic compounds by at least 30 percent by 1999, in comparison with 1988 levels. According to calculations of the Federal Environmental Agency, VOC emissions in Germany will decrease by 40–50 percent by 1999 as a result of initiated measures.

The Sofia Protocol sets forth the obligation, under international law, to reduce annual NOx emissions, or their trans-boundary fluxes, to 1987 levels by 1994. In a political declaration on the Sofia Protocol, Germany and 11 other countries have made the additional commitment to reduce annual NOx emissions by 30 percent by 1998, in comparison with emissions in one of the years between 1980 and 1985. According to current figures, measures initiated to date will enable Germany to attain this aim.

Currently, a new **Multi-component Protocol** is being prepared that will supplant existing protocols for NOx and VOC. This protocol is expected to bring about further reductions of emissions of these indirectly functioning greenhouse gases.

In October 1990, the ECE established the "Energy Efficiency 2000" initiative, which had been approved by a ministerial declaration on long-term sustainable development made in Bergen in May 1990. The aim of this ECE project is to improve trade and co-operation in the area of environmentally compatible and energy-efficient technologies and business approaches – especially such trade and co-operation between economies formerly subject to central control and market-oriented economies. This aim is to be achieved by means of exhibitions, seminars, reference works, information networks, handbooks and consulting missions to ECE countries that are making transitions to market economies. At the 1993 Hannover Trade Fair, the Federal Government carried out a workshop, within the framework of this ECE programme, entitled "Entrepreneurial opportunities in connection with reduction of energy-related greenhouse gases".

The agendas of the ECE Committee on Human Settlements and of the Inland Transport Committee also have components relevant to energy efficiency.

A workshop was held in May 1994 that focused on possibilities for using renewable energy sources in central and eastern Europe.

The Federal Government also attaches great importance to its work in the OECD and the IEA in this area.

The OECD's "Energy and the Environment" working group has established a programme entitled "Global Climate Changes". The programme's purpose is to study the economic dimensions of climate change, including consideration of cost-benefit aspects, application of economic instruments and distribution of financial assistance to developing countries to help them fulfil requirements of the Framework Convention on Climate Change. It will also produce an analysis of means and ways, in the context of support of energy technologies with lower greenhouse gas emissions, to overcome institutional and market-economic hindrances to improvement of energy efficiency, of environmentally compatible technologies and of relevant economic instruments.

Both the OECD and the IEA play an extremely important role in concretising, implementing and refining the Framework Convention on Climate Change. The ministerial meetings of both the International Energy Agency and the OECD emphasised the threats presented by current global environmental stresses, along with the need for intensified, joint efforts to develop and implement an effective strategy for reducing greenhouse gas emissions.

The OECD and IEA have carried out a number of projects that bear on reduction of greenhouse gas emissions, including:

– Preparation of recommendations for a common format for national reports in the framework of the Framework Convention on Climate Change. As part of these efforts, the IEA/OECD, in co-operation with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), sponsored an experts' conference in January 1994 in Berlin,

– Development of methods for assessing the economic consequences of climate changes (costs/benefit analysis) in the area of agriculture and in connection with rising sea levels,

– Execution of studies in the topic area "Economic costs of CO_2 reduction",

– Development of models for assessing the economic consequences of an effective policy for CO_2 reduction,

– Studies on the introduction of CO_2 taxes and tradable emissions rights,

– Study of the use "joint implementation" types of compensation, on the basis of the Framework Convention on Climate Change,

– Studies on use of revenue generated by a global CO_2 tax,

– Holding of an OECD/IEA conference on economic issues pertaining to climate change,

– Development and establishment, by the IEA, of the Greenhouse Gas Technology Information Exchange (GREENTIE) system,

– Establishment of the OECD Forum on Climate Change,

– The Climate Technology Initiative (CTI).

The OECD has established various project groups charged with studying environmental and development issues, especially climate protection strategies of cities. The aim of the project group entitled “Environmental improvements through municipal energy management” is to bring together, from throughout the OECD area, “pilot cities” for the relevant different areas of action in municipal energy policy, in order to promote exchanges of experience. Workshops held by participating cities are one means by which such exchanges are being carried out. Germany is represented in this project by the cities of Saarbrücken and Heidelberg. In June 1993, Saarbrücken carried out a workshop on the topic of “Municipal services companies and energy advice”; in September 1994, Heidelberg held the project’s final event. The results of the project are to be summarised and published in a “Handbook of the best municipal practice”.

The UN Commission for Human Settlements (UNCHS) has made implementation of the Agenda 21, in light of aims for the area of urban and settlement development, one of its focal tasks. The Federal Government, in agreement with other EU Member States, was successful in having the HABITAT II global conference on issues of human settlements, which took place in 1996 in Istanbul, treat environmentally compatible settlement development as one of its primary topics.

5.4.5 German Federal Environment Foundation

The German Federal Environment Foundation (DBU) in Osnabrück was established by a resolution of the German Bundestag, at the initiative of the Federal Government, as an independent foundation under private law. It began operating in 1991 and is now one of Europe’s largest foundations. Its most important areas of support include:

1. Future-oriented, environmentally oriented company management, products and technologies,

2. Innovative processes for re-use and recycling, waste management and emissions reductions,

3. Efficient energy use and renewable energies,

4. Environmental precaution, applied environmental research,

5. The environment and agriculture,

6. The environment and transport,

7. Provision of information on the environment, and environmental consulting,

8. Environmental education,

9. Protection and preservation of environmentally damaged cultural assets.

From its inception to 30 September 1996, the DBU has provided total support of some 950 million DM for some 2,000 projects. Some 60% of this support has gone to the new Federal *Länder.*

In addition, the DBU has established a stipend programme to support young scientists working in the area of environmental protection; this programme is now in effect throughout the country. The DBU also endows special academic chairs for environmentally oriented research and teaching in the new federal Länder. Part of the projects supported by the German Federal Environment Foundation (DBU) are aimed at reducing emissions of CO_2 and other greenhouse gases.

5.4.6 German Railways (Deutsche Bahn AG)

German Railways (Deutsche Bahn), taking into account

– national and international developments in the area of environmental protection,

– relevant entrepreneurial interests and possibilities and

– the society’s expectations,

has established the following strategic aims for reduction of greenhouse gases:

– Reduction of specific primary energy consumption for traction by 25% by the year 2005, based on the 1990 level,

– Further reductions of absolute primary energy consumption in stationary processes,

6. Emissions scenarios and projections to the year 2000, 2005, 2010, 2020, and assessment to the effects of measures

6.1 The reability of predictions and scenarios

In all political areas, and on all political levels, predictions and scenarios are indispensable tools for obtaining a concept of what could happen and for assessing the possible effects of measures. In the area of energy policy, predictions and scenarios have always played an important role on the national, European and international levels.

Predictions and scenarios have had particular significance from the start of consultations to formulate a globally coordinated climate protection strategy. Countless predictions and scenarios, with a broad range of territorial and chronological frames of reference, have been presented and discussed in the IPCC framework.

Participants in political discussion often forget that the future cannot be predicted with certainty and that predictions cannot be more than "if-then" statements. In many cases, predictions have been appropriated for certain aims and interests. This insight has been confirmed by a study entitled "Analysis of the most recent energy-requirements predictions for important nations with regard to the avoidance of energy-related greenhouse gases" *(Analyse jüngster Energiebedarfsprognosen für wichtige Nationen im Hinblick auf die Vermeidung energiebedingter Treibhausgase)* that was carried out by the Fraunhofer Institute for System Technology and Innovation Research on behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

Predictions are always closely tied to the trends on which they are based; the results of scenarios always depend on the premises from which they begin. This means that different descriptions of the future, all of them consistent and free of contradictions, can co-exist. Each description depends on the assumptions made concerning trends in economic, demographic and political parameters, and, in the present case, on the way interconnections relative to energy consumption are assessed.

In the past three decades, predictions have tended, for reasons which are clearly system-oriented, to overestimate actual energy consumption. According to the Jülich Research Centre's studies for the period from 1970 to 2000, 21 of 24 consumption curves obtained through energy predictions were markedly higher than the actual development. Only three predicted curves were below the actual development. The discrepancy between predicted and actual development was particularly pronounced during the two oil-price crises, in 1972/73 and 1979/80.

It would be wrong to criticise the predictions' authors for such mistakes. Neither predictions nor scenarios can take account of unforeseen external shocks or other externally caused parameter changes. This fact should always be remembered in connection with the interpretation of predictions and scenarios.

Another reason for the relative nature of predictions and scenarios concerning energy consumption and the development of greenhouse gas emissions is, purely and simply, that the future effects of certain measures often cannot be predicted, even with the most sophisticated methods. The following, taken from the Federal Government's climate protection strategy, are typical examples of measures whose effects cannot be predicted:

- The amendment of the Fee Table for Architects and Engineers (HOAI),
- Measures for improvement of advising and provision of information,
- Measures for improvement of training and further training.

Furthermore, it must be remembered that, due to interdependencies between the various measures, the effects of individual measures cannot simply be added in order to assess the overall impacts. The overall impacts could easily be greater than the sum of the effects of the individual measures.

In spite of such qualifications concerning their reliability, scientific predictions and scenarios remain important instruments for preparing decisions – if they clearly identify the unavoidable subjectivity and relativity of their assumptions and underlying interrelationships, and if they provide systematic information about structure-changing economic, social and technological influences.

The results summarised in Table 6.1.1 of selected predictions and scenarios must be evaluated in this light. Table 6.1.2 summarises the assumptions underlying the different studies. The Federal Government has not endorsed any of the predictions of these studies, but it does take account of the studies' results in shaping its policies. On the other hand, the Federal Government's climate protection strategy has been able to take many of the described predictions/scenarios into account only to a limited degree. The project "Policy Scenarios for Climate Protection" *(Politik-Szenarien für den Klimaschutz)*, carried out by the Jülich Research Centre, the German Institute for Economic Research, the Fraunhofer Institute for System Technology and Innovation Research and the Öko-Institut, has attempted to develop a "without-measures" scenario and a "with-measures" scenario for greenhouse gas emissions, while carefully applying the IPCC Guidelines' scenarios categories. The project "Overall economic assessment of CO_2-reduction strategies" *(Gesamtwirtschaftliche Beurteilung von CO_2-Minderungsstrategien)*, carried out by the Rhine-Westphalian Institute for Economic Research *(Rheinisch-Westfälisches Institut für Wirtschaftsforschung)*, Essen, and the Ifo Institute for Economic Research, Munich, has attempted to assess the overall economic consequences of CO_2-reduction policies.

Tab. 6.1.1: Results of selected predictions and scenarios for energy consumption and CO_2 emissions in Germany

Prediction/scenario	Time period	Development	
		of energy consumption	of CO_2 emissions
PROGNOS 1991 (commissioned by Federal Ministry of Economics)	Reference case:		
	1989–2010	-1,0%	-7,7%
	1987–2010		-11,0 %
	Sensitivity case:		
	1989–2010	-7,9%	-16%
	1987–2010		-18,4%
ESSO 1992	1991–2010	-1,0%	-11,0%
	1987–2005		-17,0%
SHELL 1993	1991–2020		
	New horizons	+18,4%	+2,2%
	Falling barriers	-4,3%	-15,7%
PROGNOS 1995 (commissioned by Federal Ministry of Economics)	1990–2005	-1,9%	-8,2%
ESSO 1995	1994–2010	+2,1% PEV	
	1990–2005		-13%
FERI Basic case 1995 (commissioned by Ruhrgas AG)	1990–2005		- 15,3%
RWI/Ifo 1996 (commissioned by Federal Ministry of Economics)	1990–2005		
	Reference scenario	about -4%	about -8%
	Measures scenario	about -12%	about -17%
Policy scenarios for climate protection 1997 (commissioned by Federal Ministry for the Environment/Federal Environmental Agency [UBA])	1990–2005		
	Without-measures scenario		about -3%
	With-measures scenario		-14,5%
IKARUS reference scenario in the framework of policy scenarios	1990–2005		
	Reference case	about -12%	about -18%

Tab. 6.1.2: Assumptions regarding demographic and overall economic development in Germany from 1990 to 2005, in accordance with available studies

Studies	Old Federal *Länder*	New Federal *Länder*	Germany
	Overall economic growth 1990/1995, in % per year		
Ifo/RWI (1996)	1,6	3,6	1,8
FERI (1995)	1,7	3,4	1,9
ESSO (1995)	2,0	4,7	2,3
PROGNOS (1995)	2,0	5,2	2,4
Enquete Commission (1994)	2,1	5,3	2,5
IKARUS reference	3,1	6,4	3,4
policy scenarios (1997)	2,0	5,2	2,4
	Population in the year 2005 (in millions)		
Ifo/RWI (1996)	68,5	15,3	83,8
FERI (1995)	67,1	15,2	82,3
ESSO (1995)	67,4	15,2	82,6
PROGNOS (1995)	67,8	14,3	82,1
Enquete Commission (1994)	67,2	13,9	81,1
IKARUS reference	65,8	15,2	81,0
policy scenarios (1997)	67,8	14,3	82,1
For comparison: actual situation in 1990	63,3	16,1	79,4

*) Data for 2005 interpolated
**) Annual average

6.2 Predications of scenarios

To project emissions into the future, a transition must be made from analysis of the effects of individual measures – as described in Chapter 5 – to an integrated consideration of the combined effects of measures and policies.

This can be accomplished with the help of the numerous studies, reviews and estimates that have been carried out for Germany in recent years by various agencies.

The recent study of the Jülich Research Centre (FZJ), the German Institute for Economic Research (DIW) Berlin, the Fraunhofer Institute for System Technology and Innovation Research (FhG/ISI), Karlsruhe and the "Öko-Institut", Berlin – "Policy scenarios for climate protection" (cf. Chap. 6.3.1.1) – and the study of RWI, Essen and Ifo, Munich, "Overall economic assessment of CO_2-reduction strategies" (cf. Chap. 6.3.1.2) have been selected from the broad range of available studies. These two studies complement each other in that the first presents conclusions regarding trends for all greenhouse gases and precursors in Germany and recommends measures, while the second focuses more strongly than the "policy scenarios" on the overall economic consequences of policies oriented exclusively to reduction of CO_2 emissions.

The studies "Policy scenarios for climate protection"/ "Overall economic assessment of CO_2-reduction strategies" use the following premises:

– The "without-measures scenario"/reference scenario assumes the absence of any climate-protection measures. Efficiency improvements are the main factor that counters increases of CO_2 emissions.

– The "with-measures scenario"/"IMA-measures scenario" takes the agreed climate-protection measures /CO_2-reduction measures into account wherever possible.

6.3 Reducing emissions of greenhouse gases

The following section describes the emissions projections for greenhouse gases for a without-measures scenario/reference scenario and for a with-measures scenario/IMA-measures scenario.

Tab. 6.3.1.1.1: Development of CO_2 emissions in Germany by the year 2005 in the "without-measures scenario" (with energy efficiency improvements)

Sectors	Act. vals.		Scenario values				
	1990	1995[1]	2000[2]	2005[2]	90/95	95/05	90/05
	CO_2-emissions in mill. t				Changes in %		
Industry	169,7	126,8	122,5	122,5	-25,3	-3,4	-27,8
Institutional[3]	75,7	51,9	70,5	73,0	-31,5	40,7	-3,6
Residential	128,4	135,2	135,3	138,5	5,3	2,5	7,9
Transport[4]	184,9	196,1	231,0	236,0	6,0	20,4	27,6
Total, final energy sectors	558,8	509,9	559,3	570,0	-8,7	11,8	2,0
Power stations	353,6	317,5	331,4	345,5	-10,2	8,8	-2,3
District heating	42,9	31,7	29,7	26,9	-26,0	-15,1	-37,2
Other energy sector[5]	43,0	24,0	21,0	19,0	-44,1	-20,9	-55,8
Total, energy sector	439,4	373,2	382,2	391,4	-15,1	4,9	-10,9
Total	998,2	883,1	941,5	961,4	-11,5	8,9	-3,7
Renewable energies	–	–	7,9	12,8	–	–	–
Total, energy-related emissions	998,2	883,1	949,3	974,2	-11,5	10,3	-2,4
Process-related emissions	27,5	25,2	26,1	25,5	-8,4	1,0	-7,5
Total emissions	1025,7	908,3	975,4	999,7	-11,4	10,1	-2,5
Minus internat. air transport[5]	11,6	13,9	15,0	15,9	19,8	14,3	36,9
Emissions without internat. air transport	1014,2	894,5	960,4	983,8	-11,8	10,0	-3,0

[1] Tentative figures calculated on the basis of energy balance data.
[2] Average values, where ranges have been listed for the individual sectors.
[3] Including military agencies, but not including their fuels.
[4] Including international air transports and emissions of mobile systems in residential, industry and military.
[5] Emissions by analogy to PROGNOS.
Source: UFO planned project "Policy scenarios for climate protection"

6.3.1 Carbon dioxide (CO_2)

6.3.1.1 Policy scenarios for climate protection (FZJ, German Institute for Economic Research (DIW), ISI, ÖKO; 1997)

a) In the **"without-measures scenario"**, the CO_2 emissions would change little between 1990 and 2005; in the year 2005, they would be only 30 million t CO_2, or about 3%, less than in the reference year (cf. Table 6.3.1.1.1).

Detailed calculation of CO_2 emissions to 2010 and 2020 has not been carried out. Assessment of the impact of the considered measures provides the following picture:

If the "without measures" trend continued, CO_2 emissions on the order of 1,025 million t would be expected in the year 2010. In comparison with levels in 1990, therefore, CO_2 emissions would hardly change. Further extrapolation of the trends indicates that CO_2 emissions in the year 2020 would be on the order of 1,130 million t.

In sectoral terms, it should be noted that industry and district heating plants would strongly reduce emissions between 1990 and the year 2005. These reductions would be driven primarily by the development in the first half of the 1990s in the new Federal *Länder.*

On the other hand, CO_2 emissions in the transport sector would be expected to rise sharply; emissions in the year 2005 would be about 50 million t, or 28% higher, than in 1990. An increasing emissions trend would also be expected for the private residential sector, while emissions in the institutional sector would tend to stay at about the same level.

b) In the **"with-measures scenario"**, as a result primarily of federal climate-protection measures, CO_2 emissions would be about 147 million t, or about 14.5%, lower in the year 2005 than in 1990; in comparison with the 1995 level, the reduction by the year 2005 would still be 27 million t, or about 3% (cf. Table 6.3.1.1.2).

The emissions reductions would be particularly large, throughout the entire period under consideration, in industry and in district-heating stations. The climate-protection measures taken in the last few years would also consider-

Tab. 6.3.1.1.2: Development of CO_2 emissions in Germany by the year 2005 in the "with-measures scenario"

Sectors	Act. vals.		Scenario values				
	1990	1995[1]	2000[2]	2005[2]	90/95	95/05	90/05
	CO_2 emissions in mill. t				Changes in %		
Industry	169,7	126,8	116,9	107,1	-25,3	-15,5	-36,9
Institutional[3]	75,7	51,9	61,6	56,5	-31,5	8,9	-25,4
Residential	128,4	135,2	115,9	110,5	5,3	-18,2	-13,9
Transport[4]	184,9	196,1	223,0	224,0	6,0	14,3	21,1
Total, final energy sectors	558,8	509,9	517,4	498,2	-8,7	-2,3	-10,8
Power stations	353,6	317,5	316,7	318,9	-10,2	0,4	-9,8
District heating	42,9	31,7	30,0	27,5	-26,0	-13,4	-35,9
Other energy sector[5]	43,0	24,0	21,0	19,0	-44,1	-20,9	-55,8
Total, energy sector	439,4	373,2	367,8	365,3	-15,1	-2,1	-16,9
Total	998,2	883,1	885,2	863,5	-11,5	-2,2	-13,5
Renewable energies	-	-	-2,3	-5,6	-	-	-
Total, energy-related emissions	998,2	883,1	882,9	857,9	-11,5	-2,9	-14,1
Prozess-related emissions	27,5	25,2	26,0	25,3	-8,4	0,4	-8,1
Total emissions	1025,7	908,3	908,9	883,2	-11,4	-2,8	-13,9
Minus internat. air transport[5]	11,6	13,9	15,0	15,9	19,8	14,3	36,9
Emissions without internat. air transport	1014,2	894,5	893,9	867,3	-11,8	-3,0	-14,5

[1] Tentative figures calculated on the basis of energy balance data.
[2] Average values, where ranges have been listed for the individual sectors.
[3] Including military agencies, but not including their fuels.
[4] Including international air transports and emissions of mobile systems in residential, industry and military.
[5] Emissions by analogy to PROGNOS.
Source: UFO planned project "Policy scenarios for climate protection"

ably reduce emissions in the institutional, residential and power-station sectors, however. An increase of CO_2 emissions would have to be expected only in the transport sector; however, this increase would be marked. In this scenario, transport-related CO_2 emissions levels would be about twice as high as all industrial emissions in the year 2005.

Overall, CO_2 emissions (Table 6.4.1.1) would continue to decrease slightly in a with-measures scenario until 2010 and 2020 (2010: 854,000 Gg; 2020: 847,000 Gg); this is predicted by a sector-specific trend analysis (as in the with-measures scenario appended to the First National Report of April 1996). Seen sectorally, this would be caused by slight emissions increases in industry and the transformation sector and by slight emissions reductions in the transport, residential and institutional sectors.

The effectiveness of various individual measures in reducing greenhouse gas emissions was also estimated in the framework of this "with-measures scenario". As part of this analysis, overlapping and synergies were taken into account in order to avoid double counting of effects. The – summable – estimates of effects of measures are listed in Chapter 5 (cf. Tab. 5.2.1 to 5.2.7).

6.3.1.2 The scenario "Overall economic assessment of CO_2-reduction strategies" (RWI/Ifo study)

The results of the RWI/Ifo study "Overall economic assessment of CO_2-reduction strategies" (cf. Table 6.3.1.2.2) complement and support the results of the above-described scenarios.

a) In the reference or basic scenario, i.e. without further specific measures for CO_2 reduction, CO_2 emissions in the year 2005 would be 83 million t lower than in 1990. This result, so the study, would be due especially to enhancements of energy efficiency, to decreases of CO_2 emissions in the new Federal *Länder* and to contrarian developments in the transport sector. The gross domestic product is expected to grow at nearly 2% per year beginning in 1996.

b) In the so-called "IWG scenario", the measures approved by the Federal Government in 1991 on the basis of the

Tab. 6.3.1.2.1: Selection of the parameters used for the scenarios of the RWI/ifo study

		1987	1990	1995	2000	2005	2010
Population	millions (comma = dec. pt.)	77,727	79,500	82,005	83,301	83,987	84,181
Private residential	millions (comma = dec. pt.)	33,831	34,847	36,696	38,599	40,185	41,064
Gainfully employed persons	Mio.		39,3	39,2	38,9	39,2	
Social insurance tariff	%		35,9	37,9	39,0	40,0	
VAT rate	%		14,0	15,0	16,0	16,0	
Corportation tax rate	%		50,0	45,0	45,0	45,0	
Long-term real interest rate	%		6,2	5,0	5,0	5,0	
Oil price	US$/b, cif(real basis 1990)	22		17	18	20	23
	US$/b, cif(nominal)	19		18	33	32	46

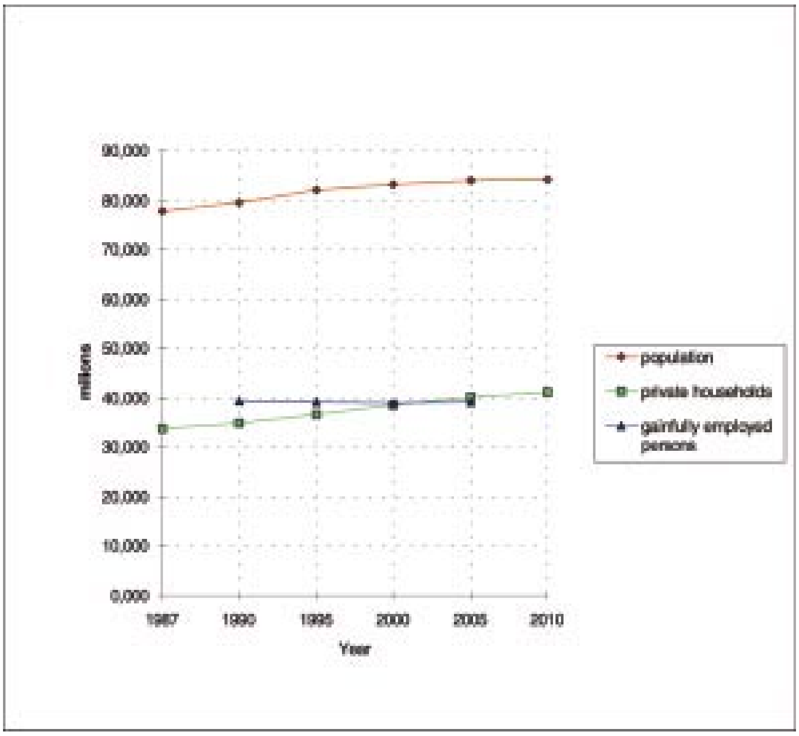
Source: RIW/ifo-study “Overall economic assessment of CO_2-reduction strategies”

2nd CO_2 report of the “CO_2 reduction” Interministerial Working Group were assessed. In addition, the quantifiable measures of the 3rd CO_2 report of 1994, and of German industry’s voluntary commitment on CO_2 emissions, made in 1995/1996, were considered in the analysis.

In sum, the reference and IWG scenarios result in a CO_2 reduction of about 170 million t by the year 2005; this would be equivalent to about 17 percentage points of the Federal Government’s objective of a 25% CO_2 reduction (on the basis of the 1990 level). Under the assumption that the population would be same as in 1992, this result would be equivalent to a CO_2 reduction of 22%.

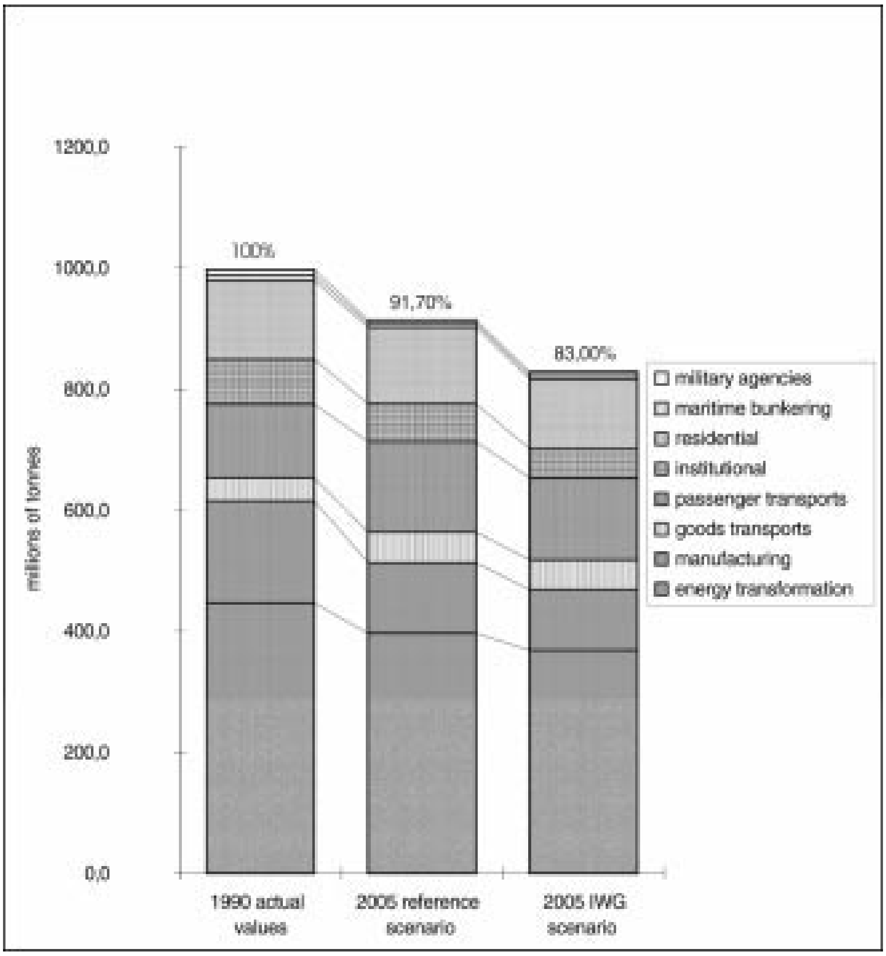
For the economy as a whole, the study assumes somewhat weaker average annual economic growth and somewhat slower workforce growth than what is assumed by the reference scenario.

Fig. 6.3.1.2.1: Trends in populations, numbers of private households and numbers of gainfully employed people in Germany



Source: RWI/Ifo study “Overall economic assessment of CO_2-reduction strategies“

Fig. 6.3.1.2.2: Development of CO_2 emissions from 1990 to 2005, using different scenarios



Source: RWI/ifo study "Overall economic assessment of CO_2-reduction strategies"

Tab. 6.3.1.2.2: Development of CO_2 emissions, in millions of tonnes

	1990 Actual values	2005 reference scenario	2005 IWG scenario
Energy transformation	446,5	396,1	368,3
Manufacturing	168,8	116,6	100,3
Goods transport	38,1	51,1	49,2
Passenger transports	121,7	148,9	135,1
Institutional	74,2	63,2	48,2
Residential	130,4	126,2	115,6
Maritime bunkering	8,0	6,0	6,0
Military agencies	9,7	5,4	5,4
Total	997,4	913,5	828,1
Reduction in % from 1990		**8,3**	**17,0**

Source: RWI/Ifo study "Overall economic assessment of CO_2-reduction strategies"

6.3.1.3 Results of the scenario for CO_2

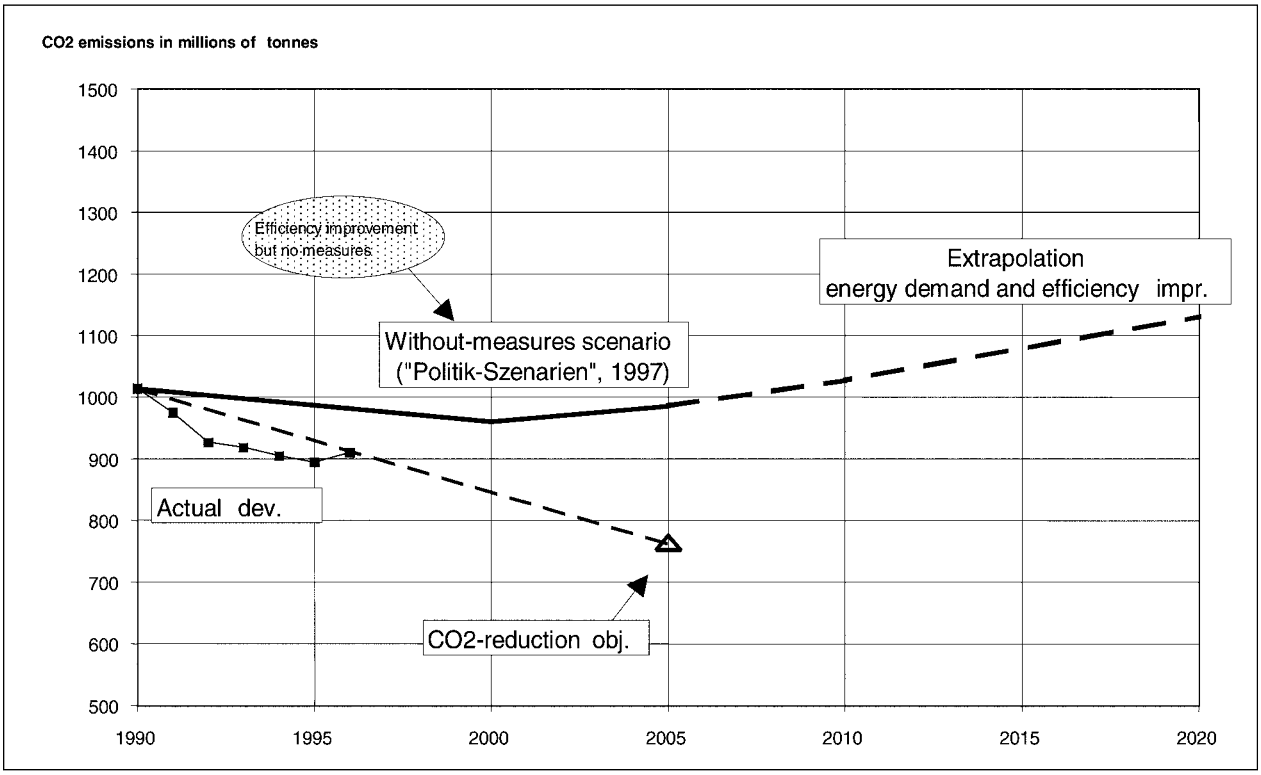
Chapter 6.3.1.3 presents graphic summaries of the results of the two studies "Policy scenarios for climate protection" and "Overall economic assessment of CO_2-reduction strategies":

- without-measures scenario (Fig. 6.3.1.3.1)
- with-measures scenario (Fig. 6.3.1.3.2)

Some differences are due simply to different underlying scenario assumptions. For example, comparable studies use different values for expected total economic growth and population. This illustrates the fact that scenario results are subject to unavoidable imprecision (Table 6.1.2).

In addition, both studies have issued recommendations for measures that go beyond existing resolutions and that are intended to close the gap seen between the Federal Government's CO_2-reduction objective and the quantifiable development. The RWI/Ifo report's recommendations are concentrated on the areas "industrial power industry" and "modernisation of existing buildings", while the "Policy scenarios for climate protection" contain broader-based proposals (transport sector, institutional, industry, electrical power and district heating, renewable energies) that focus not only on CO_2, but also on reduction of other greenhouse gases as well. The Federal Government has taken no further

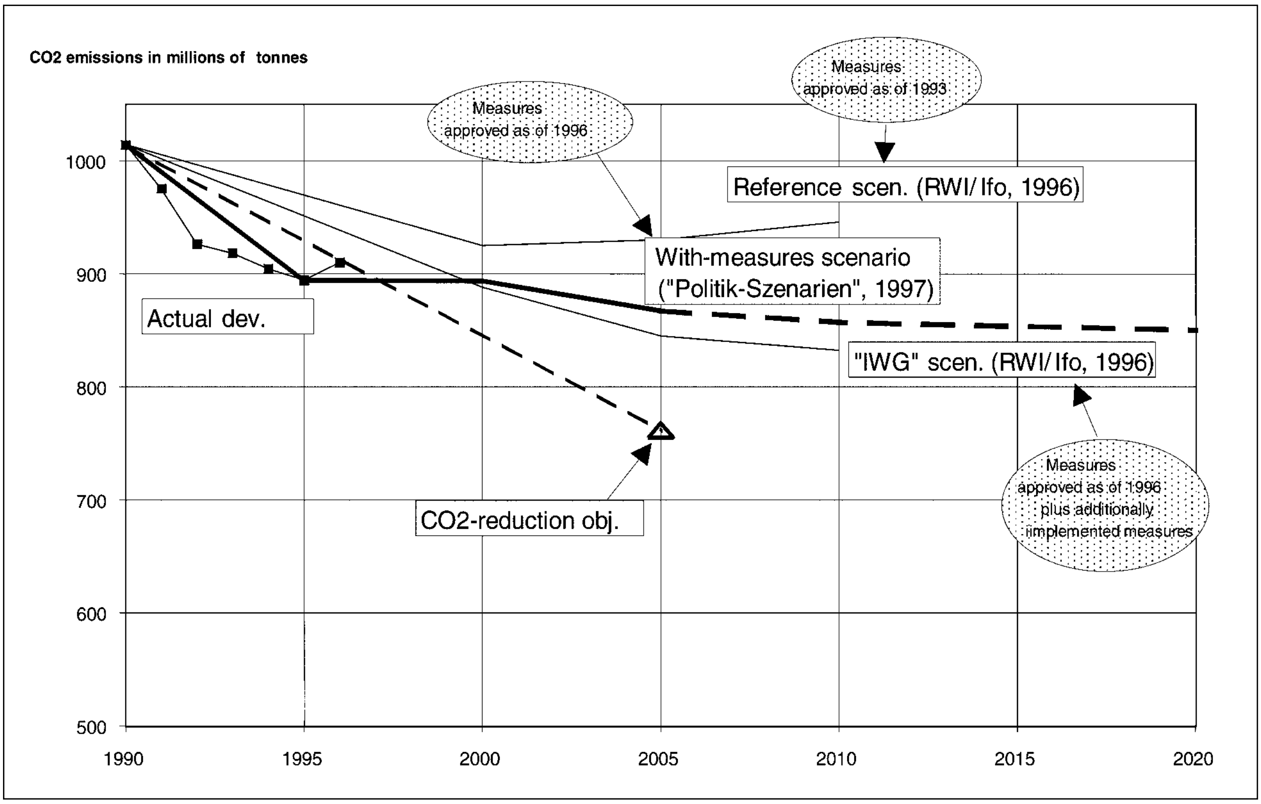
Fig. 6.3.1.3.1: Without-measures scenario for CO_2



resolutions in this regard. The "CO_2 reduction" Interministerial Working Group has been requested to analyse all existing studies on these issues and to present relevant proposals for resolutions to the Federal Cabinet. The Federal Cabinet has requested the "CO_2 reduction" Interministerial Working Group to present further recommendations in early summer 1997.

The extent to which measures can be recommended also depends significantly on the overall economic and finance-policy framework (budget moratorium).

Fig. 6.3.1.3.2: Comparison of with-measures scenarios for CO_2



Tab. 6.3.1.4.1: Assumptions regarding production trends for selected goods (1990 = 100%)

	New Federal *Länder*				Old Federal *Länder*			
	1989	1990	2005	2020	1989	1990	2005	2020
cement clinkers	165%	100%	107%	107%	96%	100%	88%	79%
lime	227%	100%	58%	53%	102%	100%	94%	87%
primary aluminium pig	270%	100%	0%	0%	103%	100%	56%	28%
glass	109%	100%	185%	185%	90%	100%	134%	147%
calcium carbide	187%	100%	0%	0%	118%	100%	47%	26%
ammonia	140%	100%	23%	15%	104%	100%	126%	114%
soda	184%	100%	100%	89%	100%	100%	69%	59%

6.3.1.4 Non-energy-related carbon dioxide

Chapter 6.3.1.4 gives separate consideration to non-energy-related CO_2 emissions. The “Policy scenarios for climate protection” (cf. Chap. 6.3.1.1) take account of these process-related CO_2 emissions, whereas the scenario in “Overall economic assessment of CO_2-reduction strategies” (Chap. 6.3.1.2) considers only energy-related CO_2 emissions.

The main sources of non-energy-related CO_2 emissions are production processes in the building materials industry (cement clinkers, lime). Other emissions are generated by the production of glass, primary aluminium pig, calcium carbide, ammonia and soda. The measures that have been approved and implemented to date within the CO_2-reduction programme have only very minor influence on these non-energy-related emissions. For this reason, the emissions reductions can be determined for only a few areas.

Direct effects on emissions of non-energy-related carbon dioxide can be achieved only through measures for increasing substance recycling. Such measures, example, are mandated by the Closed Substance Cycle and Waste Management Act and by the Ordinance on Packaging. They achieve emissions reductions primarily by increasing recycling of glass and aluminium.

The projections for non-energy-related CO_2 emissions are based on the following assumptions regarding production trends:

The decreasing demand for primary aluminium pig is actually countered by a trend in which aluminium smelting, for various reasons, is being moved abroad, while aluminium finished products and wrought products are being imported.

The emissions trends that result in the “without-measures scenario” are influenced mainly by production processes. In this scenario, non-energy-related CO_2 emissions decrease by about 16%, to about 23 million t, on the basis of the 1990 emissions level.

The following table summarises the non-energy-related CO_2 emissions levels resulting in the “with-measures scenario”, the reference scenario.

The quantifiable effect of increased glass recycling is about 700,000 t CO_2. This is likely to be the upper limit of estimates; it corresponds to emissions reductions of about 2% of total non-energy-related emissions, in comparison with the reference year.

Without the increased rates of recycling brought about by the various measures, it would not be possible to stabilise the CO_2 emissions generated in glass production.

Tab. 6.3.1.4.2: Development of non-energy-related CO_2 emissions in the “with-measures scenario” and in the “without-measures scenario” (old and new Federal *Länder*)

	1990	2005	2020
	Mio t CO_2		
cement clinkers	16,15	14,87	13,77
lime	6,42	6,42	5,63
primary aluminium pig	0,90	0,48	0,24
glass	1,21	0,97	1,06
calcium carbide	0,35	0,05	0,03
ammonia	1,75	1,34	1,17
soda	0,74	0,57	0,49
Total	27,52	24,69	22,38
for comparison: without-measure scenario			
Total	27,52	25,40	23,14

Source: calculation of the “Öko-Institut”

6.3.2 Methane (CH_4)

The main sources of methane emissions - as the emissions inventories in Chapter 4 show – are agriculture, waste management and extraction and distribution of fuels (gas-distribution networks and hard coal mining). All other emissions-relevant factors (stationary firing systems, transports and industry processes) are responsible for only about 3% of total methane emissions.

Emissions can be reduced by:

- decreasing landfill gas emissions;
- increasing use of the pit gas produced in hard coal mining;
- thoroughly modernising the pipeline networks used for natural gas distribution;
- more effectively using the methane generated by storage of farm fertilisers (livestock manure).

The following section makes use of data from the research projects mentioned below in connection with the Tables. [1)]

All of the scenarios considered here use the same data for the areas of gas extraction and distribution and for other relevant processes (firing systems and wastewater treatment). In natural gas distribution, a considerable emissions reduction – about 55% – is expected over the medium term (by the year 2010), as a result of continuing network modernisation in both the new and old Federal *Länder.* In the wastewater treatment sector, emissions reductions of about 60 kt are expected to result from phasing-out of psychrophilic sewage-sludge stabilisation in the new Federal *Länder.*

In the **"without-measures scenario"**, a considerable emissions reduction of about 23%, on the basis of the 1990

[1)] In presenting this data, the Federal Government reiterates its basic position regarding the significance of predictions and scenarios (cf. Chap. 6.1, 6.2). While it endorses none of the conclusions of the projections documented in the following section, it does plan to take account of these conclusions in preparing and implementing policies and measures that protect the climate by reducing anthropogenic greenhouse gas emissions.

Tab. 6.3.2.1: Development of CH_4 emissions in the "without-measures scenario" (in Gg)

	1990	1995	2000	2005	2010	2015	2020
other processes	312	228	168	160	155	144	133
gas extraction and transport	327	322	265	208	150	142	134
coal mining	1222	958	836	658	657	656	654
landfills	1777	1777	1777	1777	1777	1777	1777
animal husbandry	2044	1677	1691	1687	1681	1676	1663
total emissions	**5682**	**4962**	**4737**	**4490**	**4420**	**4395**	**4361**
bodies of water[*)]	318	318	318	318	318	318	318

[*)] Only partly anthropogenic; the anthropogenic contribution cannot be quantified.

Tab. 6.3.2.2: Development of CH_4 emissions in the "with-measures scenario" (in Gg)

	1990	1995	2000	2005	2010	2015	2020
other processes	312	228	142	135	128	120	112
gas extraction and transport	327	323	265	208	150	142	134
coal mining	1222	783	686	544	543	541	540
landfills	1777	1777	1125	464	307	207	140
animal husbandry	2044	1677	1674	1653	1631	1608	1579
total emissions	**5682**	**4788**	**3892**	**3004**	**2759**	**2618**	**2505**
bodies of water[*)]	318	318	318	318	318	318	318

[*)] Only partly anthropogenic; the anthropogenic contribution cannot be quantified.

emissions level, is expected by the year 2020. Much of this reduction has already been achieved – through reductions in sizes of livestock herds and decreased hard coal production.

In the **"with-measures scenario"**, the Technical Instructions on Waste from Human Settlements *(TA-Siedlungsabfall)*, which mandate reduction measures for new landfills and modernisations for existing landfills, are expected to drastically reduce landfill gas emissions: by more than 90% by the year 2020, on the basis of the 1990 emissions level. This development is being supported by implementation of the Technical Instructions on Waste Management *(TA-Abfall)*, which set forth defined "quality parameters" (covering levels of carbon, among other substances). In this scenario, a considerable reduction of domestic coal extraction for the public power supply is assumed to take place by the year 2005. Increased use of the pit gas produced in coal mining is also assumed. These measures are expected to greatly reduce methane emissions in this area by the year 2005, on the basis of the 1990 emissions level.

For animal husbandry, rough estimates indicate that about one-third of methane emissions produced in storage of animal excrement could be avoided. This scenario assumes that 50% of this reduction potential would be tapped through collection of "biogas". This would result in a reduction of about 80 kt in comparison with the "without-measures scenario".

As a result, in the **"with-measures scenario"** emissions would be expected to decrease by 45% as soon as year 2005, and by about 55% – to less than 2.5 million t – by the year 2020 (levels in comparison with emissions in 1990).

The following tables present data from the research project "Policy scenarios for climate protection".

6.3.3 Nitrous oxide (N_2O)

As the emissions inventories in Chapter 4 indicate, there are three main sources of N_2O emissions:

– industrial processes (adipic and nitric acid production),

– agriculture (animal husbandry, fertiliser use),

– combustion of fossil fuels.

The following section presents data from the research projects mentioned below in connection with the tables.

Emissions in 1990 were used as a basis for the without-measures scenario. The figures for 1995 are fictive, since they do not reflect the measures initiated between 1990 and 1995. This is especially clear in the area of industrial processes, in which highly effective emissions-reducing measures were initiated beginning in 1993. In this scenario, N_2O emissions decrease in the areas "other energy sources" and "agriculture". With emissions factors remaining constant, this reduction is due to trends in fuel use and, in agriculture, to reductions in the amount of land under cultivation. The emissions increases in the area of industrial processes are due to increased production.

In the "with-measures" scenario, N_2O emissions would decrease by about 31% by the year 2020 – with respect to 1990. The largest decrease would already be achieved by the year 2000, since by this time the voluntary reductions made by adipic acid manufacturers, as a result of their discussions with the Federal Government, would be effective. In spite of increasing production, N_2O emissions in this area would decrease by 90 to 95%. The voluntary measures are as follows: one manufacturer began operation in 1993 of an installation for thermal decomposition of N_2O; the second manufacturer plans to begin using a facility for catalytic

Tab. 6.3.3.1 Sum of projections for N_2O emissions (in Gg): "without-measures scenario"

	1990	1995	2000	2005	2010	2020
Transport[1)]	11	21	22	21	21	22
other energy sources	26	25	23	22	22	22
industrial processes	83	105	106	106	106	106
agriculture (direct)	64	60	59	59	58	57
waste	4	4	4	4	4	4
other	6	6	6	6	6	6
groundwater/surface water[*)] (agriculture)	32	31	30	30	30	29
Total	226	252	250	248	247	246

[*)] calculations based on fertiliser use
[1)] Use of catalytic converters in the transport sector will considerably reduce NOx emissions, but considerably increase N_2O emissions.

Tab. 6.3.3.2: Sum of projections for N_2O emissions: “with-measures scenario” (in Gg)

	1990	1995	2000	2005	2010	2020
Transport[1)]	11	21	22	21	21	22
other energy sources	26	25	23	22	22	22
industrial processes	83	70	23	23	23	23
agriculture (direct)	64	56	56	55	54	53
waste	4	4	4	4	4	4
other	6	6	6	6	6	6
groundwater/surface water[*)] (agriculture)	32	28	28	28	27	27
Total	226	210	162	159	157	156

*) calculations based on fertiliser use
1) Use of catalytic converters in the transport sector will considerably reduce NOx emissions, but considerably increase N_2O emissions.

N_2O decomposition by 1999 or earlier. These measures will reduce N_2O emissions from adipic acid production to 10 Gg as of 1999.

The other N_2O emissions reductions will take place in agriculture. In the “with-measures scenario”, the emissions decrease is due to reduced nitrogen inputs into the soil as a result of the Fertiliser Act, which has been in force since 1996. It would also be the result of a general trend, which has been continuing for some time, toward decreased fertiliser use. As a result of these factors, direct and indirect N_2O emissions in agriculture would decrease by 13 kt/a by the year 2005.

To a first approximation, trends in energy-related N_2O emissions would be similar to those for CO_2 emissions. Exceptions would occur in fluidised-bed firing installations and in the motor-vehicle sector.

In the transport sector, a slight increase of N_2O emissions is expected. On the one hand, the percentage of vehicles equipped with catalytic converters has been increasing since the 1980s / early 1990s; this trend would lead to increased N_2O emissions by the year 1998. On the other hand, the increases in total mileage covered by diesel trucks will slightly increase N_2O emissions: by about 2 kt. The use of new catalytic converters with lower N_2O emissions (especially) in engines’ cold-run phases, as compared to 1st generation catalytic converters, will somewhat more than compensate for N_2O emissions increases due to increased traffic on the roads.

Fluidised-bed firing installations, which currently account for less than 3 % of all firing institutions, will become more common by the year 2000, after which new commissioning is expected to level off. Since mitigation measures in this area will hardly be possible, a slight increase of emissions must be expected until the year 2000.

Tables 6.3.3.1 and 6.3.3.2 numerically summarise the above explanations.

The assumptions and data have been taken from the research project “Policy scenarios for climate protection” (FhG-ISI and Öko-Institut).

6.3.4 Perfluorocarbons (PFC)

As the emissions inventories (Chapter 4.4.4) indicate, the main sources of PFC emissions are as follows:

– Primary aluminium production (CF_4, C_2F_6)

– Semiconductor industry (CF_4, C_2F_6)

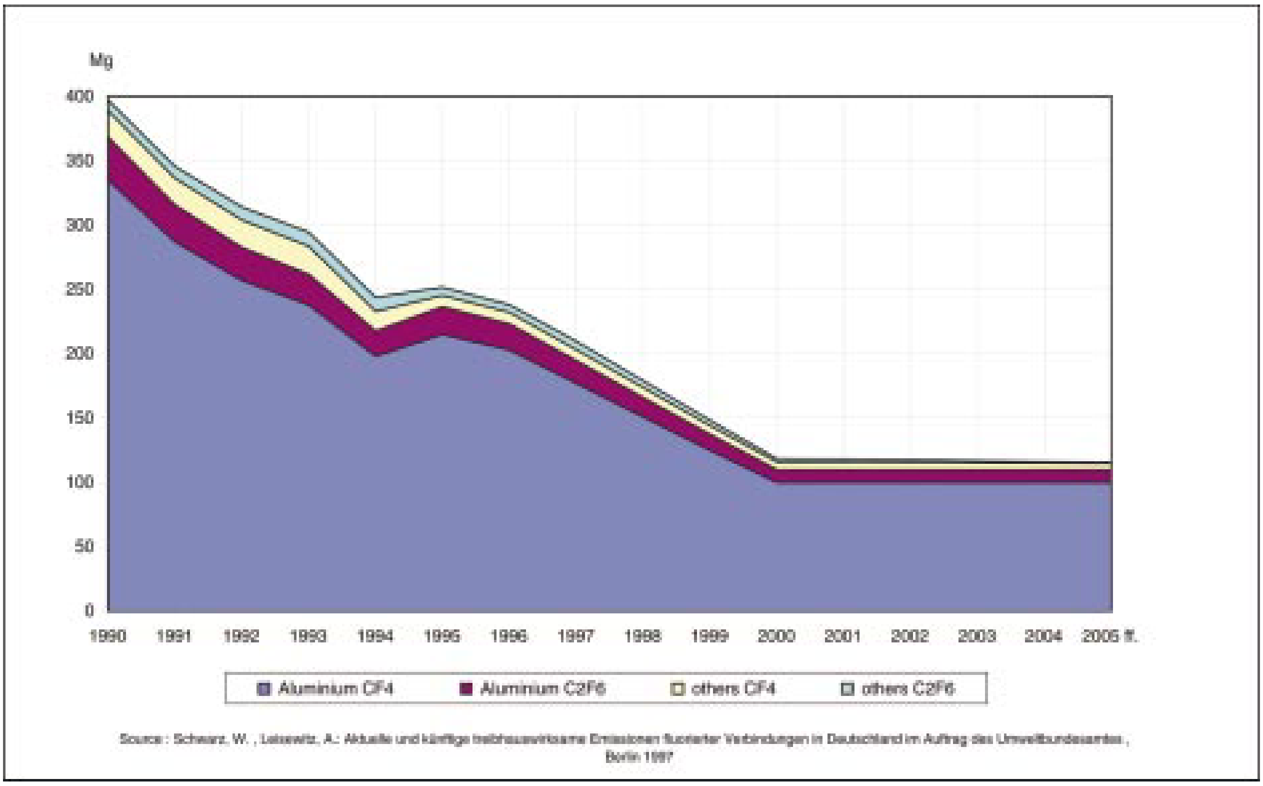
– Circuit-board production (CF_4)

– CFC manufacture (discontinued in April 1994; since then, this emissions source no longer exists).

Over 90 % of PFC emissions are generated in aluminium production. From 1990 to 1996, emissions in this area of CF_4 decreased from 335 Mg/a to 198 Mg/a; emissions of C_2F_6 decreased from 34 Mg/a to 20 Mg/a. These reductions have been brought about by both technological improvements and capacity reductions. (The specific emissions coefficient was reduced during the same period from 0.45 kg CF_4/Mg Al to 0.34 kg CF_4/Mg Al.)

In 1995, the German primary aluminium industry issued a voluntary declaration in which it made a commitment to reduce its PFC emissions by 50 %, based on the level in 1987, by the year 2005. As a result, the projection for PFC emissions assumes that the modernisation process in the aluminium smelters continues. Under the conditions that by the year 2000 point-dosage technology, which is currently the best-available furnace technology, has been introduced wherever it currently seems affordable; that this technology is used optimally; and that production is simultaneously sta-

Fig. 6.3.4.1: PFC emissions, by uses, in Mg (1990–2005)



Tab. 6.3.4.1: Total emissions of PFC (CF_4 and C_2F_6) in Mg/a

	1990	1995	2000	2005	2010	2020
CF_4	355	218	106	105	105	105
C_2F_6	42	27	12	11	11	11

bilised at the current level, estimates beginning in the year 2000 are that emissions will be 100 Mg/a for CF_4 and 10 Mg/a for C_2F_6.

Since modernisation potential for aluminium smelters will largely be exhausted by the year 2000, PFC emissions from this sector can be expected to stabilise at the level they reach by that year.

The scenario for the semiconductor industry is based on the assumption that use of PFC as etching gases will increase from 20 Mg/a to 55 Mg/a from 1990 to the year 2005. Assuming that the percentage of production systems that are equipped with exhaust-gas scrubbing systems increases from its current level of 50 % to 90 % (2000) and 99 % (by 2005), and that such systems have scrubbing efficiencies of 98 % (C_2F_6) and 95 % (CF_4), PFC emissions during the same period would decrease from 15 Mg/a to a marginal level of 2 Mg/a.

6.3.5 Hydrofluorocarbons (HFC)

Hydrofluorocarbons have been used since the early 1990s as chlorine-free substitutes for CFC. Currently, the main emissions sources are

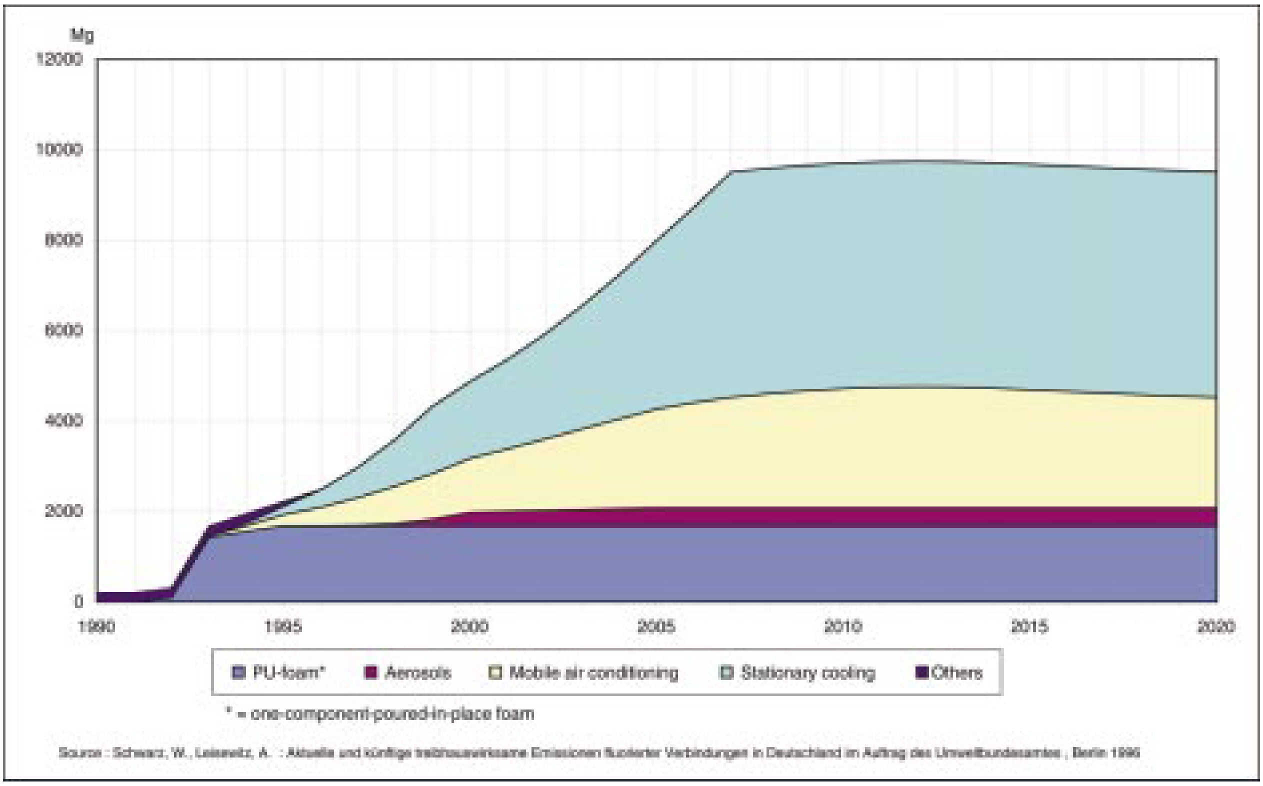
- Refrigerants for stationary uses (HFC 134a or mixtures of HFC 32, HFC 125, HFC 143a)
- Refrigerants for mobile uses (mainly HFC 134a)
- Polyurethane (PU) insulating foam (HFC 134a, HFC 152a)
- Asthma sprays (HFC 134a, HFC 227 in the test phase).

The "without-measures" scenario assumes that that HFC would completely and exclusively replace all CFC. Between 1990 and 2007, if a complete transition to HFC were made, in all four areas, total emissions would increase by almost 50-fold - from 200 Mg to 9500 Mg annually. Then they would tend to stabilise at that level (cf. Fig. 6.3.5.1).

In 1993, HFC (at first, HFC 134a, then also HFC 152a) succeeded CFC as propellants for PU insulating foam in spray cans. Since that time, annual emissions from this source have ranged between 1,500 and 1,700 Mg – the average is 1,680 Mg. By 1999, foam propellants, whose emissions remain constant (50 % HFC 134a and 50 % HFC 152a), will account for over half of total emissions.

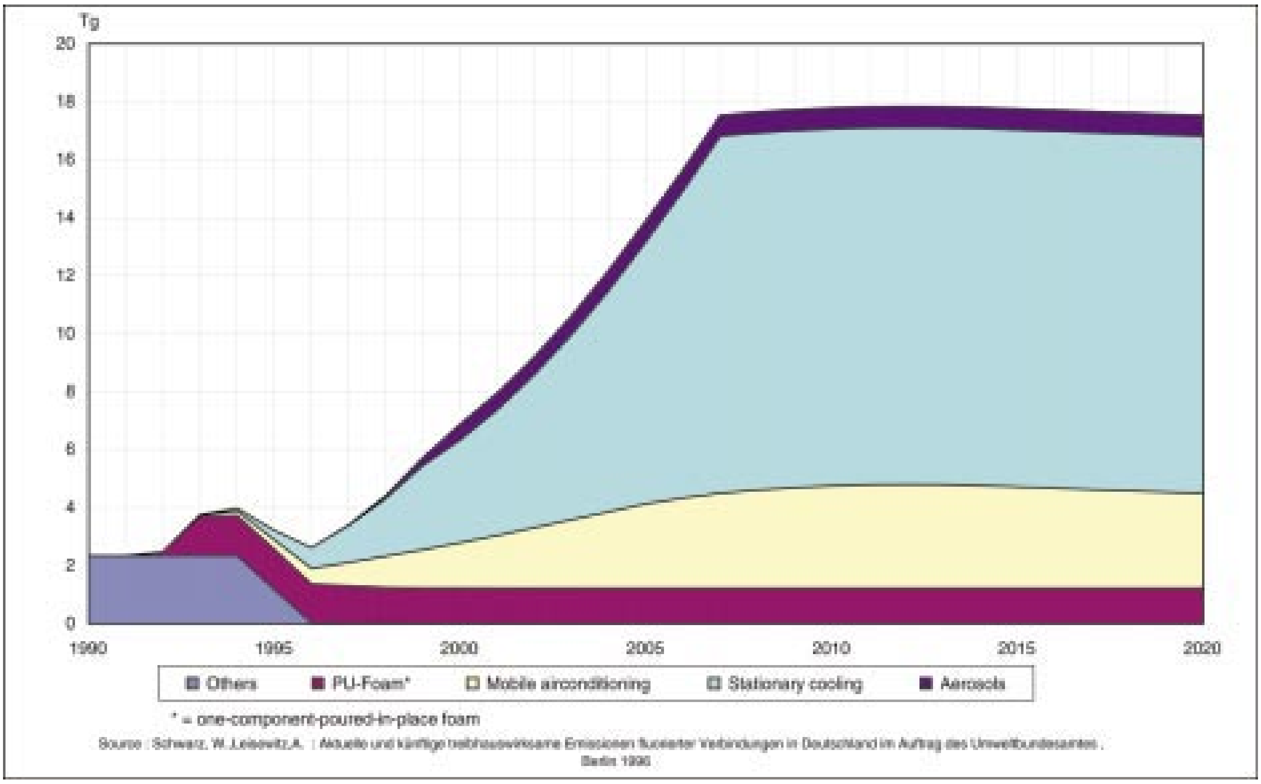
By the year 2000, the area of stationary refrigeration systems will be the largest single emitter. Emissions from stationary commercial and industrial refrigeration systems, and from building air conditioning systems, consist mostly

Fig. 6.3.5.1: HFC emissions by uses, in Mg: "without-measures scenario", 1990–2020



of HFC mixtures that replace H-CFC 22. They would reach their long-term maximum by 2007, at 4,982 Mg. By this time, this source will account for over half of total emissions.

Fig. 6.3.5.2: HFC emissions by uses, in Tg CO_2 equivalents: "without-measures scenario", 1990–2020



In the area of mobile systems, over 90 % of emissions come from automobile air conditioners. The amount of refrigerants in this area is expected to grow, because the percentage of vehicles with air conditioners is expected to increase from 7 % (1996) to 50 %. By the time this percentage is reached, in the year 2012, emissions from automobile air conditioners will have reached their maximum level of 2 400 Mg. Thereafter, emissions from this source will decrease slightly, because the fill volumes in automobile air conditioners will be reduced.

Tab. 6.3.5.1:Total emissions of HFC in Mg/a

	1990	1995	2000	2005	2010	2020
HFC	200	2 214	4 874	7 991	9 699	9 504

Most asthma sprays will not contain HFC instead of CFC until the year 2000. Since the emissions from this area are currently 400 Mg CFC, a similar amount of HFC emissions can be expected if complete substitution occurs.

6.3.6 Sulphur hexafluoride (SF_6)

As described in the emissions inventories in Chapter 4, the main sources of SF_6 emissions are as follows:

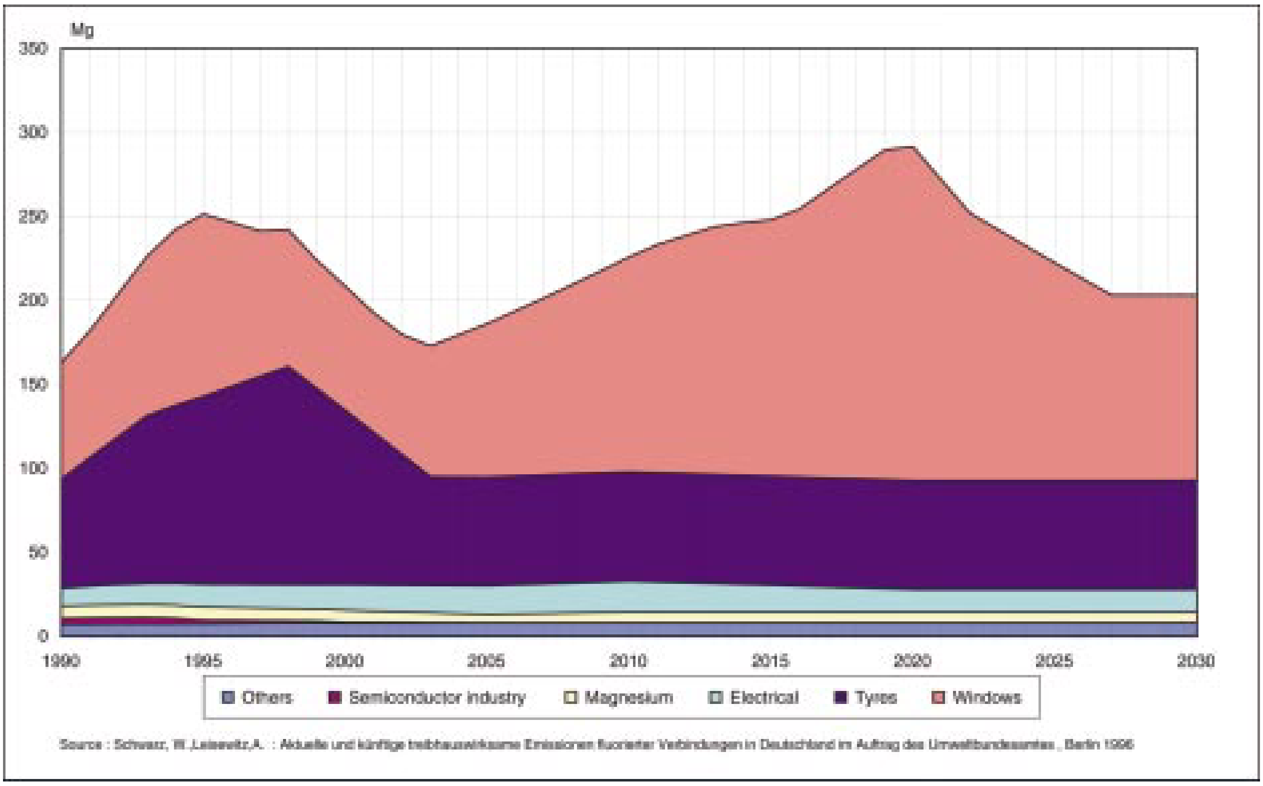
- Soundproof windows;
- Automobile tyres;
- Equipment used in the electrical power sector (especially switching systems);
- Magnesium foundries;
- Semiconductor production.

Trends in total SF_6 emissions are influenced primarily by developments in the areas of soundproof windows and automobile tyres. Unless additional measures are taken, SF_6 emissions will begin increasing again after the turn of the century (following a temporary downturn) and reach their maximum of nearly 300 Mg SF_6 in the year 2020.

The scenario for the area of soundproof windows (for sources, cf. the end of this Chapter 6.3.6) is based on the assumption that, following the entry into force of the Heat Insulation Ordinance in 1996, consumption of SF_6 fill gas (which provides only acoustic insulation) in insulating windows will be drastically reduced. To meet thermal insulation requirements, fill gas must contain higher percentages of argon (up to 70 %). The resulting decrease of filling emissions will be more than cancelled out by new disposal emissions after the year 2000, when removal of soundproof windows begins. Such windows have been installed since 1975 and can become ineffective within 20–30 years. Emissions from soundproof windows will reach a maximum in the year 2020 of nearly 200 Mg SF_6, of which disposal emissions will contribute over 70 %.

The scenario for the area of automobile tyres is based on a 50 % reduction of consumption in the next five years and a subsequent stabilisation of consumption. The SF_6 used as a

Fig. 6.3.6.1: SF_6 emissions by uses, in Mg, 1990–2030



tyre fill gas escapes completely into the atmosphere when tyres are replaced, which becomes necessary within an average of three years of service. Emissions from automobile tyres are expected to reach a maximum of 130 Mg SF_6 in 1998 and then decrease to 65 Mg SF_6 by the year 2003. Unless a stop to this use of SF_6, which is controversial, puts an end to these emissions, emissions from tyres will remain at 65 Mg per year.

Tab. 6.3.6.1: Total emissions of SF_6 in Mg/a

	1990	1995	2000	2005	2010	2020
SF_6	163	251	208	186	226	292

The scenario for the area of electrical equipment assumes that SF_6 in equipment would be reprocessed and re-used when equipment filled with SF_6 is taken out of service (cf. also Table 5.2.7). Under this assumption (avoidance of disposal emissions through re-use of SF_6 gas), emissions from this source would remain at a low level.

In the long term, emissions from magnesium foundries and other uses will remain at less than 14 tonnes (about 5–7% of total emissions). The semiconductor industry's efforts in this connection are worthy of special mention: exhaust gas systems will almost completely eliminate this sector's SF_6 emissions by the year 2000.

6.3.7 Carbon monoxide (CO)

The transport sector is the main source of carbon monoxide emissions; the next largest sources are the residential and institutional sectors. As a result, mitigation measures are aimed at mobile and stationary combustion.

Tab. 6.3.7.1: Projection of CO emissions (Gg)

Year	1990	2005
Power stations/ district heating stations	130	100
Other transformation sector and manufacturing	870	700
Residential and institutional	2300	800
Transport	6750	3250
Non-energy-related emissions	710	510
Total (rounded off)	10700	5400

The estimates of future CO emissions until the year 2005 have been taken from the 3rd report of the "CO_2 reduction" Interministerial Working Group.

Emissions from stationary combustion systems have been greatly reduced, and are being further reduced, by the Ordinance on Large Firing Installations *(TA-Luft)* of 27 February 1984, the Ordinance on Incineration Systems for Waste and Similar Combustible Substances *(Verordnung über Verbrennungsanlagen für Abfälle und ähnliche brennbare Stoffe)* of 23 November 1990 and the Ordinance on Small Firing Installations.

CO emissions in the transport sector will be reduced through phased tightening of the standards for nitrogen oxide emissions (EC Directives 91/41/EEC, 91/542/EEC).

CO emissions are expected to decrease by over 50% in the transport sector, and by 65% in the residential and institutional sectors, by the year 2005 (on the basis of the 1990 emissions levels). The non-energy-related CO emissions are very low (5%). A slight reduction is expected to occur in this area as a result of measures in the iron and steel industry.

6.3.8 Nitrogen oxides (NOx, not including N_2O)

The largest share of nitrogen oxide (NOx) emissions is produced in the transport and power station/district heating station sectors.

The estimates of future emissions are based on the same regulations mentioned above in connection with reduction of CO emissions.

The energy-related NOx emissions could decrease by about 20% by the year 2005.

Tab. 6.3.8.1: Projection of NOx emissions (Gg)

Year	1990	2005
Power stations/ district heating stations	590	370
Other transformation sector and manufacturing	35	250
Residential and institutional	180	100
Transport	1500	1430
Extraction and distribution of fossil fuels	2	2
Non-energy-related emissions	34	16
Total (rounded off)	2640	2130

6.3.9 Non-methane volatile organic compounds (NMVOC)

Over 50% of NMVOC emissions are produced through use of solvents. An additional 35% are emitted from mobile sources in the transport sector. On the other hand, stationary combustion processes account for only about 4% of total emissions. The remaining 10% are produced by various industrial processes and by extraction and distribution of fuels.

The following table shows the parameter trends used to develop the scenarios. In many areas, especially the industrial processes, no suitable parameters are available for differentiated extrapolation; for this reason, the main focus for development of the emissions scenarios was placed on petrol distribution and solvent use.

Tab. 6.3.9.1: Parameter trends for selected processes (1990 = 100%)

	1990	2005	2020
Petrol distribution	100 %	102 %	77 %
Industrial processes			
refineries	100 %	110 %	99 %
steel-rolling mills	100 %	120 %	149 %
iron, steel and malleable casting	100 %	72 %	64 %
hard coal coking	100 %	93 %	86 %
production of bituminous mixtures	100 %	100 %	100 %
production of organic products	100 %	100 %	100 %
bread production	100 %	166 %	197 %
beer brewing	100 %	166 %	197 %
wine making	100 %	166 %	197 %
sugar production	100 %	119 %	100 %
particle-board production	100 %	100 %	100 %
Solvent use			
painting	100%	100%	100%
degreasing, dry cleaning	100%	100%	100%
manufacture and use of chemical products	100%	100%	100%
other solvent use	100%	100%	100%
CFC	100%	0 %	0%
HALONs	100%	0%	0%

Source: estimates of the ÖKO-Institut, IKARUS-Model, PROGNOS AG 1995

In the “without-measures scenario”, solvent-use emissions in the area of painting follow the production indexes in the 5 industrial sectors that are the main sources of emissions: engineering, electrical industry, truck and automobile manufacturing, iron, sheet metal and metal products and the wood-working industry. For the area of petrol distribution, it is assumed that current specific emissions levels will not change in the coming years.

For the “with-measures scenario”, trend predictions for solvent emissions consider the implementation of legal regulations *(TA Luft;* 2nd Ordinance for the Implementation of the Federal Immission Control Act – Ordinance on the Limitation of Emissions of Highly Volatile Halogenated Hydrocarbons), the effects of labelling low-solvent products with the RAL-UZ 12a environmental mark and the effects of the TGRS 610 technical regulations for hazardous substances. Trends regarding petrol distribution have taken account of estimates of the effects of the ordinances on the limitation of hydrocarbon emissions during refilling and storage of carburettor fuels and during filling of motor vehicles (20th and 21st Ordinances for the Implementation of the Federal Immission Control Act).

In addition, the quantifiable effects estimates for the areas of painting and distribution of carburettor fuels were used to calculate back to the without-measures scenario, which is listed in the Table for comparison.

The prediction indicates that process-related NMVOC emissions would decrease by about 30% between 1990 and 2005, and the two largest source areas would make the largest contributions to the total emissions reductions.

Already implemented measures in the area of solvent use would contribute emissions reductions of about 300 Gg NMVOC in the year 2005.

Tab. 6.3.9.2: Development of process-related NMVOC emissions in the “with-measures scenario” and in the “without-measures scenario”

	1990	2005	2020
	millions of t of NMVOC		
CFC and halons	0,04	0	0
Solvent use	1,2	0,9	0,9
Industrial processes	0,2	0,1	0,1
Extraction and distribution of fuels	0,2	0,04	0,03
Total	1,6	1,1	1,1
For comparison: without-measures scenario			
Total	1,6	1,4	1,4

Source: calculations of the Öko-Institut

6.3.10 Sulphur dioxide (SO_2)

The trends in SO_2 emissions were predicted on the basis of the SO_2 Protocol to the 1979 Convention on Extensive, Cross-border Air Pollution. On this basis, SO_2 emissions are expected to decrease, by the year 2005, by an amount corresponding to 81% of the emissions in 1990. Most of this reduction would be achieved through the Ordinance on Large Firing Installations and through fuel conversions (with-measures case).

Tab. 6.3.10.1: SO_2 emissions (Gg) by the year 2005 (with-measures case)

Year	1980	1990	2000	2005
SO_2	7500	5 326	1 300	990

6.4 Summary of the scenarios and projections and discussion of the expected development of greenhouse gas emissions until 2000, 2005, 2010, 2020

6.4.1 Carbon dioxide (CO_2)

The CO_2-reduction measures approved as of 1996 are expected to reduce CO_2 emissions (Tab. 6.4.1.1) by 14.5% by the year 2005 and by 16.2% by the year 2020 (based on the 1990 level). The largest contribution to these reductions will be made by industry, which will register reductions of 37% by the year 2005 and 36% by the year 2020 (based on the 1990 level). On the other hand, the transport sector is expected to show CO_2 emissions increases of 25% by the year 2005 and of 18% by the year 2020 (based on the 1990 level). The measures that will made the largest contributions to the CO_2 reductions include German industry's voluntary commitment (measures no. 110, Chap. 5); the Heat Insulation Ordinance (29); the Heating Installation Ordinance (30); housing modernisation programmes in the new Federal Länder (33); increases in the mineral-oil tax (14); the Act on the Sale of Electricity to the Grid (3); and various measures to reduce demand for electricity, primarily in the residential sector.

6.4.2 Methane CH_4

The largest reductions in methane emissions can be achieved by decreasing landfill gas emissions, increasing use of the pit gas produced in hard coal mining, extensively modernising pipeline networks for natural gas distribution and by using the "biogas" generated in animal husbandry more effectively.

Implementation of the Technical Instructions on Waste From Human Settlements *(TA Siedlungsabfall)* and of the Technical Instructions on Waste Management *(TA Abfall)*, which prescribe mitigation measures for new landfills, mandate clean-ups for existing landfills and set forth mandatory "quality parameters" (establish content standards for a range of substances, including carbon) for deposited waste, is expected to greatly reduce landfill gas emissions: by over 90% by the year 2020.

A large decrease of methane emissions is also expected in the area of coal mining, because coal extraction for the public power supply will be considerably decreased by the year 2005 and because recovery of the pit gas produced in mining is being intensified.

Other reductions will result from accelerated modernisation of natural gas distribution networks and through increased use of the "biogas" produced in animal husbandry.

As a result ("with-measures scenario"), emissions are expected to decrease by over 45% by the year 2005, and by over 55% by the year 2020 – to less than 2.5 million t of methane (in comparison with the 1990 level).

Tab. 6.4.1.1: Summary of projections of anthropogenic CO_2 emissions (with measures) (in Gg)

	1990	1995	2000[1)]	2005[1)]	2010[2)]	2020[2)]
Energy and transform. industries	439000	373000	368000	365000	364000	367000
Industry	170000	127000	117000	107000	107000	109000
Transport	159000	171000	197000	198000	194000	187000
Other combustion-related emissions[3)]	219000	199000	186000	171000	164000	159000
Other emissions (Industrial processes)	28000	25000	26000	25000	25000	25000
Total emissions (not incl. internat. transport)	1014000	894000	894000	867000	854000	847000

[1)] R+D-project "Policy Scenarios for Climate Protection" (1997)
[2)] Trend extrapolation in keeping with 1st National Report for FCCC
[3)] Including emissions reductions from use of renewables energies (not sectorally allocated).

Tab. 6.4.2.1: Summary of anthropogenic CH_4-emissions projections (with measures) (in Gg)

	1990	1995	2000	2005	2010	2015	2020
other processes	312	228	142	135	128	120	112
gas extraction and transport	327	323	265	208	150	142	134
coal mining	1222	783	686	544	543	541	540
landfills	1777	1777	1125	464	307	207	140
animal husbandry	2044	1677	1674	1653	1631	1608	1579
Total emissions	**5682**	**4788**	**3892**	**3004**	**2759**	**2618**	**2505**
bodies of water[*)]	318	318	318	318	318	318	318

[*)] Only partly anthropogenic; the anthropogenic contribution cannot be quantified.

6.4.3 Nitrous oxide (N_2O)

Overall, N_2O emissions in Germany could fall by about 28% by the year 2000, and by about 31% by the year 2020 (on the basis of the 1990 emissions level).

The greatest potential reductions have been achieved through conversions in adipic acid production. Slight increases in N_2O emissions are expected in the transport sector, resulting from introduction of catalytic converters and from increases in traffic; the approved measures will not suffice to return emissions to the 1990 level.

In agriculture, consistent application of the above-discussed measures could reduce emissions by a further 7% by the year 2020.

Tab. 6.4.3.1: Summary of anthropogenic N_2O emissions projections (with measures) (in Gg)

	1990	1995	2000	2005	2010	2020
Transport	11	21	22	21	21	22
Other energy sources	26	25	23	22	22	22
Industrial processes	83	70	23	23	23	23
Agriculture	64	56	56	55	54	53
Groundwater/surface water (agriculture)	32	28	28	28	27	27
Other	10	10	10	10	10	10
Total emissions	**226**	**210**	**162**	**159**	**157**	**156**

7. Expected impacts of climate change and risk assessment

Germany is located in a temperate climate zone. While its climate exhibits a transition from strong Atlantic climatic influence to continental influence; the prevailing influence is exerted by currents above and in the Atlantic ("Azores" high-pressure systems, "Iceland" low-pressure systems, the Gulf Stream), which ensure that on the average Germany's climate remains temperate. Predictions of a global mean temperature increase, obtained using the Global Circulation Model (GCM), currently are unable to provide any reliable information as to how this temperature increase will affect Germany's various climatic regions. Estimates of the impacts of a possible change in regional climate, therefore, must be based on plausible scenarios and on intensive analysis of observed extreme events. For purposes of predicting impacts of climate change, such weather patterns (unusually long hot, dry summers and harsh winters) – which occur, for example, when prevailing currents change (stable high-pressure system over northern/north-eastern Europe) – can thus be considered, along with their impacts, as representative, realistic scenarios for possible climate change.

In Germany, research into the impacts of climate change has focused in recent years on climate-sensitive regions (the coast, mountains) and on ecologically and economically sensitive areas (agriculture and silviculture, hydrology of groundwater and inland bodies of water). During the growing season, natural and agricultural plants need an even distribution of precipitation to meet their evapo-transpiration requirements. Seasonal shifts of precipitation, or unusually intense or long dry periods, could cause significant changes in plant cover in affected regions of Germany. Lacks of precipitation during main vegetation periods could reduce harvests and cause ecological damage in forests and in wetlands.

Coastal regions

All predictions indicate that coastal regions, among the globe's natural areas and habitats, will be particularly strongly affected by climatically caused changes. For this reason, the IPCC Subgroup on Coastal Zones and Small Islands has been focusing especially on threats to these regions, in an international context. On a national level and in the medium term, studies in the research programme "Climate change and the coast" *(Klimaänderung und Küste)* will provide analyses, evaluations and action strategies for the German North Sea and Baltic Sea coastal areas with respect to possible impacts of climate change.

In spite of their biological and geological diversity, and their diversity of settlement and land-use structures, Germany's coastal regions would all have similar functions and, ultimately, similar vulnerability in the face of climate changes. Important functions that will be affected by climate changes – to an extent that remains to be clarified – include ecologically significant roles in moderating exchanges of substances and energy between the land and the sea, in regulating food networks and cycles of nutrients and pollutants and in protecting biodiversity. In addition, uses would be threatened – such as production of drinking water and raw materials, food production, settlement, industrial production and tourism.

Consequently, German coastal regions, seen in an international comparison, do not differ from other coastal regions in terms of the nature of the threat involved. For this reason, the following IPCC assessment is also valid for German coastal areas: that stresses and threats for coastal zones, as caused by climate change, will further reduce the functional stability of these zones in the coming years. According to the IPCC's relevant proposal, the functions of the coastal zones must be safeguarded in order to prevent serious impairments of the ecological and economic sustainability, and available resources, of these regions.

Apart from such qualitative statements regarding the threat to the coastal regions, few preliminary results are available that could quantify the possible extent of changes in German coastal regions. Among the input values that could be used for further studies are sea-level increases observed to date and the IPCC's predictions concerning global sea-level trends. On the North Sea Coast, a long-term (so-called secular) rate of increase of 20–30 cm/100 years has been registered; on the Baltic Sea Coast, the secular rate of increase is 15–20 cm/100 years. These figures include regionally differing, glacially-caused sinking trends (on the average, 5 cm/100 years), which must be added to the climatically caused effects. According to the IPCC's current estimates, the global rate at which sea levels rise (currently, 12–15 cm/100 years) will triple or quadruple by the year 2100. This would result in a rise of some 50 cm by that year, according to the best available estimates; the overall range would be 15–95 cm, with values in each case depending on the scenario chosen. The increased rate of rising would be due primarily to thermally caused vertical expansion of the water (the "water column"). Taking into account that this effect would be relatively more pronounced in shallow coastal seas such as the North Sea and Baltic Sea, and since the above-mentioned geological effects would continue to occur, a relative sea-level rise of 50–60 cm can be estimated for the German coastal areas.

This estimate does not take account of other expected changes. The most important of these would be changes in the frequency and intensity of extreme events in coastal areas, especially storms and storm floods. In the final analysis, the maximum water levels occurring during extreme weather conditions, rather than the average sea-level rise, are what threaten coastal inhabitants and assets and provide the basis for structures and investments for coastal protection. It is a documented fact that maximum water levels on the North Sea Coast have risen significantly in the last three decades (since the 1962 "flood of the century", which has been used as a basis for planning coastal protection). The storm-flood levels of 1976 and 1981 were each higher (up to 50 cm higher) than the so-called "standard water level" *(Bemessungswasserstand)* of 1962. In the Ems estuary, the storm flood of January 1994 was the highest ever recorded. And as to frequency, an increase of less-serious storm floods in North Sea and Baltic Sea areas has been statistically proven; significant trends can not yet be derived for medium and serious storm floods (in part, due to a lack of sufficiently long data sequences). In light of the expected accelerated rate of sea-level rise, and of changes in extreme events, a potential threat must be expected – a threat reinforced through coastal erosion. For example, since about 1950 a 30–50 % increase of erosion on beaches and steep banks has been measured on the Baltic Sea Coast, calculated as a long-term average (cm/y of the water's movement inland). In addition, changes in species composition and bioproductivity must be expected in coastal ecosystems, as a consequence of these and other influences (precipitation and temperature patterns, tidal lifting etc.).

In 1993, in order to estimate the maximum possible impacts of climate change, the Federal Ministry of Education, Science, Research and Technology (BMBF) initiated a research project that focused especially on northern German coastal areas, within the framework of a world-wide IPCC comparative study (1992–1996) of possible impacts on coastal regions. The results of this study are summarised in Table 7.1, using a standard IPCC scenario (1m sea level rise by the year 2100[3)]). The study ignores the fact that regionalisation of these global IPCC figures – for example, with respect to Germany – has not yet been possible. The study shows that the consequences of such a scenario would be more serious that what is generally assumed, in terms of possible impacts on land, population and assets, although the five German coastal *Länder* would each face a different level of risk. Even under the assumption that extensive coastal protection could be installed that would keep the actual threats from reaching the magnitude of those described by the study, the calculations still point to major economic and ecological effects. For example, on the North Sea coast, 50 % or more of outer diked areas (salt marshes and wadden areas) could be lost in the long term. The costs of raising and reinforcing dikes, and of the additional technical measures that could be required for drainage of land behind dikes, would be expected, so the study, to reach double the costs assumed to date (250 million DM/y[4)]). The possible ecological and economic consequences thus would seem to justify rapidly initiating steps in behalf of 'integrated coastal zone management'.

Mountain regions

Germany has a number of central mountain ranges; in its extreme south, it is touched by the northern edge of the Alps. These mountain regions contain a majority of the natural and semi-natural ecosystems in Germany that are still intact. Many of these ecosystems are extremely sensitive; all tend to be particularly vulnerable to climate changes.

On the ridges of the central mountains, and in the higher reaches of the German Alps, ecological stresses of recent years have already impaired the stability and biodiversity of ecosystems and caused damage. Of particular significance in this connection are pollutant discharges from the air in the form of precipitation and/or dry deposition. The stresses that would accompany possible climate change justify the expectation that the ecological and economic functionality of these areas would suffer further extensive negative impacts.

Ecological stresses would be caused in Alpine regions especially by temperature increases, which would tend to move the existing elevation ranges of the various vegetation types to higher elevations. If the speed at which this occurs, due to rapid climate shifts, is greater than species-specific (but low) migration speeds, lasting ecological instabilities, tendencies toward lower biodiversity and threats to certain species could result. Such instabilities would be intensified by changes in precipitation distribution, in conjunction with increasing evapo-transpiration in summer.

Lasting ecological instabilities for forest ecosystems in Alpine areas would go hand-in-hand with increasing soil erosion and avalanche frequency. Negative economic consequences would result for communities that depend economically on winter sports, because temperature increases would occur especially in winter; hydropower stations would also suffer economically from reduced spring runoff. In addition, higher temperatures would increase thawing of permafrost areas, thereby creating a considerable threat for the communities and cities situated below these areas.

Since the climate signals would be especially apparent in mountain regions, these regions would suffer major ecological and economic consequences.

Agrarian ecosystems

Agrarian ecosystems are used intensively in Germany as sources of raw materials and income. They have dynamic balances that are maintained artificially by means of substance inputs, and they have human-controlled, short nutrient cycles. Another significant feature of agrarian ecosystems is their relatively low biodiversity; they often have only one anthropogenically established crop, instead of veg-

[3)] At the time the global IPCC comparative study was commissioned, the following figures were being used for the rises in sea levels: maximum assumption – 110 cm, best assumption – 66 cm, minimum assumption – 30 cm. The current figures used for comparative studies, according to the most recent IPCC report, are: maximum assumption – 95 cm, best assumption – 49 cm, minimum assumption – 15 cm. The reasons for selection of the 1m secenario were 1) the availability of cartographic and geodetic data, since no cartographic images have elevation resolutions finer than 1 m and 2) researchers wished to explore the upper limit of the possible damage, to ensure that investments in prevention and adaption would not exceed what is absolutely required. In addition, the best assumption in now considered the most likely scenario.

[4)] The DM figures are based on conservative estimates from the general coastal plans. Other figures for the ecological and economic impact are based on research findings that were presented at the workshop "Climate change and the Coast" *(Klimaänderung und Küste)* – which was held in May 1996 in Oldenburg – and which appeared in "Beiträge zur Küstenforschung" ("Contribution to current coastal research"), which was published as vol. 18 in the series "Vechtaer Studien zur angewandten Geographie- und Regionalwissenschaft". ed. Sterr, H. and Preu, C.)

Tab. 7.1: Possible impact on the German coast in a scenario in which the sea level rises 1 m (IPCC standard scenario for global study to compare the possible impacts on the world's coastal regions, 1992–1996)

	Lower Saxony	Bremen	Hamburg	Schleswig-Holstein	Mecklenburg-West Pomerania	Germany Total	
Length of coastline (km)	880 (23,8%)	55 (1,5%)	60 (1,5%)	995 (26,9%)	1710 (46,2%)	3700	100%
Total area (km^2)	47 430	404	755	15650	23400	87640	23,4%
Affected area (km^2) a) up to +10 m NN	10050 (21%)	360 (90%)	220 (30%)	5060 (32%)	–	16950	4,75%
b) up to +5 m NN	7130 (15%)	300 (80%)	150 (20%)	4090 (26%)	2220 (9,5%)	13900	3,9%
Affected population	1,3 Mio (17%)	615000 (90%)	180000 (11%)	648000 (24%)	370400 (10%)	3,12 Mio	4%
Endangered population (1995)[1)]	13050	6100	1800	4400	1250	1625	0,03%
Endangered population in 2100: a) without measures	130500	61500	18000	43500	3700	257000	0,32%
b) with measures	1400	7000	2060	5000	2000	30000	0,04%
Potential loss of assets: a) maximum (billions of DM)	293,3 (16%)	170 (90%)	75,4 (16%)	168,7 (24%)	87,5 (10%)	795	4%
b) realistic scenarios (billions of DM)	208	141	51	144	80	624	3%
Endangered assets (billions of DM)[1)]	2,9	1,7	0,75	1,7	3,2	10,25	0,05%
Additional impacts (estimated) – increase of drainage area	+ 50%	+ 10%	N.A.	+ 30%	+ 100%	1000–2000 km^2	–
– increase in salt concentration	+ 10%	+ 10%	-	+10%	+ 5%	–	–
Loss of wetlands (wadden areas, salt marshes in km^2) a) without measures	1100 (52%)	–	–	1250 (45%)	- 45 (-20)	ca. 2400	–
b) with measures	1200 (57%)	–	–	1530 (55%)	110 (50%)	–	–
Cost of protecting coastal areas (millions of DM): (current annual cost) total/per year (until 2100)	90 12000/120	N.A. 1000/10	N.A. 2000/20	60 9000/90	50 6000/60	>215 30000/300	

N.A.: No data available   NN: sea level
Source: Scientific article "Die Küstenregionen im 21. Jahrhundert" ("The coastal regions in the 21st century"), Horst Sterr, Frank Simmering; in the series "Vechtaer Studien zur angewandten Geographie- and Regionalwissenschaft", vol. 18, p. 186
1) Affected population and figures multiplied by the probability of flooding

etation that has developed through natural evolution and selection. Regular interventions in agrarian ecosystems, within the framework of agriculture, such as

– Planting/sowing, elimination of undesired trophic sinks (wild plants); maintenance of low biodiversity;

– Fertilisation,

– Irrigation and drainage,

– Regular removal of biomass,

are features of such systems, as well as the factors that determine the systems' most important differences from natural and forest ecosystems. Between 70 and 90 percent of biomass produced in such systems is removed from them through harvesting and other measures. Such systems tend to be used on annual basis; consequently, cumulative effects of environmental impacts, such as climate change, appear in the soil and in the form of soil-based pests. In a first phase, climate changes would tend not to displace the plants typically found within agrarian ecosystems, because such plants have been bred to be more resistant and to have high yields. Nonetheless, changes in physiological processes, with resulting effects on agrarian ecosystems and bordering ecosystems (surface waters and groundwater, atmosphere etc.) would be expected. Only more frequent occurrence of extreme situations (such as possible continentalisation of parts of Central Europe) would bring about major changes - i.e. structural ones. Human management of such ecosystems can override and compensate for impacts of climate and weather. Possible impacts of climate changes would be expected

– in seasonal development of agricultural vegetation (shifts in the growing season and changes in the sequence of phenological stadia), as well as in the frequency and intensity of pest attacks, as a result of temperature changes,

– in substance dynamics and hydrodynamics of crops,

– in yields, and in cost-effectiveness and yield quality.

Studies to date have shown that in Germany the negative effects on plant physiology of reduced precipitation, or of seasonally unfavourable distribution of precipitation, would be greater than the negative effects of changes in typical temperature cycles.

Experience has shown that regionally varying, strong impairments in the agricultural sector occur during prolonged periods of warm/hot-dry weather during the main growing season. The sharply reduced grain harvests in much of northern and north-eastern Germany during the extremely hot and dry summer of 1992 ("north" summer 1992), and subsequent, complex studies of the consequences of that summer's unusual weather patterns, have verified such negative effects. If the frequency of such weather patterns increased, major ecological and economic impacts would have to be expected in the agricultural sector. On the other hand, it is not possible to determine the probability of the occurrence of such weather situations.

Nonetheless, increasing atmospheric CO_2 concentrations can be expected to stimulate photosynthesis, substance binding and yields, with effects varying by crop and other factors (soil quality, weather patterns). Initial, model-based regional estimates for the north-eastern part of Germany have predicted maximum yield increases for winter grains of 20 to 30 % under an assumed doubling of pre-industrial atmospheric CO_2 concentrations (550 ppm as compared to the current level of 350–370 ppm).

Forests

Forests and other natural and semi-natural terrestrial ecosystems (heaths, bogs) tolerate certain climatic fluctuations. Site-adapted forest ecosystems are assumed to have a considerable capacity to adapt to changing external influences. On the other hand, forests, as a result of their longevity and of the slowness of many of the processes that occur in them, are exposed to increased risks from the cumulative effects of different types of damage (for example, pollution inputs) and climate change. For the same reasons, expected or existing damage to these ecosystems could be prevented/limited only to a certain extent.

The ability of existing forests to adapt, especially of forest areas along the ecological boundaries of tree-species distributions, could be overwhelmed by the speed of possible climate changes. This applies especially to all-conifer stands in areas at risk, such as dryer areas of northern and north-eastern Germany. The risk is also greater for forests that have already been damaged by air and soil pollution. Extreme events that could occur more frequently as a result of climate change, such as storms, droughts, forest fires or pest epidemics, could exacerbate the damage in such forests. Complete collapses of ecosystems in extremely polluted and sensitive regions (for example, regions with nutrient-poor soils and insufficient water) could not be ruled out. Such effects could create ecological and economic problems for the silvicultural sector. A particularly serious factor in this context would be the danger that protective forests could be impaired or could lose all of their protective function.

The probable shifting of vegetation zones and elevation strata in mountain regions could threaten biodiversity. Species and subpopulations whose natural speed of migration and spreading could not keep pace with possible rapid climate change would face extinction before they could occupy climatically more favourable new habitats. In mountain regions in particular, populations could become isolated within a few remaining climatically favourable sites, sites between which no further genetic exchanges would be possible, due to climatic and topographical barriers. In Europe, during the transition from ice ages to warmer periods such processes led to losses of species and of genetic diversity. It is thus particularly disquieting that the warming predicted to occur as a consequence of the anthropogenic greenhouse effect could take place at 10 times the speed of the warming following the last ice age.

Hydrology

In general, a temperature increase would intensify the hydrological cycle; this effect could manifest itself in the form of increased rates of evaporation and precipitation. The following conclusions can be drawn on the basis of a simple summing-up of global water-cycle components:

– Run-off rates in river catchment basins react significantly more sensitively to changes in precipitation than to changes in temperature;

– Relative changes in run-off are larger than relative changes in precipitation;

– Run-off in arid and semi-arid regions is particularly sensitive to climate changes.

To date, it has been possible to quantify only some of the regional-level and local-level consequences for Germany. The distribution of individual processes, by area and in time, has a decisive influence on the extent of climate-related hydrological changes in water availability. For example, with precipitation patterns that remain unchanged on the average, but which are more pronounced in their extremes, an increase in the magnitude and frequency of flooding events can be expected. Since the interrelationship between precipitation and water run-off is highly non-linear, changes in precipitation could result in disproportionately significant relative changes in run-off.

As a rule, conclusions regarding changes of ***flooding behaviour*** can be generalised only to a limited extent, since river catchment basins are highly non-linear systems that are subject to strong natural variability, by area and in time, of driving forces and parameters such as topography, soil, vegetation, climate, groundwater conditions and conditions of bodies of water. Therefore, quantitative statements regarding the consequences of possible climate changes on flooding behaviour are subject to great uncertainty.

It is now clear that minor increases in the frequency of extreme weather events involving heavy rainfall and periods of thawing can result in considerably magnified high-water run-off. Increased frequency of weather conditions causing prolonged, heavy rainfall has been observed in Central Europe. The increased frequency of flooding in recent years could be related to this. Effects on the flood regime which might be expected as a result of climate change would be compounded by further anthropogenic interventions such as river widening and straightening and increased construction on natural flood areas.

In addition, during weather patterns in which a very large part of precipitation infiltrates the soil and then evaporates, small precipitation reductions during the main growing season would suffice to greatly reduce regional run-off. Resulting impacts on ***water availability*** could especially affect the drinking water supply, inland shipping, the coolant-water supply and, to an economically less significant extent, energy generation with hydropower. For this reason, useful analyses of water availability should be carried out on regional and local scales, taking the following effects into account:

– Seasonal and long-term variations of run-off sequences,

– Interactions between groundwater and surface waters,

– Possibilities for multiple water use along rivers,

– The balance between water removal and water recharge,

– How important the quality of existing water resources is with regard to usability of resources.

If the average, long-term precipitation decreased (and water requirements continued to increase), as is conceivable, negative effects on water resources management would be expected. At present, such effects of climate change are not yet apparent in Germany. In addition, short-term natural fluctuations in water availability, and other economic and technical factors relative to water availability, have masked any such long-term tendency. Under climate change, negative consequences of prolonged periods of dryness or frost on navigability of inland waterways and coastal waters – impacts seldom seen in the past – would be possible. Such impairments of coastal and inland shipping, if frequent, could have a profound extensive economic impact on this commercial sector. Threats to, or considerable impairment of, supplies to industry and private consumers would not be expected, however; they would be prevented by Germany's existing infrastructure and the resulting versatility of Germany's overall traffic sector.

8. Measures for adaptation

In the climate discussion, the term “adaptation” is used to describe adjustment of ecological and socio-economic systems – as a result of processes, measures and structural changes – to current or projected climate changes.

Anthropogenic climate changes would create considerable additional stress on the many ecological and socio-economic systems that are already under stress due to substance inputs, growing use of resources and non-sustainable management.

The answer to the question of whether climate change such as that predicted by the most recent models represents “dangerous anthropogenic interference with the climate system” pursuant to Article 2 of the Framework Convention on Climate Change, i. e. whether the projected breadth of plausible consequences of such climate change could significantly endanger ecosystems, food production or economic development, thus also depends significantly on the ability of these systems to adapt. For a system’s ability to adapt to and tolerate climate changes defines the threshold beyond which significant damage begins. The most vulnerable systems are those that have the largest sensitivity to climate changes and that have the smallest capability to adapt.

The effectiveness of adaptation strategies, and their cost-effective use, will depend on the availability of financial resources, technology transfer and – on both national and international levels – development attained in the areas of culture, education and training, administration, institutions, law and regulations.

In general, technological progress has tended to improve the adaptation options of managed systems.

In Germany, the development of adaptation strategies and measures began in the area of coastal protection. In this area - for example, in the framework of the integrated project “climate change and the coast” *(Klimaänderung und Küste)* – and especially through case studies, the complex effects of climate changes in coastal areas are being studied and sensitive sectors are being identified. In addition, in the next two to three years, in projects financed by the Federal Government, the consequences of expected climate changes on agricultural production, including the agricultural structures and markets in central and western Europe, and on European forests and silviculture, will be formulated. On the basis of these formulations, strategies will then be developed for efficiently preventing or reducing the possible negative consequences of climate changes.

Global climate change could have considerable, regionally differing consequences on forests. The extent of such impacts cannot yet be predicted with sufficient precision. The tree-species compositions and forest structures that would permit stable and productive forests in the future will be different from those of today. The difficulty is complicated in that tree-species compositions in some current forests must already be considered unsuitable, under today’s environmental conditions, for the areas in which the relevant forests are located. Profound changes in ranges of tree species must be expected. In natural forest communities, shifts of species ranges, changes in floral composition and losses of species must be expected, as a result of changes in conditions governing competition.

In light of the speed with which environmental conditions can change, the ability of forest ecosystems to adapt will probably be overtaxed. In many areas, the water supply could become the limiting factor on forest growth and forest stability. Climate change could result in increased frequency of weather extremes (storms, drought) and of forest damage caused by insects and fungus. As a result, forests’ protective functions could be strongly reduced or even eliminated, at least temporarily.

Development of adaptation strategies in silviculture will require considerable additional research: research on the possible regional patterns of global climate change; on the ability of tree populations and entire forest ecosystems to adapt to change; and, building on this second area, research into the possible future establishment of new forests in central Europe.

Monitoring systems for early detection of the direction and extent of forest change under changing environmental conditions would benefit both silviculture and the society as a whole. Predictions concerning the new natural forest vegetation that would form, and research into such vegetation, can draw on comparisons with forest communities in areas of Europe whose current climatic conditions are similar to those expected for central Europe. Research into the interrelationships between forests, forest structures and landscape water cycles is also extremely timely, for reasons not limited to silviculture.

The model of semi-natural silviculture applied by the Federal Government and the *Länder* is aimed at enhancing the naturalness, vitality and resistance of forests. These efforts include selection of naturally appropriate tree species in rejuvenation and replanting of forests, and forest care focused on tree health and vitality.

Semi-natural, diversely structured, stable forests can be expected to have greater resistance to extremes of weather and to pests, as well as a greater ability to adapt to future climate-related site conditions.

Naturally appropriate (i. e. site-appropriate) selection of tree species must take both substance inputs and possible climate change into account. Development of scenarios for future changes in site conditions can play a useful role in this connection.

On the other hand, the possibilities for silviculture to respond to changes are limited in that the tree-species composition in over half of total forest area, as dictated by current tree ages, will remain practically fixed until the middle of the next century.

For 10 years the Federal Government and the *Länder* have been developing a joint concept for preservation of forest genetic resources. Preservation of forest genetic resources acquires increased significance in light of the threat of climate change. Within the framework of semi-natural silviculture, and by means of special preservation measures in the forest and in forest gene banks, the genetic diversity of economically important, rare and endangered forest tree and shrub species is being preserved for future generations.

In light of the demands that climate change can place on forests' resistance and ability to adapt, prevention of additional anthropogenic stresses on forests must be an important priority. For this reason, reduction of pollutant emissions remains a central, high-priority task in the Federal Government's environmental policy - especially since emissions of air pollutants and greenhouse gases usually go hand-in-hand.

Since 1984, additional silvicultural measures to deal with new forest damage have been supported in the framework of the joint task "Improvement of agricultural structure and of coastal protection" (GAK), with federal and *Länder* funding.

These measures are aimed at reducing the consequences of substance inputs into forest ecosystems. Conversion of non-site-adapted (not naturally appropriate) forests into site-adapted, stable mixed stands is also being promoted in the GAK framework. This effort can be seen as a contribution to improvement of forests' resistance to new, climate-related stress factors.

9. Financial support and technology transfer

9.1 Basic principles and priorities in co-operation with other countries

The Federal Government promotes compliance with the principles established by the Rio Declaration and orients its bilateral and multilateral development co-operation to the aim of implementing Agenda 21.

Environmental and resources protection are among the areas emphasised by German development policy. For years, environmental projects carried out within Germany's bilateral development co-operation have focused on both local and global environmental problems.

The emphasis of climate-oriented development-policy measures is on projects that a) enhance economic vitality, through cost reductions resulting from lower consumption of energy and raw materials, and that b) minimise environmental stresses, especially stresses that pose a threat to climate, through reduction of emissions and waste ("no-regret" or "win-win" measures).

To be effective, environmental and climate-oriented programmes and projects should be integrated within national action programmes or sector strategies wherever possible. Special emphasis should be placed on applying, or building on, sustainable development strategies or other action programmes – for example, programmes to combat desertification and to support nature conservation. Only this approach produces catalyst effects and synergies, along with the political coherence required in developing countries. There is no point in financing the construction of an environmentally compatible power station if energy prices are too low for the station's operations to break even and too low to provide incentives for energy efficiency. For this reason, Germany has introduced criteria for financial co-operation that establish system-based cost-coverage as a requirement for co-financing of power stations in developing countries.

9.2 Bilateral co-operation

9.2.1 Developing countries

The Federal Government, in consultations with governments of developing countries, has prepared a broad spectrum of measures that help prevent climate change and enhance responses to such change. These problem-solving strategies are focused especially on the sectors of energy, traffic and transport, industry, agriculture and silviculture which, pursuant to Article 4.1 c of the Framework Convention on Climate Change, are of special significance in combating climate change. In addition, support is being provided, within the framework of development co-operation, for land-use planning in coastal areas and peripheries of deserts, and for a number of projects in support of waste avoidance, recycling and proper disposal.

In 1994, Germany's contributions to multilateral institutions, within the framework of public development co-operation, amounted to 4,337.4 million DM; in 1995, they totalled 3,884.2 million DM. It is impossible to separate out from this funding those payments that relate directly to the aims of the Framework Convention on Climate Change.

9.2.1.1. Capacity building

Strengthening of local capacities has become a key factor in all sectors offering potential for climate protection. Capacity building aims at enhancing the capabilities of people and their state and private organisations, to enable them to take urgently required measures in the short term, to recognise medium-term and long-term environmental problems in time and, increasingly, to solve these problems with their own resources. These aims are served by a broad range of measures such as know-how transfer; organisational development; and advising, training and education of local experts and managers – for example, advising and training of political and industrial decision-makers in issues of environmental management. A number of supplementary measures, carried out within the framework of financial co-operation, also strengthen personnel and institutional capacities.

Especially important focuses of these participation and process-oriented projects include environmentally oriented management methods, distribution of environmental information, conflict management and the application of market-economic instruments of environmental policy. In addition, know-how is provided, and jointly developed, that supports networking between actors in state and non-state sectors. Environmental and climate problems normally affect a wide range of sectors and have impacts on numerous different parties, with in part conflicting interests. As a result, involved parties must co-operate, balance their interests and manage conflicts among themselves. For example, in the forest sector, all forest users and interest groups must be included in preparing and implementing solutions (example in Table 9.5.1).

Tab. 9.2.1.1: Bilateral financial and technical co-operation with relevance to the aims of the Convention – 1994 (figures in millions of DM)

Recipient country	Measures for reduction of CO_2 emissions							
	Energy	Trans-port	Silvi-culture	Agri-culture	Waste-magement	Industry	Adaptation-measures	Other measures*)
Egypt	15,5			6				
Ethiopia			5,5					
Bangladesh							15	
Benin			12,5					
Bolivia				2,6				
Chile			10					
China (PR)	118,3		20					
Gambia			2,5					
Guatemala			4					
Guinea			20,8					
India			5	35				
Indonesia		1,4						0,4
Cameroon				3				
Columbia				3,1				
Congo			2					
Lesotho			0,5					
Madagascar	2,5		3,5					
Malawi				5				
Morocco	8							
Namibia				5				
Nepal			4					
Nicaragua	3							
Panama				3				
Philippines	10							
Zambia			1					0,3
Senegal	2,1		6,2					
Seychelles			2					
Zimbabwe	1,5							
Tanzania			2	8,3				0,4
Tunisia		22						
Turkey			2,5			10		
Surpa-regional projects			1,5	3				
Uganda				8				
CAR	14		2					
Total	**174,9**	**23,4**	**107,5**	**82**		**10**	**15**	**1,1**

*) For greenhouse-gas inventories, pursuant to Article 4.1 (a)

Tab. 9.2.1.2: Bilateral financial and technical co-operation with relevance to the aims of the Convention – 1995 (figures in millions of DM)

Recipient country	Measures for reduction of CO_2 emissions						Adaptation-measures	Other measures*)
	Energy	Trans-port	Silvi-culture	Agri-culture	Waste-magement	Industry		
Egypt	35							
Armenia	10							
Ethiopia	3			3,5				
Bangladesh			5,5					
Burkina Faso	2,5		3					
China (PR)	71		38					0,7
Costa Rica			4					
Dominican Republic			5,1					
Ecuador			2,2					
Eritrea				4				
Georgia	20							
Ghana			4,5					
Guinea			0,9					
Honduras			3					
India			1					
Indonesia	56,5		1			20		
Int. Mekong Committee			3					
Jordan	1							
Cambodia			5					
Cameroon			2,6					
Kenya			3	3,5				
Columbia			2,2					0,3
Congo			1,5					
Laos			6,5					
Lesotho	1		3					
Madagascar			4,2					
Malawi	20		7,1					
Malaysia			6					
Morocco				10				
Mexico		4						
Mongolia	5							
Niger				9,5				
Pakistan	60							0,4

Recipient country	Measures for reduction of CO_2 emissions						Adaptation-measures	Other measures*)
	Energy	Trans-port	Silvi--culture	Agri-culture	Waste-magement	Industry		
Papua-New Guinea			1					
Paraguay				2,2				
Peru			1	0,1				
Zambia			8					
South Africa				2				
Tanzania			6					
Thailand	6,5							0,4
Turkey	6					1,6		
Supra-regional projects	2,7		10,2	1,4				
Uganda			2,9					
Vietnam			10					
CAR	0,5							
Total	**300,7**	**4,0**	**151,4**	**36,2**		**21,6**		**1,8**

*) For greenhouse gas inventories, pursuant to Article l 4.1 (a)

9.2.1.2 Energy

Developing countries currently account for some 25 percent of total world-wide energy-related greenhouse gas emissions – and their share is increasing. For this reason, the Federal Government, in its co-operation with developing countries, is seeking to slow the increase of energy-related emissions by means of measures that simultaneously promote development. Over 15 percent of funds provided through German bilateral development co-operation are earmarked for improvements in the energy supply. The aims of these efforts include

– Meeting energy requirements in an environmentally compatible way, in order to improve living conditions,

– Assuring appropriate, lasting economic development,

– Strengthening technological capabilities in the energy sector.

Three strategies are being pursued in this regard: increasing energy efficiency, replacing current fuels with fuels that have lower greenhouse gas emissions or with renewable energy sources and reducing energy use. The Federal Government is supporting projects in all three areas.

Energy efficiency improvement includes implementation of cost-effective technical measures for modernisation of power stations (for example, efficiency enhancements) and reduction of losses in energy transmission. Also important are improvements of the efficiency of power companies' organisations and introduction of competition – for example, through privatisation of state enterprises.

Use of renewable energy sources is being promoted especially through the following measures:

– Development, adaptation, promotion and financing of technical installations (systems) that use renewable energy sources, especially hydropower and wind power;
  Use of solar energy (especially by means of photovoltaic and solar collecting systems);
  Use of biomass (especially biogas, and by means of gasification, incineration and carbonisation),

– Establishment and strengthening of local backers in the areas of using, producing, promoting, marketing and maintaining systems.

The Federal Government considers measures in behalf of energy-saving to be particularly important. On the other hand, many developing countries do not yet share this view to a sufficient extent. There is enormous potential for saving energy in industry and private households (for example, stoves of poor population groups and rural inhabitants are often unable to burn any fuel other than firewood).

Shortages of capital, especially in developing countries, are making it increasingly difficult for the public sector to finance the investments necessary to meet growing energy demands. This is especially true in countries whose state energy producers operate uneconomically. The economic health of electricity producers has declined rapidly in Africa: transmission losses and outstanding accounts are increasing, and power companies' profitability is decreasing.

Funds to improve the public supply of commercial fuels in developing countries can be effectively applied only where energy sectors function in accordance with market-economic principles. In many developing countries, investments in the energy sector have been the primary cause of high foreign debt; i.e. they have contributed significantly to the debt crisis. In some countries, up to five percent of the gross domestic product and up to 30 percent of all public investments have gone into the electricity sector – and yet that sector's operations have failed to produce appropriate revenue.

Consequently, energy price structures play a central role in ecologically oriented use of energy. Energy prices must gradually be set in such a manner that revenue covers the total costs of energy provision – including the environmental costs. To ensure that tariffs remain socially compatible, some cross-subsidies of poorer institutional consumers may be permitted, as long as the overall system is able to cover costs. Nuclear power is not supported within the framework of development co-operation (examples in Tables 9.5.2 and 9.5.3).

9.2.1.3 Industry

Other important components of the Federal Government's climate-oriented activities in developing countries are improvement of energy efficiency in industry and the introduction of elements of closed-substance-cycle waste management: provision of new, cleaner process technologies, as well as use of downstream "end-of-pipe" technologies where appropriate.

Energy price structures play a key role in this sector, along with technological improvements. Prices play an effective role in energy-saving, since retrofits and modernisation of installations normally pay off only following revamping of price structures, i.e. following price increases or introduction of cost-covering tariffs. Environmental lines of credit for local development banks are a new instrument that is also being applied; such banks are charged especially with advising small and medium-sized companies in designing environmentally compatible production processes and financially supporting them (example in Table 9.5.4).

9.2.1.4 Agriculture and silviculture

According to IPCC estimates, destruction of forests is responsible for 14 percent of annual emissions of greenhouse gases from anthropogenic sources. Conservation of remaining forests thus plays a particularly important role in development-policy co-operation: through methods of sustainable forest management, protection of forests and development of "buffer zones".

Since 1988, some 250 to 300 million DM have been invested annually in over 150 ongoing projects aimed at forest conservation in developing countries. In addition to its bilateral co-operation, the Federal Government has a significant financial role in multilate-ral initiatives to conserve tropical forests. To date, 291.1 million US$ have been committed to an international pilot programme for conservation of Brazilian rain forests; Germany has committed 312 million DM, or some 60 percent, of this amount. The pilot programme is internationally considered to be a good example of an integrated, interdisciplinary project and of a co-ordinated approach on the part of industry and developing countries to saving tropical forests.

Forests will be saved only if sustainable management becomes more profitable than other uses or clearing of forests. In the past, all attempts to develop regional and national forest-use strategies proved ineffective that did not harmonise with the aims of the people who live in and depend on the forest. For this reason, development co-operation programmes and projects seek to involve such people – especially the local inhabitants, indigenous and forest peoples and non-government organisations – in an appropriate way in planning forest uses and to ensure that they share in profits from uses.

Understanding of the complex interrelationships prevailing in destruction of tropical forests, and of the causes for this destruction – the majority of which lie outside of the silvicultural and timber-industry sectors – has improved; as a result, measures such as rural regional development, land-use planning and agro-silvicultural production procedures have also been integrated within the tropical forest programme.

In the areas of agriculture and improved use of natural resources, support measures are aimed at promoting adapted land-use systems and integrated plant protection and at combating desertification. The measures, which support reduction of climate-relevant emissions – especially methane (CH_4) and nitrous oxide (N_2O) – and, conversely, the preservation of CO_2 sinks, are supplemented by research into methane emissions in animal husbandry and in wet rice cultivation (example in Table 9.5.5).

9.2.1.5 Transport and traffic

Increasing – often rapidly increasing – traffic volumes are also responsible in developing countries for a growing share of the total volume of greenhouse gas emissions. In addition, the exhaust fumes of automobiles and trucks contain ozone precursors (NOx and CO) that intensify the greenhouse effect.

German development co-operation is helping to improve transport sectors and climate protection in developing countries: through expansion of urban public transport systems –

especially rail systems - through improvements of transport planning and through training and education for a wide spectrum of different actors, from decision-makers to automobile mechanics (example in Table 9.5.6).

9.2.1.6 Adaptation measures

The Federal Government's development co-operation emphasises measures that help prevent greenhouse gas emissions and that help preserve and expand CO_2 sinks. Dangers to global climate can be averted only if all available opportunities are taken in both industrial and developing countries to prevent greenhouse gas emissions.

The Federal Government is helping several countries that are especially threatened by the possible consequences of climate change (for example, Sri Lanka) to protect their coastal areas. If sea levels rise, storms and floods become more frequent and rainfall intensifies – for example, during monsoon seasons – intact ecosystems in coastal areas (such as mangrove forests and coral reefs) will provide at least some protection.

Intact local ecosystems also help in the battle against desertification. In addition to their positive economic, social and ecological effects, erosion protection and tree-planting help those affected by desertification to learn to deal with even smaller amounts of rainfall as effectively as possible.

9.3 Multilateral co-operation

9.3.1 Global Environment Facility

The Global Environment Facility (GEF) is a financing mechanism that usefully supplements existing instruments of bilateral and multilateral development co-operation. By assuming additional costs of measures with global benefits, parties (countries) to internationally binding conventions for combating global environmental dangers (Montreal Protocol on the Protection of the Ozone Layer, the Framework Convention on Climate Change, the Convention on Biodiversity) gain a means of effectively fulfilling joint, but differentiated responsibilities. For this reason, the Federal Government is seeking to have the GEF enshrined as a permanent financing mechanism for the aforementioned conventions.

To date, the GEF has effectively supported developing countries in developing local capacities for fulfilling their obligations from the conventions. The first projects in which additional costs are being financed are now being implemented. The Federal Republic of Germany has contributed some 390 million DM to commitments of over 2 billion US$ for 1994 to 1997. In the third round of negotiations on replenishing the GEF, the Federal Government is seeking funding levels that suffice to enable the GEF to fulfil its tasks.

In addition, the Federal Government is supporting selected developing countries with “Immediate-aid measures for implementation of the Framework Convention on Climate Change” (cf. also Table 9.5.7)

Tab. 9.3.1.1: New and additional funding within the framework of the financing mechanism for the Framework Convention on Climate Change

	German contributions in millions of DM		
	1994	1995	1996
Global Environment Facility	122	none	189

Source: Federal Ministry for Economic Co-operation

9.3.2 Multilateral co-operation with countries in central and eastern Europe

Central and Eastern European (CEE) countries and the New Independent Countries continue to undergo a process of political and economic restructuring. Each country is undergoing this process in its own way. On the basis of past experience, these countries have recognised the importance of adding environmental components to this political and economic restructuring, and in many cases have acted accordingly. Relevant legal frameworks and administrative structures are being created and refined.

In 1992, in order to support the CEE countries in building democratic structures and creating market economies, the Federal Government initiated the “Transform” consulting programme, which also provides advice on environmental issues.

Within the framework of this Transform programme, and within the area of climate protection administered by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, a total of 22 consulting projects have been carried out since 1992, with total funding of 3.8 million DM.

The Federal Government has also directly supported, by means of investment subsidies, selected environmental protection projects in central and eastern Europe that are leading to a reduction of cross-border environmental stresses. In 1992 and 1993, 40.75 million DM was provided for ecologically oriented conversions of two large power plants in Ukraine and the Czech Republic. Currently, the German-Czech environmental protection pilot projects “Tisova I power station” and “T 700 Chemopetrol/Litvinov power station” are being carried out with a total of up to 33.9 million DM in financial support from the Federal Government.

At the European conference of ministers for the environment entitled “Environment for Europe”, which took place in Lucerne from 28–30 April 1993, an environmental action

Tab. 9.3.2.1: Projects within the framework of the Transform programme

Country	Project
Estonia	– Use of wind power resources in the Republic of Estonia. Know-how transfer and collection of planning data
Poland	– Environmentally compatible municipal energy supplies – Environmentally compatible hard-coal production
Russia	– Development of a further training programme for energy managers in Russia – Preparation of a programme for reduction of CO_2 emissions in the Russian Federation – Follow-up to the German-Russian project “CO_2 reduction in Russia” – German-Russian partnerships and international networks for technology transfer in the area of efficient energy applications – Environmental protection in the oil and natural gas sector – Working meeting on the subject of “Environmental protection in operation of compressor stations and maintenance of line networks” – Initiation of an exchange of experience between German energy agencies and regional energy agencies in Russia
Slovakian Republic	– Seminar on efficient energy use
Community of nations (international CEE/NIC)	– Environmental technology in the area of primary energy production – IPCC workshop on Inventories of Anthropogenic Emissions and Removals of Greenhouse Gases (GHG) for Central and Eastern Europe – Business Opportunities in Reducing Energy-Related Greenhouse Gas Emissions – The environment and energy – possibilities for environmentally compatible energy production, transformation and use – Project co-ordination within the framework of the “Schwarzes Dreieck” (“Black Triangle”) trilateral working group in Usti nad Labem and evaluation of environmentally oriented data for preparation of a modernisation and development plan for the Black Triangle area
Czech Republic	– Planning services in support of investment preparations for fuel conversions and efficient energy use in the North Bohemian headland Varnsdorf/Sluknov – Energy and the environment II – Moving away from lignite – but in which direction? – Improvement of energy efficiency in the Czech Republic
Ukraine	– “Energy and the environment” partnerships – “Energy and the environment” partnerships – continuation – Workshop on “The environment and energy”

programme for central and eastern Europe was developed. This programme, a continuation of work within the framework of the 1992 Rio Conference, refined the idea of total social responsibility for preserving the natural basis for life – with respect to the special tasks in central and eastern Europe. Three multilateral bodies for shaping the Lucerne follow-up process have been established; they took up their work at the end of 1993:

– the “Task force” for the implementation of the environmental action programmes for central and eastern Europe, in which both western and eastern European partners share equally in carrying out the programme,

– the “Project Preparation Committee” of lending countries and international financial institutions, whose aim is to co-ordinate the financing of environmental projects,

– the UN-ECE “Environment for Europe” working group, which organised and prepared the agenda for the 3rd European conference of ministers for the environment in Sofia (23–25 October 1995). The UN-ECE working group negotiated the “Environmental programme for Europe”, which is supporting harmonisation of living conditions in central and eastern Europe with those in western Europe.

9.4 Programmes for technology transfer

In the framework of bilateral co-operation, the following programmes in particular can be applied to technology transfer:

– The Reconstruction Loan Corporation’s *(Kreditanstalt für Wiederaufbau – KfW)* Establishment and technology programme supports small and medium-sized German companies in introducing new technologies to developing countries; this is accomplished by means of long-term loans at favourable terms. Each year, some 35 million DM in low-interest loans are provided.

– The Integrated consulting service for private industry in developing countries *(Integrierter Beratungsdienst für die private Industrie in Entwicklungsländern)* provides consulting in support of co-operation with companies from EU countries. The prerequisites for long-term business relationships on the basis of environmentally compatible production are created through the introduction of advanced production processes, facilitation of joint ventures and influence on the framework for private business (ownership rights, competition law). Annual subsidies of some 50 million DM are available for such consulting measures.

– The German Appropriate Technology Exchange (GATE) programme of the German Society for Technical Co-operation (GTZ) seeks to promote technologies that make optimal use of existing resources and that are in keeping with the ecological and socio-economic requirements of the relevant partner countries. The programme provides comprehensive advising for the adaptation and promotion of technologies. The programme’s areas of emphasis include renewable energies, recycling of waste substances, wastewater and waste treatment and resource-conserving agricultural methods. In addition, GATE operates an information office for adapted technologies and produces documentation and publications. GATE maintains co-operation partnerships with 15 organisations in Latin America and Asia and co-operates with 2 regional networks in Africa.

9.5 Summary of projects

Tab. 9.5.1: Project: Long-term programme in the conventional energy sector

Project name: Long-term programme in the conventional energy sector			
Project aim: Develop and strengthen personnel and institutional capacities			
Recipient country/region Southern Africa	**Sector:** Capacity Building	**Funding:** 900,000,– DM	**Duration:** 1995–1996
Project description: As a result of growing energy requirements, emissions of unwanted climate-relevant gases are also increasing in developing countries. In part, these emissions are due to technical factors – for example, they result from obsolete power station equipment and inefficient distribution networks. They are also due to a lack of the proper organisational and planning prerequisites, however. To create such prerequisites, the Carl Duisberg Society *(Carl-Duisberg-Gesellschaft – CDG)*, under commission to the Federal Ministry for Economic Co-operation, has developed a long-term programme in the conventional energy sector. This further training programme is aimed at young managers in energy supply companies, and at engineers and economists in the planning and environmental departments of the energy ministries of countries in southern Africa. The emphasis of the programme is on the topic area "Energy and the environment".			
Contact: Carl-Duisberg-Gesellschaft e.V. (CDG) Hohenstaufenring 30–32 D-50674 Köln Telephone: 0049-221-20980 Energy and environmental ministries of the participating countries			
Impact on greenhouse gas emissions: cannot be quantified			

Tab. 9.5.2: Project: power station equipment and the energy sector

Project name: Power station equipment and the energy sector			
Project aim: Environmental protection in coal-fired power stations			
Recipient country/region PR China	**Sektor:** Energy	**Funding:** 13,700,000,– DM	**Duration:** 1987–1999
Project description: The People's Republic of China depends heavily on coal as a primary energy source. China has the world's largest annual coal consumption: one billion tonnes. As a result of this consumption, China contributes 2,500 million tonnes of carbon dioxide annually to the greenhouse effect – more than 11 percent of the world's total output. The average efficiency of new-generation Chinese coal-fired power stations is 29 percent. Increases in this efficiency, achieved by improving the stations' combustion process, can bring about CO_2 reductions with a global impact. To achieve this aim, the Chinese government has developed a programme for introduction of environmental protection technologies that requires power producers to improve power-station efficiency. All projects in this programme are being jointly planned and carried out by the Chinese energy ministry and the German Society for Technical Co-operation (GTZ). With the help of experts from Veba Kraftwerke Ruhr AG, the efficiency of thermal power stations has been increased by an average of 2 percentage points through optimisation of combustion processes.			
Contact: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH Dag-Hammarskjöld-Weg 1 D-65760 Eschborn Telephone: 0049-6196-790 Ministry of Electric Power (MEP), Peking			
Impact on greenhouse gas emissions: The annual emissions reduction at the Sha Jia lignite-fired power station, for example, is 200,000 tonnes of carbon dioxide			

Tab. 9.5.3: Project: Tangier Wind Park

Project name:

Tangier Wind Park

Project aim:

Establishment of a wind park near Tangier for environmentally friendly power generation

Recipient country/region:	Sector:	Funding:	Duration:
Morocco	Energy	8,500,000,– DM	36 months

Project description:

Until the end of the 1980s, Morocco's energy concept focused primarily on coal-fired power stations and hydropower. But as a result of continuing droughts in recent years, the energy output from hydropower has not been up to expectations. The need to increase power generation, without neglecting climate protection, has made wind parks an attractive option for the Moroccan government. Under commission to the Federal Ministry for Economic Co-operation (BMZ), the Reconstruction Loan Corporation (KfW) is supporting the following pilot project: The Moroccan power company, ONE (Office National de l'Electricité), is planning to build a wind park near Tangier. The planned wind power systems are expected to have an average output of three megawatts. The Tangier Wind Park is a pilot project aimed at demonstrating the suitability and environmental compatibility of wind power systems in the Moroccan context. The Moroccan side is planning larger wind parks as follow-on projects. The useful wind energy potential on the Moroccan north coast alone is estimated to be over 100 megawatts. The wind park is expected to generate environmentally compatible energy and to contribute to an economically efficient power supply.

Contact:

Kreditanstalt für Wiederaufbau (KfW)

Palmengartenstraße 5–9

D-60325 Frankfurt/Main

Telephone: 0049-69-74310

Office National de l'Electricité (ONE), Casablancaa

Impact on greenhouse gas emissions:

Reduction per year:

17,000 tonnes of carbon dioxide

14 tonnes of carbon monoxide

114 tonnes of sulphur dioxide

Tab. 9.5.4: Project: Industrial energy efficiency

Project name:

Industrial energy efficiency

Project aim:

Enhancement of energy efficiency in selected non-state-owned industrial sectors

Recipient country/region:	Sector:	Funding:	Duration:
India	Industry	6,100,000,– DM	1995–1999

Project description:

India's gross national product (GNP) grew continuously during the 1980s: about 5% per year. This growth was accompanied by increases in energy demand of over 7% toe (tons of oil equivalent) per year. The supply side has been unable to keep pace with the growing needs for a reliable energy supply. Large parts of India now suffer from energy shortages, especially shortages of diesel fuel and electricity.

The main source of demand for energy – as well as both the cause and the victim of the energy crisis - is Indian industry. Its energy efficiency is very poor by international standards. The World Bank estimates that the industry's overall efficiency could be increased by 20 to 30%.

The purpose of the project is to help improve energy efficiency and support use of environmentally compatible technologies in Indian industry. These aims are to be accomplished by means of a range of relevant measures.

Germany's contribution is concentrated on expanding an REV consulting service (Rationelle Energieverwendung = efficient energy use) within existing Indian structures. The service will work closely with local consultants and institutions in creating the organisational and technical prerequisites for improved use of REV measures. The German contribution includes assignment of two permanently based experts, assignment of temporarily based experts, and training of local experts.

Contact:

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

Dag-Hammarskjöld-Weg 1

D-65760 Eschborn

Telephone: 0049-6196-790

Energy Management Centre (EMC), New Delhi in conjunction with the TATA Energy Research Centre

Impact on greenhouse gas emissions:

cannot be quantified

Tab. 9.5.5: Project: pilot programme for conservation of Brazilian rain forests

Project name:

Pilot programme for conservation of the Brazilian rain forests

Project aim:

Protection and conservation of the Amazon rain forest

Recipient country/region:	Sector:	Funding:	Duration:
Brazil	Silviculture	312,000,000,– DM	since 1992

Project description:
At the 1990 summit of the seven leading industrial countries (G-7) in Houston, Texas (USA), the heads of the governments of the G-7 countries, together with Brazil, the European Union and the member states of the Amazon Pact, agreed to initiate a pilot programme in the Amazon. The programme's purposes are to help protect the forests, to support sustainable management and to reduce threats to global climate from environmental problems, thereby enhancing the survival chances of future generations. The World Bank has been charged with managing the programme, which has total funding of 1.6 billion US$.

Local control of projects, and co-ordination with the World Bank, are carried out jointly by the Reconstruction Loan Corporation (KfW) and the German Society for Technical Co-operation (GTZ), which also co-ordinate all German activities. The following projects are among those that have been begun:
– Establishment of forest protection zones
– Protection of the Mata Atlântica/São Paulo coastal forests
– Expansion of scientific centres for applied research on tropical forests.

Contact:

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

Dag-Hammarskjöld-Weg 1

D-65760 Eschborn

Telephone: 0049-6196-790

Kreditanstalt für Wiederaufbau (KfW)

Palmengartenstraße 5–9

D-60325 Frankfurt/Main

Telefon: 0049-69-74310

Brazilian Forest Ministry, Brasilia

Impact on greenhouse gas emissions:

cannot be quantified

Tab. 9.5.6: Project: environmentally compatible automotive technology

Project name:

Environmentally compatible automotive technology

Project aim:

Environmental protection in further training programmes for technical instructors for occupations in automotive technology

Recipient country/region:	**Sector:**	**Funding:**	**Duration:**
Costa Rica, Guatemala, Honduras, Columbia, Tanzania, Niger	Transport	Components of existing further trainings programmes	since 1992

Project description:
Although in most industrial countries the numbers of registered motor vehicles are growing only slowly, the traffic sector poses a strong threat to our climate. As a result of economic growth in developing countries, numbers of vehicles on the road in those countries have been continuously increasing – beginning at low levels. While we have no influence on the motor-vehicle industries in these countries, we can share our technical and legal experience and so help slow growth of climate-relevant emissions. In industrial countries, proper servicing and maintenance of vehicles are taken for granted – partly as a result of strict regulations. Developing countries continue to lack relevant laws (including enforcement) and the most recent findings from motor-vehicle technology, both of which are necessary for effectively combating emissions. To help provide such findings, the Central office for support of commercial vocations *(Zentralstelle für gewerbliche Berufsförderung – ZGB)*, the German Foundation for International Development *(Deutsche Stiftung für internationale Entwicklung – DSE)*, under commission to the Federal Ministry for Economic Co-operation (BMZ), have been carrying out regular further training programmes in developing countries since 1992. These programmes emphasise environmentally compatible technologies in the automotive sector.

Contact:

Deutsche Stiftung für internationale Entwicklung (DSE)
Rauchstraße 25
D-10787 Berlin
Telephone: 0049-30-254330

Zentralstelle für gewerbliche Berufsförderung (ZGB)
Käthe-Kollwitz-Straße 15
D-68169 Mannheim
Telephone: 0049-621-39020

Impact on greenhouse gas emissions:

cannot be quantified

Tab. 9.5.7: Project: Immediate-aid measures for implementation of the Framework Convention on Climate Change

Project name:

Immediate-aid measures for implementation of the Framework Convention on Climate Change

Project aim:

Strengthening personnel and institutional capabilities

Recipient country/region:	Sector:	Funding:	Duration:
includes PR China, Indonesia	Energy	10,000,000,– DM	since 1992

Project description:

Since the UNCED conference, the Federal Government has supported selected developing countries, by means of so-called “immediate-aid measures”, in preparing national strategies and national reports; this support includes assistance in analysing greenhouse gas emissions and possible countermeasures. The immediate-aid measures are in line with the “enabling activities” programme emphasis that was approved at the 8th and 9th meetings of the Intergovernmental Negotiation Committee (INC) a programme emphasis that comprises planning measures and strengthening of personnel and institutional capabilities. This effort supplements the Federal Government’s contribution to the Global Environment Facility – which, pursuant to the Framework Convention on Climate Change, is to bear the costs of future reporting by developing countries.

The emphasis of the German immediate-aid measures is on the energy sector. This area, in addition to industry, agriculture and transport, is one of the main sources of greenhouse gas emissions in developing countries, especially of CO_2. Countries that emit large amounts of greenhouse gases – such as advanced developing countries in Asia – receive preference for support.

Contact:

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D-65760 Eschborn

Telephone: 0049-6196-79-3282

Impact on greenhouse gas emissions:

cannot be quantified

9.6 The "Activities Implemented Jointly" pilot phase

The Federal Government is participating intensively in the "Activities Implemented Jointly" pilot phase, which was approved in 1995 in Berlin. The German pilot projects are being carried out and financed solely by the private sector. They meet the five criteria adopted by the 1st Conference of the Parties in Berlin, as well as three additional criteria from the German AIJ programme :

1) Pilot projects for activities implemented jointly must be in harmony with and support the relevant national environmental and development-policy priorities and strategies.

2) All activities implemented jointly in the pilot phase are subject to the prior approval, consent and confirmation of the governments of the parties involved in the activities.

3) Activities implemented jointly must lead to real, measurable and long-term environmental benefits in terms of reducing climate changes.

4) The activities implemented jointly must be financed separately from financial commitments made by developed countries in the framework of the financing mechanism of the Framework Convention on Climate Change, and they must be financed separately from current public development aid.

5) During the pilot phase, no party is permitted to apply emissions reductions achieved through activities implemented jointly to its own obligations from the Framework Convention on Climate Change with respect to greenhouse gas emissions.

6) The emphasis of the national pilot programme is to be on emissions reduction. The main emphasis should be on pilot projects that promote integrated environmental protection through use of state-of-the-art technology or of renewable energies. Increases of biomass as a CO_2 sink and emissions reductions are both acceptable, although the main emphasis should be on measures for reduction.

7) Pilot projects for activities implemented jointly may be oriented to all of the greenhouse gases and combinations of anthropogenic greenhouse gases mentioned by the Framework Convention on Climate Change, as well as to the formation of reservoirs and sinks. They should contribute to cost-effective achievement of global ecological benefits.

8) The AIJ projects should receive appropriate scientific support and should be appropriately documented. To gain sufficient practical experience with this mechanism in a range of different technology and sink projects, the Federal Government has arranged for projects to be supported scientifically by independent third parties. As part of this support, in particular, any positive or negative consequences for the relevant host country are to be analysed in detail.

In order to give private industry a greater incentive to invest in AIJ projects in the host countries, the Federal Government is currently reviewing whether declarations of voluntary (industrial) commitment and the "Declaration of German industry on climate protection" can be linked to "Activities Implemented Jointly/Joint Implementation".

To date, two projects have been officially added to the German AIJ pilot programme that have been approved by the relevant host governments (cf. Table 9.6.1 and 9.6.2). An additional project has been submitted to the relevant host government for approval (cf. Table 9.6.3).

Other projects are currently being prepared or discussed.

Tab. 9.6.1: AIJ project: “Development of a power supply in remote regions of Indonesia with the help of renewable energies”

Project name: Development of a power supply in remote regions of Indonesia with the help of renewable energies			
Project aim: For electric companies currently operating with fossil fuels to shift to use of renewable energies			
Recipient country/region: Indonesia	**Sector:** Energy	**Funding:** 3.6 million US $[1)]	**Duration:** begins in 1997
Project description: Introduction of a local power supply based on renewable energies. By means of practical applications, the project is to show whether, given the appropriate power supply, remote regions of a developing country can be supplied with electric power through cost-effective efforts that pay for themselves. The results are to be used as a basis for decisions regarding future private-economic investments in comparable projects.			
Contact: RWE Energie Zentralbereich Ausland/Politikanalyse Kruppstraße 5 D-45128 Essen Telephone: 0049-0201-1201			
Impact on greenhouse gas emissions: not yet known			

[1)] of which 0.8 million US$ is being provided by the Indonesian government

Tab. 9.6.2: AIJ Project: “Installation and operation of 2 wind power systems”

Project name: Installation and operation of 2 wind power systems			
Project aim: Substitution of fossil fuels in generation of electrical power			
Recipient country/region: Latvia	**Sector:** Energy	**Funding:** 3.147 million DM	**Duration:** since 1995
Project description: Basic site exploration, as well as delivery, installation and operation of 2 wind power systems (rated output 600 kW each) for the Latvenergo AG power company in Latvia.			
Contact: PreussenElektra Abteilung EG Postfach 48 49 D-30048 Hannover Telephone: 0049-0511-4390			
Impact on greenhouse gas emissions: about 2,480 t CO_2 /y			

Tab. 9.6.3: AIJ Project: "Modernisation of the combined heat and power generation system of the VW-Skoda automobile plant in Mlada Boleslav"

<table>
<tr><td colspan="4">Project name:
Modernisation of the combined heat and power generation system of the VW-Skoda automobile plant in Mlada Boleslav</td></tr>
<tr><td colspan="4">Project aim:
Energy-saving/emissions reductions through fuel conversion and use of energy-efficient technology</td></tr>
<tr><td>Recipient country/region:
Czech Republic</td><td>Sector:
Industry</td><td>Funding:
200 million DM</td><td>Duration:
beginning 1997</td></tr>
<tr><td colspan="4">Project description:
Modernisation and renovation of the obsolete combined heat and power generation system of the SKODA automobile plant in Mlada Boleslav in the Czech Republic. The new system, with two hard-coal-fired fluidised-bed boilers, and an additional boiler fired with natural gas/oil, will replace the old lignite-fired power station. The new system has an electrical output of some 70 MW, and a total thermal output of some 260 MW.</td></tr>
<tr><td colspan="4">Contact:
RWE Energie
Zentralbereich Ausland/Politikanlayse
Kruppstraße 5
D-45128 Essen
Tel.: 0201/1201

Bavariawerk AG
Abt. Z–G
Postfach 200553
D-80005 München

are each sponsoring half of the project</td></tr>
<tr><td colspan="4">Impact on greenhouse gas emissions:
about 280,000 t CO_2/a</td></tr>
</table>

10. Research and systematic monitoring

In Germany, research on the topics of climate change, global change and sustainability is supported primarily by the Federal Ministry of Education, Science, Research and Technology (BMBF) and the German Research Foundation (DFG). Some research institutions and projects are also funded by other ministries such as the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU; along with the Federal Environmental Agency – UBA), Federal Ministry of Transport (BMV; along with German Weather Service) and others. The Federal *Länder* also support research and research institutions (in part, in co-operation with the Federal Government) that deal with this topic. In 1994, the Federal Government's R&D expenditures for environmental and climate research amounted to 1,030 million DM, of which 435 million DM went to ecological research, 345 million DM went toward support of innovative environmental protection technologies and 249 million DM were earmarked for climate and atmosphere research. The Federal Ministry of Education, Science, Research and Technology (BMBF) is a member in the steering committee of the "International Group of Funding Agencies for Global Change Research" (IGFA). The IGFA is an alliance of national support organisations from 25 countries.

Climate and atmosphere research is focused primarily on the physical basis of climate change.

- The purpose of ecological research is to provide the information necessary to determine when and where human interventions in the natural balance threaten ecosystems' ability to regenerate themselves and to develop.
- Support of innovative environmental protection technologies is aimed at development of methods and procedures with which future environmental damage can be prevented before it occurs, by means of integrated technologies, or with which existing damage can be reduced by means of post-care measures.
- Energy research creates the technological basis for lasting reductions of energy-related stresses on the environment and on climate.

Implementation, in concrete measures, of findings regarding possible climate changes and their consequences plays an important role, in addition to this mainly scientific and technical research. Such measures also include the social and economic sectors. Ultimately, the political sector must make the relevant decisions.

Preferences for certain measures must be preceded by formulation of environmental policy aims. This requires involvement by the social sciences and economic sciences; without their participation, it will not be possible to give proper consideration to the conflicts of assessment that occur when these aims are defined (for example, by means of cost-benefit analyses).

Several bodies of experts have been established in Germany to assess the current level of knowledge and to identify the resulting research priorities with regard to the entire field of climate change, global change and sustainability. These bodies have included the enquete commissions on climate of the 11th and 12th German Bundestag and the Federal Government's Climate Advisory Board. Every two years, the Advisory board of experts on environmental issues (*Sachverständigenbeirat für Umweltfragen* – SRU), which is organised within the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, publishes a report. The annual reports published by the German Advisory Council on Global Change (WBGU) are especially relevant to the topics of global change and sustainability. The following reports have been published in recent years: "Basic structure of global relationships between man and the environment" (1993), "The threats to soils" (1994) and "Ways to solve global environmental problems" (1995). The WBGU's annual report for 1996, entitled "Challenge to German Science", considers the implications of the problem of global change for the German scientific sector.

10.1 The Climate system

The climate system is one of the central focuses of environmental research, as well as the subject of climate and atmosphere research. In addition to questions of climate change, this discipline also considers the following globally significant environmental problems:

- Ozone depletion in the stratosphere
- Air pollution in the lower atmosphere
- Emissions in aviation.

While these problem areas each require different research emphases, they are closely linked through interdisciplinary questions and through mutual use of research findings by the various disciplines. Such links are found, for example, in research into depletion of stratospheric ozone, which is also a climate-relevant gas and to aerosol research, which relates closely to all three problem areas.

As to climate change, studies of the problem of the anthropogenic influence on climate, and predictions regarding future climate development, require an integrative research concept that is not confined to the climate sciences or natural sciences. In addition to knowledge of the interrelationships within the climate system – which comprises not only the atmosphere, but also the ocean, areas covered by ice and snow, the hydrosphere and the biosphere, and which contains a large number of different substance cycles – predictions of future living conditions and, thus, socio-economic research, are necessary to predict the anthropogenic impact on climate and the possible consequences for natural and semi-natural ecosystems and human society.

In addition to an interdisciplinary approach, the great complexity of the problems of global change, especially change resulting from climate change, demands international co-ordination of research. For this reason, German scientists are involved in numerous international and European programmes, and contribute to the work of the “Intergovernmental Panel on Climate Change” (IPCC). Table 10.1.1.1 provides an overview of the activities of German researchers in international projects.

10.1.1 Basic research

The relevant basic research seeks to gain a better understanding of the significant processes that control climate, as a basis for assessing future climate trends on both global and regional scales. The following research areas are being emphasised:

Climate variability and signal analysis

This area has been successfully approached in Germany with the help of simulations with coupled ocean-atmosphere circulation models (cf. section 10.2). In addition, efforts are intensifying to obtain a better understanding of the climate system’s natural variability (including more extensive incorporation of paleontological data). In the area of climate modelling, ways of modelling coupling with other climate-relevant systems, such as the ocean, the cryosphere and the biosphere, are being sought. Efforts are also being made to improve parametrisation of the basic processes involved.

Water cycle

Within the framework of international research programmes, German scientists have made important contributions to knowledge of the interactions between clouds and radiation. The role of clouds in the climate system continues to be studied in conjunction with greater attention to the influence of aerosols. Monitoring of regional hydrological processes, and of the way they are coupled with weather and oceanic processes, will help to improve the parametrisation of global climate models. In addition, hydrological models are being developed, as building blocks of regional and global models, with the aim of calculating rates of evaporation, of new groundwater formation and of the flow of fresh water to the oceans.

Cycles of trace substances

In the area of trace-substance cycles, studies in the framework of international programmes are concentrating especially on the carbon cycle. The emphasis of future research will be to assess the current and future function of terrestrial ecosystems as CO_2 sinks, in conjunction with oceanographic studies. In addition, the cycles of nitrogen and sulphur, and their interaction with climate, are to be studied.

Tab. 10.1.1.1: Involvement of German researchers in national and international projects in climate and atmosphere research

Research emphasis	National activities	International activities
Climate variability and signal analysis	Climate research programme	WCRP: CLIVAR IGBP: GAIM, PAGES
Trace-substance cycles	Climate research programme	IGBP: IGAC, GAIM
Water cycle	Climate research programme	WCRP: GEWEX (BALTEX) IGBP: BAHC
Aerosols	Support emphasis: Atmospheric aerosol (AFS)	
Troposphere research	Support emphasis: Troposphere research (TFS)	
Aviation	Joint research programme: “Pollutants in air transport”	EU: POLINAT, AERONOX
Ozone depletion in the stratosphere	Ozone research programme Main projects: CHORUS, POLECAT	
Ocean research	Ocean research programme	WCRP: WOCE, GEWEX, ACSYS, IGBP: JGOFS, PAGES, LOICZ, ACSYS, SystemLaptevSee (bilateral with Russia), GOOS, ODP
Deep-sea research	Ocean research programme	MAST
Polar research	Polar research programme	EPICA, PAGES

Atmospheric aerosols

Aerosol research provides an important link between climate system research and atmosphere research (section 10.1.2). Locally, aerosols can have a negative radiation-driving effect that is more than large enough to compensate for the positive radiation-driving effect of greenhouse gases. But anthropogenic aerosols in the atmosphere are very short-lived; consequently, it is vitally important to

- study the cycles and distribution of particulate components of the troposphere, as well as their interactions with atmospheric chemicals and climate and
- considerably improve the reliability of global climate models by taking into account the direct and indirect effects of atmospheric aerosols on the climate.

Co-ordinated, broad-based co-operation (national and international) is a significant prerequisite for progress in this research sector. In future, the activities described here will be part of a separate support emphasis *(Förderschwerpunkt)* entitled "Atmospheric Aerosol (AFS)".

10.1.2 Atmosphere research

In spite of national efforts to achieve reductions, pollutant emissions in the industrialised regions of the middle latitudes remain at a high level and, in part, continue to increase. Changes in the troposphere's trace gas content not only directly influence the well-being of the people who live in strongly polluted regions; they also have an impact on regional and global climate.

EUROTRAC, a European EUREKA environmental project, and the "Scientific Accompanying Programme for Clean-up of the Atmosphere over the New German States" (SANA), terminated in 1995. In the coming years, troposphere research in Germany is to be concentrated on improving knowledge regarding the problem of oxidant formation and of changes in oxidation capacity. A primary focus of this work, in turn, will be on enhancing the diagnostic and predictive quality of chemical transport models for the troposphere, as well as on enabling the future use of such models -for example, for predicting episodes of summer smog and for assessing measures to prevent summer smog. Plans call for combining future research in this area within the framework of a support emphasis *(Förderschwerpunkt)* entitled "Troposphere research (TFS)".

The joint programme "Pollutants in air transport" (*"Schadstoffe in der Luftfahrt"*) has been in progress since 1992. In a second phase of the programme, to continue until the end of 1997, the following important work with regard to climate research is planned – in addition to obtaining of emissions data and emissions indexes and study of spreading and conversion processes in aircraft wakes, and their significance for global processes:

- study of contrails on the basis of satellite data, measurement programmes and model calculations, as a basis for calculations with global climate models and models of heterogeneous chemistry;
- Regional and global modelling of ozone chemistry and of the climate-relevance of aircraft exhaust, using three-dimensional models.

Depletion of stratospheric ozone in the northern hemisphere is being studied in national programmes and, especially, in international projects within the "Ozone research programme". Measurement programmes to determine the mass balance of all families of trace gases that are responsible for ozone depletion, and for the occurrence and influence of polar stratospheric clouds (PSC), are a central focus of these studies. Other studies are examining ozone variability, which in the northern hemisphere is strongly influenced by meteorological and highly dynamic processes. A third emphasis of the ozone research programme is on measurement and prediction of UVB radiation.

10.1.3 Ocean and polar research

Since the ocean directly influences the earth's thermal and substance cycles, the main emphasis of ocean and polar research is on further clarifying the role of the oceans and the polar regions in global climate. The polar regions and certain ocean areas are key regions for global climate processes. Polar ice and sediments are climate "archives" from which past climate fluctuations can be read. It is known that climate changes influence oceanic current systems and the mass balance of the polar ice caps. In addition, they can cause fundamental changes in flows of climate-influencing gases and of heat. For this reason, the Federal Republic of Germany is participating in important core projects of the "World Climate Research Programme (WCRP)" and of the "International Geosphere-Biosphere Programme (IGBP)". Central focuses in this context include global circulation and heat transport, the global water cycle and the global carbon cycle, including associated gases. The role of the world's oceans in the earth's climate system can be understood only through study of the deep sea. In the interest of quantifying, modelling and predicting deep-sea substance and energy transports, the Federal Ministry of Education, Science, Research and Technology (BMBF), in co-operation with scientists, has developed a deep-sea research concept. Within the framework of international projects such as PAGES (Past Global Changes), ODP (Ocean Drilling Programme) and EPICA (European Project for Ice Coring in Antarctica), sediments and ice deposits are being studied in key areas. These studies are providing findings concerning the development of climate and biogeochemical substance cycles in the course of the earth's history, during eras when human beings had not yet intervened in climate processes. The findings are entering into models and predictions of future changes in the coupled ocean-atmosphere system.

10.2 Climate models and predictions

Prediction of climate changes is carried out with sophisticated numerical climate models, for which the German Climate Computing Centre (DKRZ) in Hamburg offers computing resources. For example, climate simulations are carried out at the Centre with the ECHAM model, which was developed in co-operation with the MPI in Hamburg for meteorological purposes, and which has also been used within the framework of status analyses of the IPCC. Similar additional use has been gained from coupled ocean-atmosphere circulation models in simulations in the context of studies on climate variability and signal analysis. In these simulations, the central issue has been the question of an anthropogenic "fingerprint" in the climate record since the beginning of the Industrial Revolution.

The DKRZ co-ordinates the European Climate Computing Network (ECCN), a network of the most important climate computing centres in Europe. In addition to the DKRZ, the ECCN also includes the Hadley Centre in Great Britain and Meteo France and the Centre Laplace in France.

10.3 Estimates on sensitivity to climate changes and regarding the consequences of climate changes

10.3.1 Ecosystem research

Ecosystem research is concerned with studying the structure, function and dynamics of representative ecosystems such as forests, river and lake landscapes, agrarian landscapes and urban-industrial landscapes. Research into marine ecosystems is carried out within the framework of the ocean research programme. Integration of knowledge gained in a range of different disciplines will permit early recognition of potential dangers from human-caused environmental stresses. As a result, ecosystem research supplies important information regarding the sensitivity of important ecosystems to climate changes. In addition, it also illuminates the possibilities for sustainable use and shaping of such ecosystems, especially with regard to the problems of global change.

In Germany, ecosystem research is supported with funding from relevant research institutions. These include:

– Bayreuth Institute for Terrestrial Ecosystem Research

– The Forest Ecosystem Research Centre in Göttingen

– The Agri-ecosystems research alliance *(Forschungsverbund Agrarökosysteme)* in Munich

– The Ecosystem Research Project Centre in Kiel

– the Leipzig-Halle Environmental Research Centre (UFZ)

Internationally, the ecosystem research is integrated within the UNESCO "Man and the Biosphere" (MAB) programme and within projects of the IGBP.

10.3.2 Climate-impact research and research on global change

The aims of climate-impact research are to reveal the interactions between climate and sensitive areas of nature and society, to describe possible consequences of climate changes and to help develop political options for protecting the earth's atmosphere. The Potsdam Institute for Climate Impact Research (PIK) carries out an important co-ordinating function in this area. This interdisciplinary and internationally oriented institute studies the possible consequences of global change (on all scales), especially those due to climate changes, develops protection and response strategies and advises the political sector in implementing suitable measures. Another important institution is the Wuppertal Institute for Climate, Environment, and Energy of the North Rhine-Westphalia Science Centre, which began its work in 1991. Relevant projects carried out by these institutes (sometimes in co-operation with each other) have included cost-benefit analyses of climate protection strategies and development of integrated assessment models for estimating and evaluating climate impacts on different systems, and for evaluating measures for climate protection.

A central project in climate-impact research in Germany is the Federal-*Länder* project "Climate change and the coastline" (*"Klimaänderung und Küste"*). Its aim is to provide the scientific basis for developing decision and implementation strategies that will enable inhabitants of coastal areas and authorities to respond to challenges presented by climate change. Concepts for so-called "case studies" have been developed that, as interdisciplinary joint projects, link perspectives of natural and social sciences and should lead to management-relevant conclusions. The scientific secretariat for the "Climate change and the coastline" project is collaborating with the IPCC Coastal Zone Management Subgroup.

Other research is focusing on the consequences of climate changes in agriculture and silviculture. A "status seminar" held at the end of 1994 identified over 90 ongoing and planned research projects in the area of responsibility of the Federal Ministry of Food, Agriculture and Forestry (BML) with the following emphases:

– the contribution of agricultural and silvicultural activities to climate change,

– the effects of changing climatic elements on agriculture and silviculture and on fisheries,

– possibilities and strategies for emissions reductions and carbon storage and for adaptation, in agriculture and silviculture, to climate changes,

– system-analytic consideration of agriculture and silviculture, as an instrument for precautionary political decisions.

The human influence on climate, and changes in living conditions resulting from climate change, are only aspects of the problem of global change, an area in which systematic research is still at an early stage. The Federal Ministry of Education, Science, Research and Technology (BMBF) is currently developing a support concept for research in this complex area; this concept should help enable German science to participate actively in designing content of international programmes, such as the IGBP, the WCRP and the

IHDP, in which a system-oriented understanding of global environmental changes is to be achieved through international co-operation.

One step in this direction is the establishment of the Secretariat of the "International Human Dimensions Program on Global Environmental Change" in Germany (in 1996 in Bonn), a programme which will surely provide strong impetuses for German research in this area.

10.4 Research into the prevention of climate changes and into ways of adapting to climate changes and their consequences

In Germany, the question of adaptation to possible climate changes has been considered especially in connection with problems related to protection of coastal areas. The aforementioned "Climate change and the coastline" joint-research project (Chapter 10.3.2) is focused especially on measures for protecting people living in coastal areas – measures necessary in light of the possibility of rising water levels and increasing storm-flood frequency.

Research aimed at improving possibilities for avoidance of greenhouse gas emissions, especially of CO_2 emissions, is currently receiving greater emphasis than research into adaptation to climate changes, however.

10.4.1 Environmental protection technologies

The problem of emissions of the greenhouse gas CO_2, in particular, clearly shows that downstream (end-of-pipe) cleansing measures aimed at reducing pollution have their limits. Use of preventive, production-integrated environmental protection measures must be intensified. Technology-oriented research support in the area of "product-integrated and production-integrated environmental protection" (*Produkt- und Produktionsintegrierter Umweltschutz"* – PIUS) is aimed at optimising production processes and products, and at closing substance cycles, in the following ways: from the very beginning of processes,

– product/production-related emissions (waste gas, waste, wastewater) are prevented and

– use of raw materials and energy in manufacture, use and disposal of products is minimised.

Projects have already commenced that are supporting exemplary demonstration of the technical, organisational and economical feasibility of integrated environmental technology in different industrial sectors.

Practical evaluation methods must be available before the ecological sustainability of production processes, products and substance flows can be optimised. Since considerable research is still required in this area, the Federal Government is supporting projects for refinement of ecological life-cycle-analysis methods for certain products, as well as for ecological studies in support of PIUS projects.

A resources conservation concept has also been developed for the waste-management sector: the Closed Substance Cycle and Waste Management Act of 1994. In addition, new technologies for waste re-use and recycling are being developed that are expected to be free of additional ecological stresses. Examples include an integrated project for study of possibilities for re-use and recycling of industrial by-products in the construction industry and a project involving mechanical and biological pre-treatment of landfill waste. These projects are also aimed at reducing emissions of greenhouse gases such as methane (CH_4).

On the whole, the environmental protection technology sector is developing into an economically significant, job-creating field that is gaining a considerable share of the international, competitive market. It is achieving this in the areas of both downstream cleansing and re-use/recycling technologies and integrated environmental protection solutions.

10.4.2 Energy research and energy technology

The energy sector accounts for the largest share of total CO_2 emissions. Reductions of CO_2 emissions can be achieved by increasing efficiency of energy transformation, as well as through use of renewable energies and through more efficient energy use.

Basic research in the framework of the TECLAM integrated project has produced findings regarding more cost-effective, more environmentally compatible operation of power stations and combustion systems for fossil fuels. Applied basic research is expected to lead to further efficiency increases and environmental relief. Through international co-operation, Germany is participating in relevant IEA and EU projects. Joint projects for improving oil and gas production and pipeline integrity are being carried out with countries of the former Commonwealth of Independent States (CIS).

There is potential for further development of renewable energies such as hydropower, solar power, wind power, biomass and geothermal and environmental energy. In order to tap this potential, research is being carried out especially in the following areas:

– The "Photovoltaics 2005" programme;

– Co-operation with developing and threshold countries for development of innovative wind power and solar power technologies (ELDORADO-Wind and ELDORADO-Sun);

– Evaluation of the "250 MW Wind" project, a wind power demonstration project;

– An EU research project on use of geothermal energy (hot dry rock technology) in Soultz-sous-Forêt;

– Development of environmentally compatible combustion and gasification technologies for generating energy from biomass and waste materials.

Efficiency and reduced fossil fuel consumption in final energy use are especially useful when it comes to generation of heat for households, over 80 % of which comes from fossil energy sources. Use of renewable energy sources instead in this area would bring about considerable CO_2 reductions. The “solar heating 2000” *(Solarthermie 2000)* programme is a prime recipient of research support in this area. Other research projects are aimed at improving energy efficiency in industry.

The “4th Energy Research and Energy Technologies Programme”, which was published in May 1996, seeks to reconcile the need to assure a long-term supply of energy with the need to solve environmental and climate-protection problems. It gives special attention to the CO_2 problem and its threats to global climate.

Since about one-third of anthropogenic CO_2 emissions in Germany are produced by the energy sector, emissions reductions in this sector are particularly desirable. Such reductions can be achieved by increasing efficiency of energy transformation, i.e. efficiency of energy production and use, and by using energy technologies that generate either no CO_2 emissions or very low levels of emissions.

The programme has the following support emphases:

I. Reduction of energy requirements

– efficiency increases in energy transformation, new secondary energies
  – power station technology, combustion research
  – fuel cells, hydrogen, batteries (storage media for electrical energy)
  – district heating

– Efficient energy use, reduced use of fossil energies in the final energy sector
  – solar heating, heat for buildings
  – heat-storage media
  – enhancement of energy productivity in industry.

II. Reduction of CO_2 emissions and pollution in the energy supply

– Renewable energies
  – photovoltaic
  – wind power
  – biomass
  – geothermal and other renewable energies
  – technologies for countries in southern climate zones

– Nuclear power
  – safety of LWR, innovative reactor concepts
  – long-term safety of nuclear-waste disposal.

III. Long-term options for the energy supply

– Controlled nuclear fusion

IV. Overarching issues

– System analysis, barriers to innovation in energy saving, provision of information, interdisciplinary topics.

The programme’s financial emphasis is on renewable energies, followed by nuclear fusion, nuclear power and efficiency enhancements in energy transformation and energy use. Funding of up to 700 million DM per year is tentatively planned for the next 5 years.

In the framework of the European Fusion Programme, Germany is also participating in a global programme of the European Union, the USA, Japan and Russia to develop nuclear fusion as a long-term option for CO_2-free energy production (the so-called ITER programme). The research and development of the past few years supports the expectation that it will become possible to replicate the sun’s nuclear fusion process on the earth and harness it for energy production. The ITER team’s study of the necessary next steps will be completed by 1998; its findings will be used as a basis for defining further German involvement, within the EU framework.

10.4.3 Mobility research

As a result of continuing growth in the transport sector, CO_2 emissions in this sector have continued to increase in absolute terms – even though the specific energy consumption of most modes of transportation has decreased. This is one reason why the Federal Government, within the framework of the “Cornerstones of a future-oriented mobility research policy” (*“Eckwerte einer zukunftsorientierten Mobilitätsforschungspolitik”*), which was approved by the Federal Cabinet in December 1996, has accepted as a guiding principle that mobility must be maintained over the long term, but undesirable consequences of transports must be noticeably reduced. Reduction of transport-related emissions, and resources protection, are thus among the most important areas of future mobility research. Emphases will be placed in this context on the development and evaluation of technologies, strategies and regulatory frameworks that contribute to reduction of greenhouse gas emissions of transports – especially road traffic – so that the Federal Government’s reduction objective can be reached. In addition, research is charged with identifying long-term prospects; with showing to what quantitative extent, within what periods and at what costs a further reduction of all emissions (climate-relevant gases, air pollution and noise) is possible, in light of the long-term aim of achieving minimal emissions. These efforts are to provide the scientific basis for orienting technological development.

10.5 Systematic monitoring

Since 1972, the Federal Environmental Agency’s (UBA’s) measuring network has recorded CO_2 concentrations at 5 background measuring stations. Since then, at various locations, the programme has been expanded to include measurement of other climate-relevant gases such as CH_4, N_2O, VOC and chlorohydrocarbons. In 1994, in the framework of the WMO’s Global Atmosphere Watch (GAW) programme, the Federal Environmental Agency and the German Weather Service began construction of the Zugspitze/Hohenpeißenberg global station. The station's purposes are to record background concentrations of climate-relevant and reactive gases and to identify trends in these concentrations in Germany. It took up its programme of measurements in 1995; currently, the programme covers CO_2, CH_4, N_2O, CO, O_3, NO, NOx, VOC, Be-7 and UV-B. Measurements are carried out through consultation and co-operation with Germany's neighbours Austria and Switzerland.

The Federal Environmental Agency also operates 2 GAW regional stations, on Schauinsland mountain and at Neuglobsow; these stations also measure concentrations of selected climate-relevant gases.

Greenhouse gas data collected in Germany is also forwarded to international data centres, such as the WMO's World Centre For Greenhouse Gases in Japan and the World Ozone Centre in Canada. The Federal Government is currently preparing a German contribution to the Initial Operational System (IOS) of the Global Climate Observing System (GCOS). In addition to the GAW global station, the German Weather Service (DWD) will operate the Stuttgart-Schnarrenberg station in the GCOS framework: as a long-term contribution to the "GCOS upper air network". Stations are currently being selected for a similar "GCOS surface network". The aim of GCOS is to support international observation programmes in climate monitoring, making climate predictions and detecting climate changes in time. An important role is played in this context by the meteorological monitoring data and measurements that are exchanged world-wide in the framework of the World Weather Watch (WWW), through co-ordination by the WMO. In this context, the German Weather Service maintains various relevant measuring networks, with different purposes. It is participating in international exchanges of meteorological monitoring data and measurements, and of aerological sounding data - gathered within a region extending from the troposphere up to the stratosphere – via the Global Telecommunications System (GTS).

Many commercial ships, on all the world's oceans, carry out voluntary weather observations. The German Weather Service collects and archives such data. In the framework of the "Voluntary Observing Ships" (VOS) mobile network, the German Weather Service maintains contact with more than 550 commercial ships and supports standardisation of observation instruments. Since 1994, the German Weather Service, in co-operation with the British Weather Service, has operated a Global Collecting Centre (GCC) that collects and sets quality standards for climate data from ships. The German Weather Service's meteorological observations combine ongoing, long-term measurements and monitoring in the areas of radiation (including UV-B radiation), ozone (total ozone, near-ground ozone and vertical profiles), atmospheric structure, precipitation and clouds with applied research in all these areas. Its observing stations continue to carry out numerous monitoring tasks relevant to long-term changes in the atmosphere.

The Fraunhofer Institute for Atmospheric and Environmental Research and the German Weather Service's Hohenpeißenberg Meteorological Observatory are part of the European Stratospheric Monitoring Stations (ESMOS). Stations of the Alfred-Wegener Institute and of the German Weather Service will participate in the global Network for the Detection of Stratospheric Change (NDSC), which has been initiated by the USA.

Oceanographic monitoring data is being provided by national programmes for description of oceanic contributions to climate, in the framework of the Integrated Global Oceanographic Services System (IGOSS) and the International Oceanographic Data and Information Exchange (IODE) programmes. The German Federal Institute for Navigation and Hydrography (BSH) maintains a network of oceanographic measurement stations in German Bight and the Western Baltic. Currently, the Marine Environment Remote-Controlled Measuring and Integrated Detection (MERMAID) system, an automatic, event-controlled monitoring system, is being integrated within this measuring network. MERMAID was developed with the support of the Federal Ministry of Education, Science, Research and Technology (BMBF). The BSH also operates its own measuring programmes, within the IGOSS framework, whose data is distributed via the GTS. The BSH is participating in the development of the oceanic component of the GCOS, the Global Ocean Observing System (GOOS).

10.5.1 Monitoring systems

Considerable requirements for monitoring exist – for monitoring of the current state and the development of the climate system and its subsystems and for monitoring of the states of natural and man-made systems and structures that are affected by climate changes and global change in general.

German institutions such as the German Weather Service (DWD) and the Alfred Wegener Institut for Polar and Ocean Research (AWI) are participating extensively in international measuring networks supporting observation of the atmosphere and the oceans.

In the framework of support for German environmental research, suitable measuring instruments for data-collection campaigns have been developed and implemented – for both in-situ measurements and remote observation. The available measuring platforms include balloons, aircraft and research ships (such as the "Polarstern").

An important role in provision of ecological data is played by the systematic "Integrated Monitoring" (*Ökologische Umweltbeobachtung* – ÖUB) programme, which is being established through co-operation between the Federal Government and the *Länder.*

The purposes of this programme include

– Harmonising and combining suitable Federal and *Länder* monitoring systems;

– Establishing a network of permanent monitoring sites for keeping track of the most important ecosystems;

– Combining data within one information system.

10.5.2 Space-based earth monitoring

Germany has taken a central role in the missions of the ERS-1 European Remote Sensing Satellite, which is being used for environmentally relevant space-based earth monitoring. Germany is also playing a key role in evaluating the data gathered by this satellite.

Germany also has an important role in the POEM-1 programme approved by the European Space Agency's (ESA's) 1991 Council Conference in Munich. The programme comprises the ENVISAT-1 environmental satellite and the METOP-1 meteorological operations satellite. The emphasis of ENVISAT will be on climate and atmosphere research and on continuing the ERS missions' oceanographic measurements. In addition, this programme includes payload research that can be applied to work in the oceans and in the rest of the biosphere. In a national initiative, Germany is developing part of the ENVISAT payload: the SCIAMACHY sensor, which is expected to make a significant contribution to atmospheric sensing. As part of the same initiative, Germany is expanding the German Remote Sensing Data Centre *(Deutsches Fernerkundungs-Datenzentrum)* into a user-oriented centre that will archive and distribute environmentally relevant satellite data. EUMETSAT, the European organisation for the use of meteorological satellites, will use the Eumetsat Polar System (EPS) to contribute to the global system satellites in polar orbits; the system's mission emphasis will be on global weather and climate monitoring with long-term continuity. The Federal Republic of Germany is bearing 25.53% of the costs of EPS. The relevant development work and supplementary activities are being carried out within a programme named METOP-1, which is being jointly sponsored by ESA and EUMETSAT. With its participation in the METEOSAT programme, Germany is also making a significant contribution to a satellite system that will provide complete global data collection and guarantee long-term availability of earth-observation data – which are significant prerequisites for detection of climate changes - until the year 2012. The German Weather Service is seeking to make an important contribution in the area of monitoring important components of the climate system, by means of satellite remote sensing, in the following manner: by establishing a central facility for use of data from meteorological satellites for climate monitoring (Satellite Application Facility, SAF, for climate monitoring).

10.5.3 Data and information management

In view of the enormous amounts of data that are being generated, information management systems are required that permit

– User-friendly presentation of data;

– Continual monitoring of data quality;

– Reliable, secure archiving of data; and

– Fast access to data.

The German information systems listed below are available to support interested users, with the help of data catalogues and metadatabases, in finding relevant data. Some of the listed information systems also permit direct access via the Internet:

The German Remote Sensing Data Centre (*Deutsches Fernerkundungsdatenzentrum* – DFD), housed within the German Aerospace Research Establishment (DLR) in Oberpfaffenhofen, is concerned with storage, management and evaluation of satellite remote-sensing data. The Intelligent Satellite Data Information System (ISIS) supports users in searches.

The Central climate and environmental data information system *(Zentrales Klima- und Umweltdateninformation system* – ZUDIS) at the Karlsruhe Research Centre (FZK) provides information about the climate-relevant data collections and databases obtained through measuring and monitoring programmes in Germany and available in Germany.

To improve availability of climate-relevant data, a network of national databases and an information system are being established, under the management of the German Climate Computing Centre. This network will involve all authorities, scientific institutions and major research institutions that have climate-relevant data. This effort is also a contribution to the G7 ENRM (Environmental and Natural Resource Management) project. In this context, the German Weather Service (DWD) is planning to establish a German centre for climate observation. The German Weather Service also offers a climate information system in the World Wide Web.

In the German Oceanographic Data Centre, the German Federal Institute for Navigation and Hydrography (BSH) collects oceanographic data gathered by German institutions.

Paleoclimatological databases are available at the Alfred Wegener Institut for Polar and Ocean Research (AWI) and the Potsdam Geo Research Centre *(Geoforschungszentrum Potsdam* – GFZ).

The Federal Environmental Agency's environment planning and information system (*Umweltplanungs- und -informationssystem* – UMPLIS) stores important data relative to environmental protection, including data on emissions of climate-relevant substances. The Environmental Research Catalogue *(Umweltforschungskatalog* – UFOKAT) provides an overview of environmentally relevant research projects in Germany. UV-B data, including data of the German Federal Institute for Radiation Protection *(Bundesamt für Strahlenschutz)* and of the *Länder,* is collected and stored in a central database of the Federal Environmental Agency.

Other examples of information systems that provide data about the state of the environment in Germany include the LANIS Landscape Information System of the Federal Agency for Nature Conservation, the Central Office for Agricultural Information and Documentation *(Zentralstelle für Agrarinformation und Dokumentation* – ZADI) and the various Länder information systems. A Federal/*Länder* working group has been established to co-ordinate and harmonise the establishment of the environmental information systems *(Bund/Länder-Arbeitskreis Umweltinformationssysteme* – BLAK UIS).

An important part of the information management network is housed at the GSF Research Centre for Environment and Health, located in Neuherberg, near Munich. Here, an environmental research information system *(Umweltforschungsinformationssystem* – UFIS) is being established to collect the existing models and data from environmental research projects funded to date by the Federal Ministry of Education, Science, Research and Technology (BMBF) – and to analyse them with a view to defining overarching principles of modelling and data collection.

In connection with international activities, Germany maintains the following data and information systems:

The German Weather Service (DWD), in addition to maintaining the national climatological archives, collects and processes international data distributed via the GTS in the framework of the WMO's WWW (World Weather Watch) programme. The DWD checks the data for quality and then archives it.

In the framework of the WCRP, the following international data centres have been established in Germany to manage data relevant to the global water cycle:

– The Global Precipitation Climatology Centre (GPCC), which is operated by the DWD;

– The Global Runoff Data Centre (GRDC), at the Federal Institute for Water Science *(Bundesanstalt für Gewässerkunde)* in Koblenz

These two centres are important components of the GCOS.

At the Fraunhofer Institute for Atmospheric Environmental Research *(Fraunhofer-Institut für Atmosphärische Umweltforschung)*, one of four globally planned centres for checking and monitoring data quality in the framework of the GAW is being established.

Central archives for globally collected data have also been established at the Institute for oceanography *(Institut für Meereskunde* – IfM; for oceanographic research data) at the University of Kiel, in the framework of the Joint Global Ocean Flux Study (JGOFS) programme; and at the Alfred Wegener Institute (AWI; for paleontological data). As part of the WCRP sub-programme World Ocean Circulation Experiment (WOCE), data assimilations (dynamic interpolation of data with the help of global models) are being carried out in a Special Analysis Centre (SAC) at the Max Planck Institute for Meteorology, in co-operation with the German Federal Institute for Navigation and Hydrography.

11. Training, education and public awareness

11.1 Impetus

In the first half of the 1990's, the topic of "climate protection" has been emphasised in environmental education, and this emphasis has reflected society's debate on global climate changes. This debate was initiated by the publications of the German Bundestag's (Parliament's) Enquete Commission on "Preventive Measures to Protect the Earth's Atmosphere". In 1989, the former Federal Ministry for Education and Science commissioned a group of experts to submit proposals for measures, based on the Enquete Commission's findings, for all sectors of training and education. These recommendations were published in 1990. They have led to a number of projects in which pedagogical concepts have been developed and tested, especially in the areas of school education and further training.

11.2 Activities in the individual sectors of training

11.2.1 Schools

At the end of 1991, a model experiment entitled "Energy use and climate" began in three Federal *Länder.* In this framework, numerous course materials have been developed and numerous further training events have been carried out.

Independently of this project, individual schools have carried out relevant projects of their own. In addition, the topic is treated in recommendations on environmental education that have been designed as a supplement to the framework guidelines *(Rahmenrichtlinien)* for specific subjects. Teachers' journals have published proposals for teaching the topic in simplified form in projects with schoolchildren. Many schools around the country now have energy-saving programmes.

11.2.2 Vocational training

An important area in this connection is that of crafts and technical professions. The Federal Institute for Vocational Training *(Bundesinstitut für Berufsbildung)* and the Society for environmentally oriented vocational training *(Gesellschaft für berufliche Umweltbildung)* have dealt with this topic in model experiments and publications – for example, A. Fischer (Ed), *Berufliche Umweltbildung und Klimaschutz. Ein Blick über die Grenzen – Ansätze und Perspektiven* (Environmentally oriented vocational training and climate protection. A look beyond our borders – approaches and perspectives), Bielefeld 1996.

11.2.3 Further training

Adult evening schools, environmental centres, church academies, academies of environmental associations and other organisations offer a wide spectrum of further training in the area of global climate change and possibilities for climate protection.

The Federal Ministry of Education, Science, Research and Technology (BMBF) promoted climate protection awareness in adult education by means of a special project entitled "Concepts for protecting the earth's atmosphere in further training", which ran from 1993 to 1995.

Under the working title, "Concrete climate protection – in training and in dialogue with citizens", the German Institut for Adult Education *(Deutsche Institut für Erwachsenenbildung)* and the Working alliance of environmental centres *(Arbeitsgemeinschaft der Umweltzentren)* have carried out numerous conferences and workshops aimed at promoting the development of topic emphases and relevant teaching methods. Since 1995, this work has been continued by means of a project entitled: "Environmental education clearinghouse" (*Clearing-Stelle Umweltbildung*), which is seeking to improve nation-wide co-ordination of the various relevant activities.

The German Ministry for the Environment has also supported further training events on the topic of "climate protection" during the period covered by this report. Examples include a further training seminar for environmental advisors of the German Housewives' Association *(Deutscher Hausfrauenbund e.V.)* on the topic of "climate protection"; a seminar offered by the University of Bonn on the topic of "Anthropogenic climate and environmental changes"; and a project entitled "Summer-smog measures for reduction of solvent emissions from painting facilities", carried out by the Health and Environmental Protection Further Training Centre (*Fortbildungszentrum Gesundheits- und Umweltschutz Berlin e.V.)*.

11.3 Activities of Non-governmental Organisations

In recent years, a number of training initiatives of Non-governmental Organisations (NGOs) have become established that deal with topics of the environment and development, including climate protection. Some of these organisations offer special environmental education for children and young people; others prefer projects that relate only indirectly to environmental education.

During the period covered by this report, the German Ministry for the Environment has again financially supported numerous projects of associations and clubs aimed at "enhancing awareness of climate protection". The following project sponsors and projects are mentioned here as examples:

– The "Mobile without a Car" action alliance; decentralised activities in support of environmentally compatible mobility are carried out by local initiative groups on a selected nation-wide "action" day.

– German Association for Environmental and Nature Protection (BUND); the “Climate and transport” campaign, the aims of which include reducing automobile traffic.

– BUND youth groups and other youth groups for nature conservation; a joint youth congress on the topic of “Turning point in the energy sector” (*Energiewende*).

– Deutscher Heimatbund e.V. (Federal Association for Nature Conservation and Environmental Protection, and for the Preservation of Customs and Historical Monuments); a young peoples’ media competition entitled “The Environment and Energy”; since 1995, this has included emphases on “Contributions to decreasing energy consumption in the household” and “The environment and renewable energies”.

– Federal Association of Home Economists *(Bundesverband der Meisterinnen der Hauswirtschaft e.V.)*; development and testing of learning concepts aimed at ecologically oriented home economics; one emphasis of this effort is on saving energy in large households.

11.4 Activities in the media

The mass media, especially TV, have repeatedly examined climate protection issues. Series such as “Globus”, “In Sachen Natur” (“In matters relating to nature”) and others reach broad audiences and help bring about the necessary increases in awareness.

Since 1994, high-circulation print media have been publishing relevant consumer tips.

For the past five years, Germany’s ARD TV network (especially its third channel) has broadcast relevant commercials; these reach a large part of the population. Since 1992, four different movie-theatre commercials have been run; these are directed primarily at a young audience.

11.5 Other activities

11.5.1 At the municipal level

Many communities are taking responsibility for climate protection. In one state *(Land)*, numerous communities have established a “Climate protection network”. This project treats climate protection as a high-priority educational task. The German Cities’ Assembly *(Deutscher Städtetag)* holds conferences and publishes a guide to municipal climate protection within the framework of the Local Agenda 21 (cf. Chap. 5.4.3).

11.5.2 Consumer protection

Consumer associations and consumer advice centres have also become involved in the climate discussion. They carry out broad-based campaigns in behalf of climate-aware consumerism. They have also developed their own range of relevant activities.

11.6 Outlook for the training sector

It is becoming apparent that, in the follow-up process to the Rio conference, efforts in the interest of climate protection will be absorbed into the more comprehensive efforts in behalf of sustainability. These efforts are holistic and less technical in their approach; i.e. they incorporate social and democratic concerns, which are often treated at the local level within the framework of a local Agenda 21. The political sector is promoting and supporting this development. This is apparent in two documents that are to appear in spring 1997:

– The Federal Government’s report to the German Bundestag on the status of environmental education,

– The global concept for environmental education of the Federal-*Länder* Commission for training-sector planning and research support *(Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung)*.

11.7 Public awareness and environmental information

Protection of the environment, along with safeguarding peace and protecting jobs, has become one of the most important issues, over the last 10 years, in public discussion in Germany. In keeping with this significance, aspects of environmental protection have been integrated into a great many different areas of social and private life. These areas span a spectrum, for example, from private consumption and recreation patterns to schooling and vocational training and to issues of social philosophy and world views.

The younger generation is particularly environmentally aware. While the middle-aged and older generations gave some consideration to environmental problems, these generations were not particularly informed about these problems. The younger generation, on the other hand, has been confronted with this problem from the very beginning, and it tends to see this problem as a threat to its future.

If environmental policy is to be effective and successful in the long term, it must be designed and explained in such a manner that the entire population, wherever possible, can identify with this policy and be willing to make its own contribution to it. Pursuant to the principles of co-operation and precaution, all citizens are called on to translate their high level of environmental awareness into a willingness to act and to take measures today in order to prevent future environmental damage. For this reason, the Federal Government considers provision of comprehensive environmental information to be an important instrument of its environmental policy. The Federal Government, and the *Länder* ministries and authorities, carry out intensive public-information campaigns in the area of climate protection – especially with regard to the possibilities for stemming climate change.

For example, in December 1995, the German Ministry for the Environment launched the *“Mensch ändere Dich”* (approximately: “Change your ways, man”) climate protection campaign. This effort was preceded by other campaigns in the framework of the UN Conference on Environment and Development in 1992 and of the 1st Conference of the Parties to the Framework Convention on Climate Change in spring 1995. The aim of the "*Mensch ändere Dich*" campaign is to make as many people as possible aware of the topic of "climate protection" and to convince as many as possible to take personal action. The campaign is emphasising the climate-relevant areas of households and transport. The emphasis of its public-information measures in 1996 was on directly contacting target groups through an "Infoline" and through a bus tour. In addition, both electronic and print media have been used to motivate citizens to change their behaviour along the lines of climate protection. The campaign has also been publicised in the Internet.

In addition, the Federal Government and individual federal ministries and departments regularly publish numerous informational materials, aimed at specific target groups, on climate-relevant issues. Finally, subordinate institutions (i.e. subordinate to the ministries) help make the public more aware of climate-protection issues by participating in exhibitions and by preparing and distributing a range of different informational materials.

Annex A: List of figures

Annex B: List of tables

Annex C: List of abbreviations

AG BM – Ad hoc-Arbeitsgruppe zum Berliner Mandat (Ad hoc Working Group for the Berlin Mandate)

AGÖL – Arbeitsgemeinschaft für Ökologischen Landbau (Working group for organic farming)

AgV – Arbeitsgemeinschaft der Verbraucherverbände (Consumer associations' working group)

AIJ – Activities Implemented Jointly

ARGEBau – Arbeitsgemeinschaft für das Bau-, Wohnungs- und Siedlungswesen (Working party of the *Länder* ministers for construction, housing and settlement)

AWI – Alfred-Wegener-Institut für Polar- und Meeresforschung (Alfred-Wegener-Institute for Polar and Ocean Research)

BAHC – Biosphären-Aspekte des Wasserkreislaufs (Biosphere Aspects of the Hydrology Cycle)

BALTEX – Baltic Sea Experiment

BauGB – Baugesetzbuch (Building Code)

BDI – Bundesverband der Deutschen Industrie e.V. Köln (Federation of German Industries)

BENSY – Berliner Energiesparsystem (Berlin Energy-saving System)

BHKW – Blockheizkraftwerk (small-scale combined heat and power (chp) station)

BImSchV – Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Ordinance on the Execution of the Federal Immission Control Act)

BINE – Bürgerinformation Neue Energietechniken, nachwachsende Rohstoffe, Umwelt (Citizens' information about new energy technologies, renewable raw materials and the environment)

BIP – Bruttoinlandsprodukt (gross domestic product)

BIZET – Berliner Impulsprogramm zum Energiespar-Transfer (Berlin impulse programme for transfer of energy-saving technology)

BMBau – Bundesministerium für Raumordnung, Bauwesen und Städtebau (Federal Ministry for Regional Planning Building and Urban Development)

BMBF – Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (Federal Ministry of Education, Science, Research and Technology)

BMF – Bundesministerium der Finanzen (Federal Ministry of Finance)

BMG – Bundesministerium für Gesundheit (Federal Ministry of Health)

BMI – Bundesministerium des Innern (Federal Ministry of the Interior)

BML – Bundesministerium für Ernährung, Landwirtschaft und Forsten (Federal Ministry of Food, Agriculture and Forestry)

BMU – Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)

BMV – Bundesministerium für Verkehr (Federal Ministry of Transport)

BMWi – Bundesministerium für Wirtschaft (Federal Ministry of Economics)

BMZ – Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry for Economic Cooperation and Development)

BR-Drs – Bundesratsdrucksache (Bundesrat printed paper)

BSE – Rinderseuche (bovine spongiform encephalopathy)

BSP – Bruttosozialprodukt (gross national product)

BTU – Brandenburgische Technische Universität Cottbus (Brandenburg Technical University, Cottbus)

BUND – Bund für Umwelt und Naturschutz Deutschland (Association for Enviromental and Nature Protection)

BVWP – Bundesverkehrswegeplan (German Traffic Infrastructure Plan)

BWaldG – Bundeswaldgesetz (Federal Forest Act)

BWI – Bundeswaldinventur (Federal Forest Inventory)

BWS – Bruttowertschöpfung (gross added value)

BZ (MCFC) – Karbonatschmelze-Brennstoffstelle (melted carbonate fuel cell)

BZ (SOFC) – Oxidkeramische-Brennstoffstelle (ceramic-oxide fuel cell)

CLIVAR – Klimavariabilität und Vorhersage (Climate Variability and Predictability)

CARMEN – Centrales Agrar-, Rohstoff-Marketing- und Entwicklungsnetz (Central network for agriculture, marketing of raw materials and development)

CDG – Carl-Duisberg-Gesellschaft (Carl-Duisberg-Society)

CE-Zeichen – Europäisches Konformitätszeichen (European mark of conformance)

CSD – VN-Kommission für nachhaltige Entwicklung (UN Commission on Sustainable Development)

DB-AG – Deutsche Bahn Aktiengesellschaft (German Railways)

DBU – Deutsche Bundesstiftung Umwelt (German Federal Environment Foundation)

DDR – Deutsche Demokratische Republik (German Democratic Republic)

DFD – Deutsches Fernerkundungsdatenzentrum (German Remote Sensing Data Centre)

Difu – Deutsches Institut für Urbanistik (German Institute for Urban Studies)

DIW – Deutsches Institut für Wirtschaftsforschung (German Institute for Economic Research)

DLR – Deutsche Forschungsanstalt für Luft- und Raumfahrt (German Aerospace Research Establishment)

DM – Deutsche Mark

DSE – Deutsche Stiftung für internationale Entwicklung Berlin (German Foundation for International Development, Berlin

DtA – Deutsche Ausgleichsbank Bonn

DWD – Deutscher Wetterdienst (German Weather Service)

ECE – Economic Commission for Europe, Wirtschaftskommission für Europa

ECU – Europäische Währungseinheit (European Currency Unit)

EDV – elektronische Datenverarbeitung (electronic data processing)

EESG – Energetische Empfehlungen zur Siedlungs- und Gebäudeplanung (Energy efficiency recommendations for planning of settlements and buildings)

EEV – Endenergieverbrauch (final energy consumption)

EG – Europäische Gemeinschaft (European Community – EC)

EMC – Energy Management Centre New Delhi

ENVISAT-1 – Umweltsatellit (Environmental satellite)

EnWg – Energiewirtschaftsgesetz (Energy Management Act)

EPS – Eunetsat Polar System

ERP – European Recovery Program (Europäisches Wiederaufbauprogramm)

ERS – European Remote Sensing Satellite

ESA – Europäische Weltraumbehörde (European Space Agency)

ESMOS – Europäische Stratosphärenüberwachungsstationen (European Stratospheric Monitoring Stations)

EU – Europäische Union (European Union)

EUMETSAT – Europäische Organisation für die Nutzung meteorologischer Satelliten (European Organisation for the Exploitation of Meteorological Satellites)

EURATOM – Europäische Atomgemeinschaft (European Atomic Energy Community)

EUREKA – Europäische Forschungsinitiative (European Reseach Initiative)

EUROTRAC – European Experiment on Transport and Transformation of Environmentally Relevant Trace Constituents in the Troposphere over Europe

EVU – Energieversorgungsunternehmen (electric company)

EW – Einwohner (inhabitant)

EWG – Europäische Wirtschaftsgemeinschaft (European Economic Community)

ExWoSt – Experimenteller Wohnungs- und Städtebau (Experimental housing construction and urban development)

FH – Fachhochschule

FhG-ISI – Fraunhofer Institut für Systemtechnik und Innovationsforschung, Karlsruhe (Fraunhofer Institute for System Technology and Innovation Research, Karlsruhe)

FIZ – Fachinformationszentrum (Technical Information Centre)

FOPS – Forschungsprogramm Stadtverkehr (City traffic research programme)

FuE – Forschung und Entwicklung (research and development)

FZJ – Forschungszentrum Jülich GmbH (Jülich Research Centre)

FZK – Forschungszentrum Karlsruhe GmbH (Karlsruhe Research Centre)

GAIM – Globale Analyse, Interpretation und Modelliering (Global Analysis, Interpretation and Modelling)

GAK – Gemeinschaftsaufgaben der Agrarstruktur und des Küstenschutzes (Joint task "Improvement of the agricultural structure and of coastal protection")

GATE – German Appropriate Technology Exchange Programme

GAW – Globale Atmosphärenüberwachung (Global Atmosphere Watch)

GCC – Globales Datenzentrum für Schiffbeobachtungen (Global Collecting Center for ships' data)

GCOS – Globales Klimaüberwachungssystem (Global Climate Observing System)

GCTE – Globaler Wandel und terrestrische Ökosysteme (Global Change and Terrestrial Ecosystems)

GEF – Globale Umweltfazilität (Global Environmental Facility)

GEW – Gas-, Elektrizitäts- und Wasserwerke Köln AG (Cologne gas, electricity and water company)

GEWEX – Globales Energie- und Wasserkreislaufprogramm (Global Energy and Water Cycle Experiment)

GFAVO – Großfeuerungsanlagen-Verordnung (Ordinance on Large Firing Installations)

GG – Grundgesetz (Germany's Basic Law)

GGO – Gemeinsame Geschäftsordnung der Bundesministerien (Common Rules of Procedure of Germany's federal ministries)

GOOS – Globales Meeresbeobachtungssystem (Global Ocean Observing System)

GRDC – Bundesanstalt für Gewässerkunde im Weltdatenzentrum für Abfluß (Global Runoff Data Centre)

GTS – Globales Telekommunikationsnetzwerk (Global Telecommunication Network)

GTZ – Gesellschaft für Technische Zusammenarbeit Eschborn (Society for technical cooperation, Eschborn)

GuD – Gas und Dampf (gas and steam)

GVFG – Gemeindeverkehrsfinanzierungsgesetz (Act on Financing of Municipal Transport)

GVZ – Güterverkehrszentren (freight centres)

GWP – Global Warning Potential (Klimawirksamkeit eines Stoffes)

HDR – Heißdampfreaktor (hot steam reactor)

HEAG – Hessische Energie Agentur GmbH (Hesse Energy Agency)

HEnG – Hessisches Energiegesetz (Hesse Energy Act)

HEW – Hamburgische Elektrizitätswerke AG (Hamburg electric company)

HOAI – Honorarordnung für Architekten und Ingenieure (Fee Table for Architects and Engineers)

HOT ELLY – Hochleistungselektrolysen (high-performance electrolysis)

IAEA – International Atomic Energy Agency

IAKF – Interessengemeinschaft Autofreie Kur- und Fremdenverkehrsorte in Bayern (interest group for auto-free spas and tourist sites in Bavaria)

ICLEI – International Council for Local Environment

ICLEI – International Council for Local Environmental Initiatives (Internationaler Rat für Kommunale Umweltinitiativen)

IDOSS – Integriertes globales System Ozeanographischer Dienste (Integrated global system of oceanographic services)

IEA – Internationale Energieagentur (International Energy Agency)

IFE – Institut für Energetik, Leipzig (Institute for Energy Research, Leipzig)

IfG – Investitionsförderungsgesetz (Investment-promotion Act for the economic recovery programme in the new Federal *Länder*)

IfO – Institut für Wirtschaftsforschung (Institute for Economic Research)

IGAC – Internationales Globales Atmosphärenprogramm (International Global Atmospheric Chemistry Project)

IGBP – International Geosphere and Biosphere Programme

IGBP-Sub-programmes – BAHC, GAIM, GCTE, IGAC, IGOFS, PAGES

IGFA – International Group of Funding Agencies for Global Change Research

IGOSS – Integriertes globales System ozeanographischer Daten und Informationen (International Oceanographic Data and Information Exchange)

IKARUS – Instrumente für Klimagas-Reduktionsstrategien (Instruments for Climate-gas Reduction Strategies)

IMA – Interministerielle Arbeitsgruppe (Interministerial Working Group)

INC – Intergovernmental Negotiating Committee

IOC – Ozeanographische Kommission (Intergovernmental Oceanographic Commission)

IODE – Internationaler Austausch ozeanographischer Daten und Informationen (International Oceanographic Data and Information Exchange)

IPCC – Zwischenstaatliches Forum für Klimaveränderungen (Intergovernmental Panel on Climate Change)

IPP – Max-Planck-Institut für Plasmaphysik (Garching) (Max-Planck-Institute for Plasma Physics, Garching)

IRRI – Internationales Reisforschungsinstitut (International Rice Research Institute)

ISIS – Intelligentes Satellitendaten-Informationssystem (Intelligent Satellite Data Information System)

J – Joule

JGOFS – Gemeinsame Studie zu globalen Meeresströmungen (Joint Global Ocean Flux Study)

KfW – Kreditanstalt für Wiederaufbau Frankfurt (Reconstruction Loan Corporation)

Kfz – Kraftfahrzeug (motor vehicle)

KMU – Kleinere und mittlere Unternehmen (small and medium-sized companies)

KRK – Klimarahmenkonvention (Framework Convention on Climate Change)

KV – Kombinierter Ladungsverkehr (combined road/rail freight systems)

KWK – Kraft-Wärme-Kopplung (combined heat and power generation)

LANIS – Landschaftsinformationssystem (Landscape Information System)

LBO – Ökologisierung der Landesbauordnung (adding an ecological orientation to the state-*Land*-building code)

LT – Landtag (state-*Land*-parliament

MAB – Der Mensch und die Biosphäre (UNESCO-Programm) (Man and the Biosphere-UNESCO programme)

MEP – Ministry of Electric Power Peking

METEOSAT – Meteorologischer Satellit (Meteorological Satellite)

METOP-1 – Meteorologischer Satellit (Meteorological Satellite)

Mio – Million

Mrd – Milliarde (billion)

MVEG – Motor Vehicle Emission Group

NDSL – Globales stratosphärisches Forschungsnetz (Network for Detection of Stratospheric Change)

NRW – Nordrhein-Westfalen (North Rhine-Westphalia)

ODP – Ozeanbohrprogramm (Ocean Drilling Programme)

OECD – Organisation for Economic Cooperation and Development (Organisation für wirtschaftliche Zusammenarbeit und Entwicklung der westlichen Industrieländer)

ONE – Office National de l’Electricité Casablanca

ÖPNV – Öffentlicher Personennahverkehr (local public transportation)

ÖUB – Allgemeine Ökologische Umweltbeobachtung (Integrated Monitoring)

ÖV – Öffentlicher Verkehr (public transportation)

PAGES – Globaler Wandel in der Vergangenheit (Past Global Changes)

PEMFC – Membranbrennstoffzelle (permeable membrane fuel cell)

Pf – Pfennig

PIK/TSHS – Potsdam Institut für Klimafolgenforschung (Potsdam Institute for Research into the Impacts of Climate Change)

PKL – Primärkreislauf (primary cycle)

Pkm – Personenkilometer (person-kilometre)

Pkw – Personenkraftwagen (automobile)

POEM-1 – Umweltsatellit (environmental satellite)

PV – Photovoltaik (photovoltaics)

REV – Rationelle Energieverwendung (efficient energy use)

RKW – Rationalisierungskuratorium der Deutschen Wirtschaft Eschorn (German industry efficiency group, Eschborn)

RME – Rapsmethylester (rape methyl ester)

r_o – mittlere Raumdichte (mean density by volume)

RWI – Rheinisch-Westfälisches Institut für Wirtschaftsforschung Essen (Rhine-Westphalian Institute for Economic Research, Essen)

SANA – Wissenschaftliches Begleitprogramm zur Sanierung der Atmosphäre über den Neuen Bundesländern (Scientific Accompanying Programme for Clean-up of the Atmosphere over the New German States)

SAVE – Begrenzung der Kohlendioxidemissionen durch eine effizientere Energienutzung (Limitation of carbon dioxide emissions through more efficient energy use (EU directive))

SKE – Steinkohleeinheit (hard coal unit)

St MGB – Mißbrauchsbekämpfungs- und Steuerbefreiungsgesetz (Act for combatting abuses and providing tax exemptions)

TA – Technische Anleitung (Technical Instructions)

TgV/ICE – Schienenverkehr-Hochgeschwindigkeitsnetz (high-speed rail network)

tkm – Tonnenkilometer (tonne-kilometre)

TOGA – Tropisches Ozean- und globales Atmosphärenprogramm (Tropical Ocean and Global Atmosphere Programme)

TRAM – Transient and Accident Management

TWD – Transluzente Wärmedämmung (translucent thermal insulation)

UAN – Vereinigung der Kommunalen Umwelt Aktion (Association of community environmental action programmes)

UBA – Umweltbundesamt Berlin (Federal Environmental Agency)

UFIS – Umweltforschungsinformationssysteme (Environmental research informationsystems)

UFOKAT – Umweltforschungskatalog (Environmental research catalogue)

UMEG – Umweltmeß- und Erhebungsgesellschaft (Environmental measurement and survey company)

UMK – Umweltministerkonferenz (Conference of Ministers for the Environment)

UMPLIS – Umweltinformationssystem (Environmental information system)

UNCED – Konferenz der Vereinten Nationen über Umwelt und Entwicklung (United Nations Conference on Environment and Development)

UNEP – United Nations Environment Programme (Umweltprogramm der Vereinten Nationen)

UNESCO – United Nations Educational, Scientific and Cultural Organisation (Organisation der Vereinten Nationen für Erziehung, Wissenschaft und Kultur)

UPTF – Upper Plenum Test Facility Anlage Mannheim

US $ – U.S. dollar

UV-Strahlen – Ultraviolette Strahlen (ultraviolet radiation)

VAP – Verkehrsauswirkungsprüfung (traffic impact assessment)

VEP – Integrierter Verkehrsentwicklungsplan (integrated traffic development plan)

Vfm – Vorratsfestmeter (cubic metre measure used for wood)

VKU – Verband Kommunaler Unternehmen (Association of Municipal Companies)

VN – Vereinte Nationen (United Nations)

VO – Verordnung (ordinance)

VOC – Flüchtige, organische Verbindungen (volatile organic compounds)

VOS – Freiwillige Beobachtungsschiffe (voluntary observing ships)

VSK – Vertragsstaatenkonferenz (Conference of the Parties to the Framework Convention on Climate Change)

WAP – Wirtschaftspolitisches Aktionsprogramm (Economic policy action programme)

WCRP – Weltklimaforschungsprogramm (World Climate Research Programme)

WMO – Weltorganisation für Meteorologie (World Meteorological Organisation)

WOCE – Internationales Experiment zu Meeresströmungen (World Ocean Circulation Experiment)

WSchV – Wärmeschutzverordnung (Ordinance on Heat Insulation)

WWW – Internationale Wetterbeobachtung (World Weather Watch)

ZADI – Zentralstelle für Agrarinformation und -dokumentation (Central agency for agricultural information and documentation)

ZAMV – Zentrum für Atmosphärische und Marine Wissenschaften (Centre for Atmospheric and Marine Sciences)

ZAR – Zentralafrikanische Republik (Central African Republic)

ZDH – Zentralverband des Deutschen Handwerks (German Crafts Federation)

ZEWU – Zentrum für Energie, Wasser und Umwelttechnik der Handwerkskammer Hamburg (Hamburg's Crafts Chambre's centre for energy, water and environmental technology)

ZGB – Zentralstelle für gewerbliche Berufsförderung Mannheim (Central agency for promotion of industrial occupations, Mannheim)

ZUDIS – Zentrales Klima- und Umweltdateninformationssystem (Central Climate and Environmental Data Information System)

Annex D:

Chemical formulas, units, conversion factors

C	– carbon
CF_4	– tetrafluoromethane
C_2F_6	– hexafluoroethane
CaO	– burnt lime
CHC	– chlorohydrocarbons
CH_4	– methane
CO	– carbon monoxide
CO_2	– carbon dioxide
CFC	– chlorofluorocarbons
PFC	– perfluorocarbons (includes CF_4 and C_2F_6)
H-CFC	– partially halogenated fluorocarbons
HFC	– hydrofluorocarbons
K	– potassium
N	– nitrogen
N_2O	– nitrous oxide
NH_3	– ammonia
NMVOC	– non-methane volatile organic compounds
NO_2	– nitrogen dioxide
NOx	– nitrogen oxides
P_2O_5	– phosphate
PFC	– perfluorocarbons (includes CF_4 and C_2F_6)
SF_6	– sulphur hexafluoride
SO_2	– sulphur dioxide
VOC	– volatile organic compounds

Units:

%	percent
a	year
°C	degrees Celsius
g	gram
ha	hectare
J	joule[2)]
l	litre
m	metre
ppm	parts per million (10^{-6}),
ppb	parts per billion (10^{-9})
ppt	parts per trillion (10^{-12})
t	tonne
W	watt

Prefixes and their symbols:

kilo	k	10^3 thousand
mega	M	10^6 million
giga	G	10^9 billion
tera	T	10^{12} trillion
peta	P	10^{15} quadrillion
exa	E	10^{18} quintillion

Mass relationship:

$CO_2/C = 3{,}67$

Conversion factors[1) 2)]:

	kJ	kcal	kWh	kg HCU	kg COU	m^3 natural gas
1 kilojoule (kJ)	–	0,2388	0,000278	0,000034	0,000024	0,00032
1 kilocalorie (kcal)	4,1868	–	0,001163	0,00143	0,0001	0,00013
1 kilowatt-hour (kWh)	3600	860	–	0,123	0,086	0,113
1 kg hard coal units (HCU)	29,308	7000	8,14	–	0,7	0,923
1 kg crude oil units (COU)	41868	10000	11,63	1,428	–	1,319
1 m^3 natural gas	31736	7580	8,816	1,083	0,758	–

1) The figures refer to the thermal value (= "lower thermal value")
2) As of 1 January 1978 in Germany, the joule is the legally mandated unit for energy. Units such as hard coal units (HCU) and crude oil units (COU) (1 HCU = 0.7 COU) may be used only additionally, in the interest of clarity, for a transition period.

Annex E: CO_2 -Emissions according to IPCC Reference Approach

E 1 CO_2-Emissionen 1987 nach IPCC-Referenzmethode

Fuel Types			Pro-duction TJ	Imports TJ	Exports TJ	Inter-national Bunkers TJ	Stock Increase TJ	Stock Decrease TJ	Stock Change TJ	Apparent Con-sumption TJ	Carbon Emission Factor Mg C / TJ	Carbon Content Gg C	Carbon Stored *) Gg C	Net Carbon Emission Gg C	Fraction of Carbon Oxidised %	CO_2 Emission Gg CO_2
			A	B	C	D	E	F	G G=(E–F)	H H=(A+B –C–D–G)	I	J J=(H*I)	K	L	M	N N=([L+M]* [44/12])
Liquid Fuel	Primary Fuels	Crude Oil	163305	3536643	43		23780	0	23780	3014125	20,0	60283		60283	99,0	218825
		Natural Gas Liquids	12000	0	0		0	0	0	12000	17,2	206		206	99,0	749
	Secondary Fuels	Gasoline		379521	83721	0	0	5180	-5180	300980	18,9	5689		5689	99,0	20649
		Jet Kerosene		13455	910	1366	0	0	0	11179	19,5	218		218	99,0	791
		Other Kerosene		85965	4653	117423	2135	0	2135	-38246	19,6	-750		-750	99,0	-2721
		Gas / Diesel Oil		1053233	145803	30456	12159	41936	-29777	906751	20,2	18300	587	17712	99,0	64296
		Residual Fuel Oil		343293	159650	115181	121	22485	-22364	90826	21,1	1916	512	1405	99,0	5099
		LPG		48416	23785		46	1881	-1835	26466	17,2	455	492	-37	99,0	-135
		Ethane							0	0				0	99,0	0
		Naphta		223201	7402		7751	0	7751	208048	20,0	4161	3588	573	99,0	2080
		Bitumen		9043	15273		0	1206	-1206	-5024	22,0	-111		-111	99,0	-401
		Lubricants		13745	45011	1830	0	4711	-4711	-28385	20,0	-568		-568	99,0	-2061
		Petroleum Coke		38218	10903		1553	0	1553	25762	27,5	710	381	329	99,0	1193
		Refinery Feedstocks		0	0		0	0	0	650000	20,0	13000	194	12806	99,0	46486
		Other Oil		16545	9283		1064	0	1064	6198	20,0	124	5111	-4987	99,0	-18103
Liquid Fuels Totals			**175305**	**5761278**	**506437**	**266256**	**48609**	**77399**	**-28790**	**5192680**		**103634**	**10866**	**92768**		**336748**
Solid Fuels	Primary Fuels	Anthracene							0	0						
		Coking Coal							0	0						
		Other Bituminous Coal	2264913	384727	195356	0	0	19603	-19603	2473887	25,8	63826	1748	62079	98,0	223070
		Subbituminous Coal							0	0				0		0
		Lignite	3601799	0	32		0	1918	-1918	3603685	28,5	102705	616	102089	98,0	366840
		Peat	3772	0	3203		0	0	0	569	28,9	16		16	99,0	60
	Secondary Fuels	Patent Fuel		63	11053		94	0	94	-11084	25,8	-286		-286	98,0	-1028
		BKB		54714	80472		4871	5873	-1002	-24756	25,8	-639		-639	98,0	-2295
		Coke oven coke		73499	82460		39995	1872	38123	-47084	29,5	-1389		-1389	98,0	-4991
		Gas coke		1543	11667		1306	260	1046	-11170	29,5	-330		-330	98,0	-1184
		Derived gases		0	203		913	0	913	-1116	12,0	-13		-13	98,0	-48
Solid Fuels Totals			**5870484**	**514546**	**384243**	**0**	**46266**	**29526**	**16740**	**5984047**		**163905**	**2363**	**1611541**		**580472**
Gaseous Fuels		Natural Gas (Dry)	705022	1666380	51603		33737	0	33737	2286062	15,3	34914	620	34295	99,5	125118
TOTAL			**6750811**	**7942204**	**942283**	**266256**	**128612**	**106925**	**21687**	**13462789**		**302453**	**13849**	**288604**		**1042338**
Biomass		Solid biomass							0	0						
		Liquid biomass							0	0						
		Gas biomass							0	0						
Biomass Total									**0**	**0**						

*) Vergleiche Tabelle: CO_2-Emissionen 1987 nach IPCC-Referenzmethode (Kohlenstoffestlegung)
Quelle: Umweltbundesamt

E 2 CO_2-Emissionen 1990 nach IPCC-Referenzmethode

Fuel Types			Production TJ	Imports TJ	Exports TJ	International Bunkers TJ	Stock Increase TJ	Stock Decrease TJ	Stock Change TJ	Apparent Consumption TJ	Carbon Emission Factor Mg C / TJ	Carbon Content Gg C	Carbon Stored *) Gg C	Net Carbon Emission Gg C	Fraction of Carbon Oxidised %	CO_2 Emission Gg CO_2
			A	B	C	D	E	F	G G=(E–F)	H H=(A+B –C–D–G)	I	J J=(H*I)	K	L	M	N N=([L+M]* [44/12])
Liquid Fuel	Primary Fuels	Crude Oil	155909	3727125	0		16442	0	16442	3206531	20,0	64131		64131	99,0	232794
		Natural Gas Liquids	10061	0	0		0	0	0	10061	17,2	173		173	99,0	628
	Secondary Fuels	Gasoline		460602	136727	0	0	23949	-23949	347824	18,9	6574		6574	99,0	23863
		Jet Kerosene		11670	1044	1950	6619	0	6619	2057	19,5	40		40	99,0	146
		Other Kerosene		110478	3587	154663	0	4777	-4777	-42995	19,6	-843		-843	99,0	-3059
		Gas / Diesel Oil		792999	243025	23336	0	96490	-96490	623128	20,2	12576	712	11864	99,0	43065
		Residual Fuel Oil		248462	129916	80230	0	12803	-12803	51119	21,1	1079	792	287	99,0	1042
		LPG		31616	23231		0	1655	-1655	10040	17,2	173	564	-392	99,0	-1422
		Ethane							0	0				0	99,0	0
		Naphta		264916	14456		1437	871	566	249894	20,0	4998	5721	-723	99,0	-2623
		Bitumen		13565	14269		1734	0	1734	-2438	22,0	-54		-54	99,0	-195
		Lubricants		4633	54665	1791	8054	0	8054	-59877	20,0	-1198		-1198	99,0	-4347
		Petroleum Coke		37544	13365		1612	0	1612	22567	27,5	622	328	293	99,0	1065
		Refinery Feedstocks		0	0		0	0	0	650000	20,0	13000	202	12798	99,0	46458
		Other Oil		18151	9630		1498	0	1498	7023	20,0	140	4389	-4248	99,0	-15422
Liquid Fuels Totals			**165970**	**5721761**	**643915**	**261971**	**37396**	**140545**	**-103149**	**5084994**		**101411**	**12708**	**88703**		**321993**
Solid Fuels	Primary Fuels	Anthracene							0	0						
		Coking Coal							0	0						
		Other Bituminous Coal	2089305	357551	163451	0	0	45880	-45880	2329285	25,8	60096	1233	58863	98,0	211513
		Subbituminous Coal							0	0				0		0
		Lignite	3142191	375	916		359	38141	-37782	3179432	28,5	90614	526	90087	98,0	323714
		Peat	3559	0	3274		0	0	0	285	28,9	8		8	99,0	30
	Secondary Fuels	Patent Fuel		1884	11933		0	377	-377	-9672	25,8	-250		-250	98,0	-897
		BKB		54421	76159		614	45665	-45051	23313	25,8	601		601	98,0	2161
		Coke oven coke		55517	70732		10486	5716	4770	-19985	29,5	-590		-590	98,0	-2118
		Gas coke		4631	14594		0	7932	-7932	-2031	29,5	-60		-60	98,0	-215
		Derived gases		0	191		0	1205	-1205	1014	12,0	12		12	98,0	44
Solid Fuels Totals			**5235055**	**474379**	**341059**	**0**	**11459**	**143711**	**-132252**	**5500627**		**150420**	**1759**	**148661**		**534188**
Gaseous Fuels		Natural Gas (Dry)	588649	1791411	40633		22725	0	22725	2316702	15,3	35382	477	34906	99,5	127348
TOTAL			**5989674**	**7987551**	**1025607**	**261971**	**71580**	**284256**	**-212676**	**12902323**		**287213**	**14944**	**272270**		**983528**
Biomass		Solid biomass							0	0						
		Liquid biomass							0	0						
		Gas biomass							0	0						
Biomass Total									**0**	**0**						

*) Vergleiche Tabelle: CO_2-Emissionen 1990 nach IPCC-Referenzmethode (Kohlenstoffestlegung)
Quelle: Umweltbundesamt

E 3 CO_2-Emissionen 1991 nach IPCC-Referenzmethode

Fuel Types			Production TJ	Imports TJ	Exports TJ	International Bunkers TJ	Stock Increase TJ	Stock Decrease TJ	Stock Change TJ	Apparent Consumption TJ	Carbon Emission Factor Mg C / TJ	Carbon Content Gg C	Carbon Stored *) Gg C	Net Carbon Emission Gg C	Fraction of Carbon Oxidised %	CO_2 Emission Gg CO_2
			A	B	C	D	E	F	G G=(E–F)	H H=(A+B –C–D–G)	I	J J=(H*I)	K	L	M	N N=([L+M]* [44/12])
Liquid Fuel	Primary Fuels	Crude Oil	148521	3762814	0		0	4062	-4062	3255801	20,0	65116		65116	99,0	236371
		Natural Gas Liquids	9596	0	0		0	0	0	9596	17,2	165		165	99,0	599
	Secondary Fuels	Gasoline		400595	95838	0	0	9144	-9144	313901	18,9	5933		5933	99,0	21536
		Jet Kerosene		6183	218	1916	9057	0	9057	-5008	19,5	-98		-98	99,0	-354
		Other Kerosene		115901	1239	151688	0	6235	-6235	-30791	19,6	-604		-604	99,0	-2191
		Gas / Diesel Oil		933959	100741	19303	6918	51459	-44541	858456	20,2	17325	594	16731	99,0	60733
		Residual Fuel Oil		201872	76030	68029	5950	0	5950	51863	21,1	1094	708	386	99,0	1402
		LPG		42123	19960		0	230	-230	22393	17,2	385	528	-143	99,0	-518
		Ethane							0	0				0	99,0	0
		Naphta		298444	9840		1307	0	1307	287297	20,0	5746	5835	-89	99,0	-322
		Bitumen		12095	13157		1432	0	1432	-2494	22,0	-55		-55	99,0	-199
		Lubricants		10746	44972	2025	3192	0	3192	-39443	20,0	-789		-789	99,0	-2864
		Petroleum Coke		34232	13745		1055	0	1055	19432	27,5	535	290	246	99,0	892
		Refinery Feedstocks		0	0		0	0	0	650000	20,0	13000	207	12793	99,0	46437
		Other Oil		16734	8089		967	424	543	8102	20,0	162	4427	-4265	99,0	-15482
Liquid Fuels Totals			**158117**	**5835698**	**383829**	**242961**	**29878**	**71554**	**-41676**	**5408701**		**107917**	**12589**	**95328**		**346040**
Solid Fuels	Primary Fuels	Anthracene							0	0						
		Coking Coal							0	0						
		Other Bituminous Coal	1979914	408559	106408	0	0	59700	-59700	2341765	25,8	60418	585	59832	98,0	214998
		Subbituminous Coal							0	0				0		0
		Lignite	2461692	8583	113		0	23362	-23362	2493524	28,5	71065	554	70511	98,0	253370
		Peat	2704	0	2562		0	0	0	142	28,9	4		4	99,0	15
	Secondary Fuels	Patent Fuel		251	9766		377	0	377	-9892	25,8	-255		-255	98,0	-917
		BKB		41074	27652		2952	4831	-1879	15301	25,8	395		395	98,0	1419
		Coke oven coke		38754	49271		0	4888	-4888	-5629	29,5	-166		-166	98,0	-597
		Gas coke		450	2853		0	552	-552	-1851	29,5	-55		-55	98,0	-196
		Derived gases		0	192		0	1423	-1423	1231	12,0	15		15	98,0	53
Solid Fuels Totals			**4444310**	**497671**	**198625**	**0**	**3329**	**93333**	**-90004**	**4833360**		**131406**	**1139**	**130266**		**468091**
Gaseous Fuels		Natural Gas (Dry)	580760	1880897	52962		0	24151	-24151	2432846	15,3	37156	313	36844	99,5	134418
TOTAL			**5183187**	**8214266**	**635416**	**242961**	**33207**	**189038**	**-155831**	**12674907**		**276479**	**14041**	**262438**		**948549**
Biomass		Solid biomass							0	0						
		Liquid biomass							0	0						
		Gas biomass							0	0						
Biomass Total									**0**	**0**						

*) Vergleiche Tabelle: CO_2-Emissionen 1991 nach IPCC-Referenzmethode (Kohlenstoffestlegung)
Quelle: Umweltbundesamt

E 4 CO_2-Emissionen 1992 nach IPCC-Referenzmethode

Fuel Types			Production TJ	Imports TJ	Exports TJ	International Bunkers TJ	Stock Increase TJ	Stock Decrease TJ	Stock Change TJ	Apparent Consumption TJ	Carbon Emission Factor Mg C / TJ	Carbon Content Gg C	Carbon Stored *) Gg C	Net Carbon Emission Gg C	Fraction of Carbon Oxidised %	CO_2 Emission Gg CO_2
			A	B	C	D	E	F	G G=(E–F)	H H=(A+B –C–D–G)	I	J J=(H·I)	K	L	M	N N=([L+M]· [44/12])
Liquid Fuel	Primary Fuels	Crude Oil	140114	4202144	8820		57681	0	57681	3615696	20,0	72314		72314	99,0	262500
		Natural Gas Liquids	10061	0	0		0	0	0	10061	17,2	173		173	99,0	628
	Secondary Fuels	Gasoline		406430	114387	0	3222	0	3222	288821	18,9	5459		5459	99,0	19815
		Jet Kerosene		2874	218	1358	0	131	-131	1429	19,5	28		28	99,0	101
		Other Kerosene		134733	3416	163509	6747	0	6747	-38939	19,6	-763		-763	99,0	-2770
		Gas / Diesel Oil		856706	151005	18961	14477	40441	-25964	712704	20,2	14384	515	13868	99,0	50342
		Residual Fuel Oil		176392	182260	54038	0	5908	-5908	-53998	21,1	-1139	745	-1884	99,0	-6839
		LPG		38820	25421		0	2799	-2799	16198	17,2	279	553	-275	99,0	-996
		Ethane							0	0				0	99,0	0
		Naphta		293174	19246		0	3745	-3745	277673	20,0	5553	5893	-339	99,0	-1231
		Bitumen		9269	11079		339	0	339	-2149	22,0	-47		-47	99,0	-172
		Lubricants		14329	45050	2219	2336	0	2336	-35276	20,0	-706		-706	99,0	-2561
		Petroleum Coke		34496	15299		293	0	293	18904	27,5	521	297	223	99,0	811
		Refinery Feedstocks		0	0		0	0	0	650000	20,0	13000	218	12782	99,0	46398
		Other Oil		15489	4122		0	0	0	11367	20,0	227	4770	-4543	99,0	-16491
Liquid Fuels Totals			**150175**	**6184856**	**580323**	**240085**	**85095**	**53024**	**32071**	**5482552**		**109282**	**12991**	**96291**		**349535**
Solid Fuels	Primary Fuels	Anthracene							0	0						
		Coking Coal							0	0						
		Other Bituminous Coal	1957494	409358	51120	0	106571	0	106571	2209161	25,8	56996	430	56567	98,0	203263
		Subbituminous Coal							0	0				0		0
		Lignite	2128641	9478	19		0	15363	-15363	2153463	28,5	61374	604	60770	98,0	218366
		Peat	2776	0	2634		0	0	0	142	28,9	4		4	99,0	15
	Secondary Fuels	Patent Fuel		408	8667		157	0	157	-8416	25,8	-217		-217	98,0	-780
		BKB		42735	18992		5650	3553	2097	21646	25,8	558		558	98,0	2007
		Coke oven coke		52431	36872		26074	0	26074	-10515	29,5	-310		-310	98,0	-1115
		Gas coke		360	462		0	1233	-1233	1131	29,5	33		33	98,0	120
		Derived gases		0	176		0	3167	-3167	2991	12,0	36		36	98,0	129
Solid Fuels Totals			**4088911**	**514770**	**118766**	**0**	**138452**	**20149**	**118303**	**4366612**		**118439**	**1034**	**117405**		**421875**
Gaseous Fuels		Natural Gas (Dry)	590685	1927962	61944		49159	0	49159	2407544	15,3	36770	338	36432	99,5	132914
TOTAL			**4829771**	**8627588**	**761033**	**240085**	**272706**	**73173**	**199533**	**12256708**		**264490**	**14363**	**250127**		**904325**
Biomass		Solid biomass							0	0						
		Liquid biomass							0	0						
		Gas biomass							0	0						
Biomass Total									**0**	**0**						

*) Vergleiche Tabelle: CO_2-Emissionen 1992 nach IPCC-Referenzmethode (Kohlenstoffestlegung)
Quelle: Umweltbundesamt

E 5 CO_2-Emissionen 1993 nach IPCC-Referenzmethode

Fuel Types			Production TJ	Imports TJ	Exports TJ	International Bunkers TJ	Stock Increase TJ	Stock Decrease TJ	Stock Change TJ	Apparent Consumption TJ	Carbon Emission Factor Mg C / TJ	Carbon Content Gg C	Carbon Stored *) Gg C	Net Carbon Emission Gg C	Fraction of Carbon Oxidised %	CO_2 Emission Gg CO_2
			A	B	C	D	E	F	G G=(E–F)	H H=(A+B –C–D–G)	I	J J=(H*I)	K	L	M	N N=([L+M]* [44/12])
Liquid Fuel	Primary Fuels	Crude Oil	130567	4252132	4617		0	12773	-12773	3731252	20,0	74625		74625	99,0	270889
		Natural Gas Liquids	9603	0	0		0	0	0	9603	17,2	165		165	99,0	600
	Secondary Fuels	Gasoline		351741	152444	0	0	34834	-34834	234131	18,9	4425		4425	99,0	16063
		Jet Kerosene		4615	87	975	131	0	131	3422	19,5	67		67	99,0	242
		Other Kerosene		128441	2838	173238	5332	0	5332	-52967	19,6	-1038		-1038	99,0	-3769
		Gas / Diesel Oil		856632	154556	21093	0	54425	-54425	735408	20,2	14842	493	14349	99,0	52087
		Residual Fuel Oil		226301	195272	70059	0	6295	-6295	-32735	21,1	-691	652	-1343	99,0	-4875
		LPG		36330	29111		0	7312	-7312	14531	17,2	250	657	-408	99,0	-1479
		Ethane							0	0				0	99,0	0
		Naphta		276628	25564		0	18656	-18656	269720	20,0	5394	6070	-675	99,0	-2452
		Bitumen		8516	9595		38	0	38	-1117	22,0	-25		-25	99,0	-89
		Lubricants		30801	46300	2191	0	4940	-4940	-12750	20,0	-255		-255	99,0	-926
		Petroleum Coke		37656	14858		682	0	682	22116	27,5	609	411	198	99,0	720
		Refinery Feedstocks		0	0		0	0	0	650000	20,0	13000	211	12789	99,0	46424
		Other Oil		11018	4969		185	0	185	5864	20,0	117	4406	-4289	99,0	-15569
Liquid Fuels Totals			**140170**	**6220811**	**640211**	**267557**	**6368**	**139235**	**-132867**	**5586080**		**111486**	**12901**	**98586**		**357866**
Solid Fuels	Primary Fuels	Anthracene							0	0						
		Coking Coal							0	0						
		Other Bituminous Coal	1734566	345960	30070	0	0	50967	-50967	2101423	25,8	54217	524	53282	98,0	191461
		Subbituminous Coal							0	0				0		0
		Lignite	1938628	7612	9		0	11096	-11096	1957327	28,5	55784	426	55769	98,0	200395
		Peat	2705	0	2562		0	0	0	143	28,9	4		4	99,0	15
	Secondary Fuels	Patent Fuel		2323	7033		534	0	534	-5244	25,8	-135		-135	98,0	-486
		BKB		38913	15699		0	1046	-1046	24260	25,8	626		626	98,0	2249
		Coke oven coke		58865	18336		1571	0	1571	38958	29,5	1149		1149	98,0	4130
		Gas coke		884	359		0	551	-551	1076	29,5	32		32	98,0	114
		Derived gases		0	160		0	2207	-2207	2047	12,0	25		25	98,0	88
Solid Fuels Totals			**3675899**	**454557**	**74068**	**0**	**2105**	**63660**	**-61555**	**4117943**		**111676**	**950**	**110727**		**397878**
Gaseous Fuels		Natural Gas (Dry)	588201	2056937	69071		29642	0	29642	2546425	15,3	38891	280	38611	99,5	140864
TOTAL			**4404270**	**8732305**	**783350**	**267557**	**38115**	**202895**	**-164780**	**12250448**		**262053**	**14131**	**247923**		**896608**
Biomass		Solid biomass							0	0						
		Liquid biomass							0	0						
		Gas biomass							0	0						
Biomass Total									**0**	**0**						

*) Vergleiche Tabelle: CO_2-Emissionen 1993 nach IPCC-Referenzmethode (Kohlenstoffestlegung)
Quelle: Umweltbundesamt

E 6 CO_2-Emissionen 1987 nach IPCC-Referenzmethode (Kohlenstoffestlegung)

Fuel Types		**Estimated Fuel Quantities** TJ	**Carbon Emission Factor** Mg C / TJ	**Carbon Content** Gg C	**Fraction of Carbon Stored**	**Carbon Stored** *) Gg C	**CO_2 Stored** Gg CO_2
		A	B	C CO(A*B)	D	E E=(C*D)	F F=(E*44/12)
Liquid Fuel	Gas / Diesel Oil	58164	20,2	1175	0,5	587	2154
	Residual Fuel Oil	48499	21,1	1023	0,5	512	1876
	LPG	35792	17,2	616	0,8	492	1806
	Naphta	224246	20,0	4485	0,8	3588	13156
	Petroleum Coke	17320	27,5	476	0,8	381	1397
	Refinery gas	19392	20,0	388	0,5	194	711
	Lubricants Bitumen	256191	21,0	5380	0,95	5111	18740
Liquid Fuels Totals		**659604**		**13543**		**10866**	**39840**
Solid Fuels	Coking Coal	242	25,8	6	1	6	23
	Coke oven coke	22413	29,5	661	1	661	2424
	Tar	11643	28,9	336	1	336	1234
	Coal Oils	21995	28,0	616	1	616	2258
	Lignite	0	28,0	0	1	0	0
	Gas Coke	25208	29,5	744	1	744	2727
	Pulverised Coal	0	27,6	0	1	0	0
Solid Fuels Totals		**81501**		**2363**		**2363**	**8666**
Gaseous Fuels	Natural Gas	122755	15,3	1878	0,33	620	2273
Gaseous Fuels Totals		**122755**		**1878**		**620**	**2273**
TOTAL		**863860**		**17784**		**13849**	**50779**

*) Vergleiche Tabelle: CO_2-Emissionen 1987 nach IPCC-Referenzmethode
Quelle: Umweltbundesamt

E 7 CO_2-Emissionen 1990 nach IPCC-Referenzmethode (Kohlenstoffestlegung)

Fuel Types		**Estimated Fuel Quantities** TJ	**Carbon Emission Factor** Mg C / TJ	**Carbon Content** Gg C	**Fraction of Carbon Stored**	**Carbon Stored** *) Gg C	**CO_2 Stored** Gg CO_2
		A	B	C CO(A*B)	D	E E=(C*D)	F F=(E*44/12)
Liquid Fuel	Gas / Diesel Oil	70526	20,2	1425	0,5	712	2612
	Residual Fuel Oil	75035	21,1	1583	0,5	792	2903
	LPG	41023	17,2	706	0,8	564	2070
	Naphta	357532	20,0	7151	0,8	5721	20975
	Petroleum Coke	14918	27,5	410	0,8	328	1203
	Refinery gas	20165	20,0	403	0,5	202	739
	Lubricants Bitumen	219994	21,0	4620	0,95	4389	16093
Liquid Fuels Totals		**799193**		**16298**		**12708**	**46595**
Solid Fuels	Coking Coal	216	25,8	6	1	6	20
	Coke oven coke	18571	29,5	548	1	548	2009
	Tar	12209	28,9	353	1	353	1294
	Coal Oils	18798	28,0	526	1	526	1930
	Lignite	0	28,0	0	1	0	0
	Gas Coke	11076	29,5	327	1	327	1198
	Pulverised Coal	3374	27,6	93	1	93	341
Solid Fuels Totals		**64244**		**1852**		**1852**	**6792**
Gaseous Fuels	Natural Gas	94411	15,3	1444	0,33	477	1748
Gaseous Fuels Totals		**94411**		**1444**		**477**	**1748**
TOTAL		**957848**		**19594**		**15037**	**55135**

*) Vergleiche Tabelle: CO_2-Emissionen 1990 nach IPCC-Referenzmethode
Quelle: Umweltbundesamt

E 8 CO_2-Emissionen 1991 nach IPCC-Referenzmethode (Kohlenstoffestlegung)

Fuel Types		**Estimated Fuel Quantities** TJ	**Carbon Emission Factor** Mg C / TJ	**Carbon Content** Gg C	**Fraction of Carbon Stored**	**Carbon Stored** *) Gg C	**CO_2 Stored** Gg CO_2
		A	B	C CO(A·B)	D	E E=(C·D)	F F=(E*44/12)
Liquid Fuel	Gas / Diesel Oil	58847	20,2	1189	0,5	594	2179
	Residual Fuel Oil	67127	21,1	1416	0,5	708	2597
	LPG	38362	17,2	660	0,8	528	1935
	Naphta	364673	20,0	7293	0,8	5835	21394
	Petroleum Coke	13160	27,5	362	0,8	290	1062
	Refinery gas	20746	20,0	415	0,5	207	761
	Lubricants Bitumen	221902	21,0	4660	0,95	4427	16232
Liquid Fuels Totals		**784817**		**15995**		**12589**	**46160**
Solid Fuels	Coking Coal	0	25,8	0	1	0	0
	Coke oven coke	9851	29,5	291	1	291	1066
	Tar	5878	28,9	170	1	170	623
	Coal Oils	19799	28,0	554	1	554	2033
	Lignite	789	28,0	22	1	22	81
	Gas Coke	3476	29,5	103	1	103	376
	Pulverised Coal	3694	27,6	102	1	102	374
Solid Fuels Totals		**43487**		**1241**		**1241**	**4552**
Gaseous Fuels	Natural Gas	61908	15,3	947	0,33	313	1146
Gaseous Fuels Totals		**61908**		**947**		**313**	**1146**
TOTAL		**890212**		**18184**		**14143**	**51858**

*) Vergleiche Tabelle: CO_2-Emissionen 1991 nach IPCC-Referenzmethode
Quelle: Umweltbundesamt

E 9 CO_2-Emissionen 1992 nach IPCC-Referenzmethode (Kohlenstoffestlegung)

Fuel Types		**Estimated Fuel Quantities** TJ	**Carbon Emission Factor** Mg C / TJ	**Carbon Content** Gg C	**Fraction of Carbon Stored**	**Carbon Stored** *) Gg C	**CO_2 Stored** Gg CO_2
		A	B	C CO(A·B)	D	E E=(C·D)	F F=(E·44/12)
Liquid Fuel	Gas / Diesel Oil	51031	20,2	1031	0,5	515	1890
	Residual Fuel Oil	70573	21,1	1489	0,5	745	2730
	LPG	40197	17,2	691	0,8	553	2028
	Naphta	368285	20,0	7366	0,8	5893	21606
	Petroleum Coke	13511	27,5	372	0,8	297	1090
	Refinery gas	21808	20,0	436	0,5	218	800
	Lubricants Bitumen	239118	21,0	5021	0,95	4770	17491
Liquid Fuels Totals		**804523**		**16406**		**12991**	**47635**
Solid Fuels	Coking Coal	0	25,8	0	1	0	0
	Coke oven coke	8504	29,5	251	1	251	920
	Tar	4521	28,9	131	1	131	479
	Coal Oils	21571	28,0	604	1	604	2215
	Lignite	586	28,0	16	1	16	60
	Gas Coke	1076	29,5	32	1	32	116
	Pulverised Coal	3701	2716	102	1	102	375
Solid Fuels Totals		**39959**		**1136**		**1136**	**4165**
Gaseous Fuels	Natural Gas	66995	15,3	1025	0,33	338	1240
Gaseous Fuels Totals		**66995**		**1025**		**338**	**1240**
TOTAL		**911477**		**18567**		**14465**	**53040**

*) Vergleiche Tabelle: CO_2-Emissionen 1992 nach IPCC-Referenzmethode
Quelle: Umweltbundesamt

E 10 CO_2-Emissionen 1993 nach IPCC-Referenzmethode (Kohlenstoffestlegung)

Fuel Types		**Estimated Fuel Quantities** TJ	**Carbon Emission Factor** Mg C / TJ	**Carbon Content** Gg C	**Fraction of Carbon Stored**	**Carbon Stored** *) Gg C	**CO_2 Stored** Gg CO_2
		A	B	C CO(A*B)	D	E E=(C*D)	F F=(E*44/12)
Liquid Fuel	Gas / Diesel Oil	48804	20,2	986	0,5	493	1807
	Residual Fuel Oil	61815	21,1	1304	0,5	652	2391
	LPG	47781	17,2	822	0,8	657	2411
	Naphta	379368	20,0	7587	0,8	6070	22256
	Petroleum Coke	18673	27,5	514	0,8	411	1506
	Refinery gas	21114	20,0	422	0,5	211	774
	Lubricants Bitumen	220862	21,0	4638	0,95	4406	16156
Liquid Fuels Totals		**798417**		**16273**		**12901**	**47302**
Solid Fuels	Coking Coal	0	25,8	0	1	0	0
	Coke oven coke	7103	29,5	210	1	210	768
	Tar	6218	28,9	180	1	180	659
	Coal Oils	14676	28,0	411	1	411	1507
	Lignite	546	28,0	15	1	15	56
	Gas Coke	1943	29,5	57	1	57	210
	Pulverised Coal	2787	27,6	77	1	77	282
Solid Fuels Totals		**33273**		**950**		**950**	**3482**
Gaseous Fuels	Natural Gas	55506	15,3	849	0,33	280	1028
Gaseous Fuels Totals		**55506**		**849**		**280**	**1028**
TOTAL		**887196**		**18072**		**14131**	**51812**

*) Vergleiche Tabelle: CO_2-Emissionen 1993 nach IPCC-Referenzmethode
Quelle: Umweltbundesamt

Annex F: Emission factors

Reference data and emission factors (according to IPCC Standard Data Table) for determining emissions of greenhouses gases in Germany 1990–1994 (Emissions of sector 1 A, tables F1 to F28 –1990 only)

F 1	1 A	Fuel Combustion Activities (FRG)
F 2	1 A 1	Energy and Transformation Industries (FRG)
F 3	1 A 1 a	Electricity and Heat Production (FRG)
F 4	1 A 1 b+c	Transformation Industry (FRG)
F 5	1 A 2	Industry (FRG)
F 6	1 A 3	Transport (FRG)
F 7	1 A 3 b	Road Transportation (FRG)
F 8	1 A 3 a,c,d,e	Other Transportation (FRG)
F 9	1 A 4	Small Combustion (FRG)
F 10	1 A 4 a	Commercial/Institutional (FRG)
F 11	1 A 4 b	Residential (FRG)
F 12	1 A 4 c	Agriculture/Forestry/Fishing (FRG)
F 13	1 A 5	Other (Military) (FRG)
F 14	1 A 6	Traditional Biomass Burned for Energy (FRG)
F 15	1 A	Fuel Combustion Activities (GDR)
F 16	1 A 1	Energy and Transformation Industries (GDR)
F 17	1 A 1 a	Electricity and Heat Production (GDR)
F 18	1 A 1 b+c	Transformation Industry (GDR)
F 19	1 A 2	Industry (GDR)
F 20	1 A 3	Transport (GDR)
F 21	1 A 3 b	Road Transportation (GDR)
F 22	1 A 3 a,c,d,e	Other Transportation (GDR)
F 23	1 A 4	Small Combustion (GDR)
F 24	1 A 4 a	Commercial/Institutional (GDR)
F 25	1 A 4 b	Residential (GDR)
F 26	1 A 4 c	Agriculture/Forestry/Fishing (GDR)
F 27	1 A 5	Other (Military) (GDR)
F 28	1 A 6	Traditional Biomass Burned for Energy (GDR)
F 29	1 B 1	Coal Mining 1990
F 30	1 B 1	Coal Mining 1991–1994
F 31	1 B 2	Oil and Gas 1990 (FRG)
F 32	1 B 2	Oil and Gas 1990 (GDR)
F 33	1 B 2	Oil and Gas 1991
F 34	1 B 2	Oil and Gas 1992
F 35	1 B 2	Oil and Gas 1993
F 36	1 B 2	Oil and Gas 1994
F 37	2	Industrial Processes 1990 (FRG)

F 38	2	Industrial Processes 1990 (GDR)
F 39	2	Industrialprocesses 1991
F 40	2	Industrialprocesses 1992
F 41	2	Industrialprocesses 1993
F 42	2	Industrialprocesses 1994
F 43	3	Solvent and Other Product Use 1990
F 44	3	Solvent and Other Product Use 1991–1994
F 45	4 A + B	Agriculture 1990
F 46	4 A + B	Agriculture 1991
F 47	4 A + B	Agriculture 1992
F 48	4 A + B	Agriculture 1993
F 49	4 A + B	Agriculture 1994
F 50	4 D	Agriculture 1990-1994
F 51	5 A	Land Use Change & Forestry 1990–1994 – Annual Growth Increment –
F 52	5 A	Land Use Change & Forestry 1990–1994 – Annual Harvest –
F 53	5 A	Land Use Change & Forestry 1990-1994 – Uptake –
F 54	6 A	Waste 1990–1994 – Solid Waste Disposal on Land –
F 55	6 B	Wastewater Treatment 1990-1994 CH_4
F 56	6 B	Wastewater Treatment 1990-1994 N_2O

F 1 Standard Data Table: 1 Energy

1 A Fuel Combustion Activities — Detailed Technology Based Calculation — Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A Fuel Combustion Activities													
Hard Coal	1558879	143729	11	6,2	238	304	7,5	92200	6,9	4,0	153	195	5
Coke Oven Coke	276472	29030	1,4	0,3	15	434	1,3	105000	5,0	1,2	54	1569	4,8
Lignite	944864	102329	9,2	3,3	98	189	9,2	108300	9,7	3,5	104	200	10
Fuelwood	89728	0	24	0,4	6,0	446	36	0	269	4,9	67	4969	403
Peat	285	28	0,1	0,0	0,0	1,2	0,1	98000	225	2,5	100	4300	225
Industrial Waste	53491	1048	2,4	0,2	7,3	2,2	1,1	19600	44	3,0	137	42	21
Municipal Wastes	77350	1160	2,5	0,2	11	3,2	2,5	15000	33	3,0	137	42	33
Petroleum Coke	23681	2392	0,1	0,1	6,6	1,7	0,1	101000	4,8	4,0	280	71	5
Motor Gasoline (incl. Naphta)	1186982	85463	46	4,4	854	4803	487	72000	39	3,7	720	4046	411
Jet Kerosene / Aviation Gasoline	69716	5159	0,1	0,1	19	29	5,4	74000	1,5	1,5	270	419	77
Kerosene	982	73	0,0	0,0	0,0	0,0	0,0	74000	2,9	1,5	48	41	2
Diesel Oil	789744	58441	4,1	2,7	797	309	176	74000	5,2	3,4	1009	391	223
Gas Oil	1290972	95532	4,4	1,9	71	51	2,1	74000	3,4	1,5	55	39	1,6
Residual Oil	291730	22755	1,0	0,9	42	14	1,0	78000	3,5	3,1	145	47	3,4
Other Petroleum Products	1168	93	0,0	0,0	0,2	0,0	0,0	80000	4,0	3,5	165	10	4,0
Liquefied Petroleum Gas	74079	4815	0,1	0,1	4,6	3,2	0,2	65000	2,0	1,5	62	43	3,2
Refinery Gas	125345	7521	0,3	0,2	8,2	1,7	0,3	60000	2,3	1,5	65	13	2,3
Gas Works Gas / Coke Oven Gas	149895	6595	0,3	0,2	14	14	0,3	44000	2,2	1,5	94	92	2,2
Blast Furnace Gas	156711	16455	0,0	0,2	10	9,0	0,5	105000	0,0	1,5	66	57	3,3
Natural Gas	1860709	104200	3,9	2,8	115	130	3,9	56000	2,1	1,5	62	70	2,1
Biogas	10284	0	0,0	0,0	0,6	0,1	0,0	0	2,4	1,5	61	10	2,4

Quelle: Umweltbundesamt

F 2 Standard Data Table: 1 Energy

1 A 1 Energy and Transformation Industries — Detailed Technology Based Calculation — Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 1 Energy and Transformation Industries (excl. heat production of industr. powerplants)													
Hard Coal	1349698	124172	2,0	5,4	182	26	2,0	92000	1,5	4,0	135	20	1,5
Coke Oven Coke	257	27	0,0	0,0	0,0	0,0	0,0	105000	0,5	4,0	155	73	0,5
Lignite	845690	92603	1,5	3,0	75	18	1,5	109500	1,8	3,5	88	21	1,8
Industrial Waste	31921	575	1,1	0,1	4,4	1,3	1,0	18000	36	3,0	137	42	33
Municipal Wastes	77350	1160	2,5	0,2	11	3,2	2,5	15000	33	3,0	137	42	33
Petroleum Coke	16735	1690	0,0	0,1	2,6	1,2	0,0	101000	0,5	4,0	157	71	0,5
Naphta	87	7	0,0	0,0	0,0	0,0	0,0	80000	2,5	1,5	70	10	2,5
Diesel Oil	1452	107	0,0	0,0	1,2	0,3	0,0	74000	3,5	1,5	840	190	3,5
Gas Oil	38349	2838	0,1	0,0	7,8	2,0	0,1	74000	3,4	1,3	205	53	3,4
Residual Oil	122641	9566	0,5	0,4	14	2,8	0,5	78000	3,7	3,5	115	23	3,7
Other Petroleum Products	1168	93	0,0	0,0	0,2	0,0	0,0	80000	4,0	3,5	165	10	4,0
Liquefied Petroleum Gas	3671	239	0,0	0,0	0,2	0,0	0,0	65000	2,3	1,5	62	10	2,3
Refinery Gas	123604	7416	0,2	0,2	8,1	1,6	0,3	60000	1,8	1,5	66	13	2,3
Gas Works Gas / Coke Oven Gas	69893	3075	0,2	0,1	11	11	0,1	44000	2,2	1,5	156	154	1,8
Blast Furnace Gas	77748	8164	0,0	0,1	8,6	7,4	0,1	105000	0,0	1,5	111	95	1,7
Natural Gas	425826	23846	0,2	0,6	38	19	0,2	56000	0,5	1,5	89	44	0,5

Quelle: Umweltbundesamt

F 3 Standard Data Table: **1 Energy**

1 A 1 a Electricity and Heat Production **Detailed Technology Based Calculation** **Former FRG Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 1a Electricity and Heat Production (excl. heat production of industr. powerplants)													
Hard Coal, incl. Coke Oven Coke	1347428	123963	2,0	5,4	181	26	2,0	92000	1,5	4,0	135	20	1,5
Lignite	824927	90247	1,2	2,9	71	17	1,2	109400	1,5	3,5	86	21	1,5
Industrial Waste	31921	575	1,1	0,1	4,4	1,3	1,0	18000	36	3,0	137	42	33
Municipal Wastes	77350	1160	2,5	0,2	11	3,2	2,5	15000	33	3,0	137	42	33
Petroleum Coke	909	92	0,0	0,0	0,2	0,0	0,0	101000	0,5	4,0	200	30	0,5
Diesel Oil	555	41	0,0	0,0	0,5	0,1	0,0	74000	3,5	1,5	840	190	3,5
Gas Oil	36257	2683	0,1	0,0	7,0	2,0	0,1	74000	3,5	1,3	212	56	3,5
Residual Oil	82677	6449	0,3	0,3	7,5	2,4	0,3	78000	3,5	3,5	90	29	3,5
Liquefied Petroleum Gas	321	21	0,0	0,0	0,0	0,0	0,0	65000	0,3	1,5	62	10	0,3
Refinery Gas	11510	691	0,0	0,0	0,9	0,3	0,0	60000	0,3	1,5	75	23	0,3
Gas Works Gas / Coke Oven Gas	22695	999	0,0	0,0	1,6	0,5	0,0	44000	0,3	1,5	72	23	0,3
Blast Furnace Gas	57567	6045	0,0	0,1	3,6	1,3	0,0	105000	0,0	1,5	62	23	0,5
Natural Gas	377763	21155	0,1	0,6	35	18	0,1	56000	0,3	1,5	92	49	0,3

Quelle: Umweltbundesamt

F 4 Standard Data Table:
1 A 1 b+c Transformation Industry

1 Energy
Detailed Technology Based Calculation

Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 1 b+c Transformation Industries													
Hard Coal	2298	211	0,0	0,0	0,4	0,2	0,0	92000	15	4,0	155	73	15
Coke Oven Coke	229	24	0,0	0,0	0,0	0,0	0,0	105000	0,5	4,0	155	73	0,5
Lignite	20763	2305	0,3	0,1	3,9	0,8	0,3	111000	15	3,5	188	38	15
Petroleum Coke	15826	1598	0,0	0,1	2,5	1,2	0,0	101000	0,5	4,0	155	73	0,5
Naphta	87	7	0,0	0,0	0,0	0,0	0,0	80000	2,5	1,5	70	10	2,5
Diesel Oil	897	66	0,0	0,0	0,8	0,2	0,0	74000	3,5	1,5	840	190	3,5
Gas Oil	2092	155	0,0	0,0	0,1	0,0	0,0	74000	2,5	1,5	70	10	2,5
Residual Oil	39964	3117	0,2	0,1	6,6	0,4	0,2	78000	4,0	3,5	165	10	4,0
Other Petroleum Products	1168	93	0,0	0,0	0,2	0,0	0,0	80000	4,0	3,5	165	10	4,0
Liquefied Petroleum Gas	3350	218	0,0	0,0	0,2	0,0	0,0	65000	2,5	1,5	62	10	2,5
Refinery Gas	112094	6726	0,3	0,2	7,2	1,3	0,3	60000	2,5	1,5	65	12	2,5
Gas Works Gas / Coke Oven Gas	47198	2077	0,1	0,1	9,3	10	0,1	44000	2,5	1,5	196	217	2,5
Blast Furnace Gas	20181	2119	0,0	0,0	5,0	6,1	0,1	105000	0,0	1,5	250	300	5,0
Natural Gas	48063	2692	0,1	0,1	3,0	0,5	0,1	56000	2,5	1,5	62	10	2,5

Quelle: Umweltbundesamt

F 5 Standard Data Table: 1 Energy

1 A 2 Industry — Detailed Technology Based Calculation — Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 2 Industry (excl. heat production of industr. powerplants)													
Hard Coal	175352	16378	3,2	0,7	53	177	3,2	93400	18	4,0	301	1011	18
Coke Oven Coke[1)]	255759	26855	1,3	0,2	14	362	1,3	105000	5,2	0,9	54	1414	5,0
Lignite	70104	6947	1,1	0,2	20	46	1,1	99100	15	3,5	292	659	15
Industrial Waste	21570	477	1,2	0,1	3,0	0,9	0,1	22100	57	3,0	137	42	3,0
Petroleum Coke	6946	702	0,1	0,0	4,0	0,5	0,1	101000	15	4,0	575	73	15
Kerosene	555	41	0,0	0,0	0,0	0,0	0,0	74000	2,5	1,5	48	41	2,5
Gas Oil	118421	8763	0,3	0,2	9,1	1,2	0,3	74000	2,5	1,5	77	10	2,5
Residual Oil	158790	12386	0,5	0,4	27	11	0,5	78000	3,3	2,8	167	68	3,3
Liquefied Petroleum Gas	36480	2371	0,1	0,1	2,1	1,5	0,1	65000	2,5	1,5	57	41	2,5
Refinery Gas	1741	104	0,0	0,0	0,1	0,1	0,0	60000	2,5	1,5	38	41	2,3
Gas Works Gas / Coke Oven Gas	64200	2825	0,2	0,1	2,6	2,3	0,1	44000	2,5	1,5	40	36	2,2
Blast Furnace Gas[2)]	78963	8291	0,0	0,1	1,8	1,6	0,3	105000	0,0	1,5	23	20	3,3
Natural Gas	617497	34580	1,5	0,9	41	70	1,3	56000	2,5	1,5	66	113	2,1

Quelle: Umweltbundesamt
[1)] Incl. coke oven coke for pig iron production – acc. to UBA methodology
[2)] EF CO_2 acc. to UBA methodology

F 6 Standard Data Table: 1 Energy

1 A 3 Transport — Detailed Technology Based Calculation — Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 3 Transport													
Motor Gasoline	1159942	83516	45	4,29	834	4694	477	72000	39	3,7	719	4047	412
Jet Kerosene / Aviation Gasoline	37409	2768	0,0	0,06	12	14	2,2	74000	1,0	1,5	326	362	59
Diesel Oil	702497	51985	3,6	2,39	679	278	152	74000	5,1	3,4	967	396	217
Liquefied Petroleum Gas	138	9	0,0	0,00	0,1	0,0	0,0	65000	3,0	1,7	975	350	157

Quelle: Umweltbundesamt

F 7 Standard Data Table: 1 Energy

1 A 3 b Road Transportation — Detailed Technology Based Calculation — (Preliminary Data) — Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption TJ	Quantities Emitted (Gg of Full Mass Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 3 b Road Transportation													
Motor Gasoline	1158602	83419	33	5,9	685	5051	744	72000	29	5	591	4360	643
Diesel Oil	657058	48622	1,7	2,1	395	151	56	74000	3	3	601	230	85

Quelle: Umweltbundesamt

F 8 Standard Data Table: 1 Energy

1 A 3 a,c,d,e Other Transportation — Detailed Technology Based Calculation — Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 3 a Civil Aviation													
Jet Kerosene / Aviation Gasoline	37409	2768	0,0	0,1	12,2	13,5	2,2	74000	1,0	1,5	326	362	59
1 A 3 c Railways													
Diesel Oil	18107	1340	0,1	0,1	21,2	8,5	4,1	74000	5,0	3,4	1170	470	225
1 A 3 d Navigation													
(incl. fishing)													
Diesel Oil	26947	1340	0,1	0,06	17,0	6,0	2,5	74000	3,0	3,4	940	330	137
1 A 3 e Pipeline Transportation													
Natural Gas	100000	1014	0,0	0,03	3,7	1,9	0,0	56000	2,5	1,5	205	105	3

Quelle: Umweltbundesamt

F 9 Standard Data Table: 1 Energy

1 A 4 Small Combustion — Detailed Technology Based Calculation — Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 Small Combustion													
(incl. mobile sources military, excl. fishing)													
Hard Coal	27415	2563	5,4	0,1	2,1	100	2,3	93500	197	5,0	77	3650	85
Coke Oven Coke	19682	2067	0,1	0,1	1,0	72	0,0	105000	3,4	5,0	50	3660	0,5
Lignite	29070	2820	6,5	0,1	2,9	125	6,5	97000	225	3,5	100	4300	225
Peat	285	28	0,1	0,0	0,0	1,2	0,1	98000	225	2,5	100	4300	225
Motor Gasoline	26953	1941	1,0	0,10	20	108	10	72000	37,0	3,7	725	4010	375
Kerosene	427	32	0,0	0,0	0,0	0,0	0,0	74000	3,5	1,5	48	41	1,5
Diesel Oil	85795	6349	0,5	0,3	117	30	24	74000	6,0	3,5	1360	350	275
Gas Oil	1120237	82898	3,9	1,7	53	47	1,7	74000	3,5	1,5	47	42	1,5
Residual Oil	8658	675	0,0	0,0	1,4	0,1	0,0	78000	5,6	3,5	165	10	2,5
Liquefied Petroleum Gas	33773	2195	0,1	0,1	2,1	1,6	0,1	65000	1,5	1,5	64	48	3,5
Gas Works Gas / Coke Oven Gas	15795	695	0,0	0,0	0,7	0,8	0,0	44000	2,5	1,5	42	48	2,5
Natural Gas	799965	44798	2,0	1,2	35	39	2,0	56000	2,5	1,5	44	49	2,5

Quelle: Umweltbundesamt

F 10 Standard Data Table: **I Energy**

1 A 4 a Commercial / Institutional **Detailed Technology Based Calculation** **Former FRG Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 Commercial / Institutional													
(incl. stationary sources of Agriculture)													
Hard Coal	7318	688	0,2	0,0	1,1	3,7	0,0	94000	27	5,0	150	500	3,0
Coke Oven Coke	5905	620	0,0	0,0	0,3	5,9	0,0	105000	0,9	5,0	50	1000	0,1
Kerosene	427	32	0,0	0,0	0,0	0,0	0,0	74000	3,5	1,5	48	41	1,5
Gas Oil	381674	28244	1,3	0,6	18	16	0,6	74000	3,5	1,5	48	41	1,5
Residual Oil	8658	675	0,0	0,0	1,4	0,1	0,0	78000	5,6	3,5	165	10	2,4
Liquefied Petroleum Gas	15214	989	0,0	0,0	0,9	0,6	0,1	65000	1,5	1,5	57	41	3,5
Gas Works Gas / Coke Oven Gas	7088	312	0,0	0,0	0,3	0,3	0,0	44000	2,5	1,5	38	41	2,5
Natural Gas	240391	13462	0,6	0,4	9,1	9,9	0,6	56000	2,5	1,5	38	41	2,5

Quelle: Umweltbundesamt

F 11 Standard Data Table: **1 Energy**

1 A 4 b Residential **Detailed Technology Based Calculation** **Former FRG Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 b Residential													
Hard Coal	20097	1877	5,2	0,1	1,0	96	2,3	93400	259	5,0	50	4800	114
Coke Oven Coke	13777	1447	0,1	0,1	0,7	66	0,0	105000	4,5	5,0	50	4800	0,5
Lignite	29070	2820	8,5	0,1	2,9	125	6,5	97000	225	2,5	100	4300	225
Peat	285	28	0,1	0,0	0,0	1,2	0,1	98000	225	2,5	100	4300	225
Gas Oil	738563	54654	2,6	1,1	35	32	1,1	74000	3,5	1,5	47	43	1,5
Liquefied Petroleum Gas	18559	1206	0,0	0,0	1,3	1,0	0,1	65000	1,5	1,5	69	53	3,5
Gas Works Gas / Coke Oven Gas	8707	383	0,0	0,0	0,4	0,5	0,0	44000	2,5	1,5	46	53	2,5
Natural Gas	559574	31336	1,4	0,8	26	30	1,4	56000	2,5	1,5	46	53	2,5

Quelle: Umweltbundesamt

F 12 Standard Data Table: 1 A 4 c Agriculture / Forestry / Fishing

1 Energy – Detailed Technology Based Calculation

Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 c Agriculture / Forestry / Fishing (incl. mobile sources military, excl. stationary sources agriculture and fishing)													
Motor Gasoline	26953	1941	1,0	0,10	20	108	10	72000	37	3,7	725	4010	373
Diesel Oil	85795	6349	0,5	0,29	117	30	24	74000	6	3,4	1360	350	274

Quelle: Umweltbundesamt

F 13 Standard Data Table: 1 A 5 Other (Military)

1 Energy – Detailed Technology Based Calculation

Former FRG Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 5 Other (Military) (excl. mobile sources [Off-road] military)													
1 A 5 a Stationary													
Hard Coal	6414	603	0,2	0,0	1,0	0,5	0,0	94000	27	4,0	155	73	3,0
Coke Oven Coke	774	81	0,0	0,0	0,1	0,1	0,0	105000	0,9	5,0	155	73	0,1
Gas Oil	13965	1033	0,0	0,0	1,0	0,1	0,0	74000	3,5	1,5	70	10	1,5
Residual Oil	1641	128	0,0	0,0	0,3	0,0	0,0	78000	5,6	3,5	165	10	2,4
Liquefied Petroleum Gas	17	1	0,0	0,0	0,0	0,0	0,0	65000	1,5	1,5	57	41	3,5
Gas Works Gas / Coke Oven Gas	7	0,3	0,0	0,0	0,0	0,0	0,0	44000	2,6	1,6	38	41	2,6
Natural Gas	7421	416	0,0	0,0	0,3	0,3	0,0	56000	2,5	1,5	38	41	2,5
1 A 5 b Off-road and other Machinary													
Jet Kerosene / Aviation Gasoline	32307	2391	0,1	0,0	6,6	16	3,2	74000	2,0	1,5	205	485	98

Quelle: Umweltbundesamt

F 14 Standard Data Table: **1 Energy**

1 A 6 Traditional Biomass Burned for Energy **Former FRG Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Fuelwood	89728	0	24	0,4	6,0	449	36	0	270	5,0	67	5000	400
Biogas	10284	0	0,0	0,0	0,6	0,1	0,0	0	2,4	1,5	61	10	2,5

Quelle: Umweltbundesamt

F15 Standard Data Table: **1 Energy**

1 A Fuel Combustion Activities **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A Fuel Combustion Activities													
Hard Coal	63425	5899	1,6	0,3	11	25	0,7	93000	25	4,1	177	389	12
Coke Oven Coke	38202	3820	0,1	0,1	4,1	46	0,1	100000	2,9	2,4	107	1199	2,6
Lignite	2219851	240632	83	7,3	383	1757	83	108400	37	3,3	172	791	37
Fuelwood	23541	0	5,6	0,1	1,2	118	8,5	0	240	5,0	50	4993	359
Industrial Waste	18684	1756	1,1	0,1	4,3	1,7	0,4	94000	59	3,0	233	93	21
Motor Gasoline	173974	12526	24	0,3	70	948	357	72000	140	1,7	400	5450	2050
Jet Kerosene / Aviation Gasoline	7822	353	0,0	0,0	1,0	2,2	0,4	74000	1,8	1,5	217	455	92
Diesel Oil	140872	10284	1,1	0,5	130	109	52	73000	7,5	3,4	922	775	369
Gas Oil	4773	348	0,0	0,0	0,3	0,1	0,0	73000	2,7	1,5	67	18	2,3
Residual Oil	55480	4327	0,2	0,2	11	1,0	0,2	78000	3,5	3,2	206	17	3,5
Other Petroleum Products	15407	1202	0,1	0,1	2,9	0,4	0,1	78000	4,4	3,5	188	27	3,8
Liquefied Petroleum Gas	6956	445	0,0	0,0	0,5	0,3	0,1	64000	4,1	1,5	68	38	8,1
Refinery Gas	19841	1190	0,0	0,0	1,6	0,2	0,0	60000	2,4	1,5	82	11	2,4
Gas Works Gas / Coke Oven Gas	98924	4798	0,5	0,1	8,1	4,2	0,5	48500	5,0	1,5	82	42	5,0
Blast Furnace Gas	13357	1336	0,0	0,0	1,9	0,1	0,1	100000	0,0	1,5	142	10	4,9
Natural Gas	194395	10692	0,3	0,3	24	6,4	0,3	55000	1,4	1,5	123	33	1,4
Biogas	1027	0	0,0	0,0	0,1	0,1	0,0	0	2,5	1,5	50	60	2,5

Quelle: Umweltbundesamt

F 16 Standard Data Table: 1 Energy

1 A 1 Energy and Transformation Industries — Detailed Technology Based Calculation — Former GDR Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 1 Energy and Transformation Industries (excl. heat production of industr. powerplants)													
Hard Coal	15487	1440	0,12	0,06	2,4	1,4	0,12	93000	7,9	4,0	155	88	7,9
Coke Oven Coke	60	6	0,00	0,00	0,0	0,0	0,00	100000	0,5	4,0	140	100	0,5
Lignite	1343723	151169	2,82	4,70	264	95	2,82	112500	2,1	3,5	197	71	2,1
Industrial Waste	8051	757	0,32	0,02	2,0	0,7	0,24	94000	40	3,0	245	84	29
Diesel Oil	156	11	0,00	0,00	0,1	0,0	0,00	73000	3,5	1,5	420	105	3,5
Gas Oil	1257	92	0,00	0,00	0,1	0,0	0,00	73000	2,5	1,5	81	13	2,5
Residual Oil	34300	2675	0,13	0,12	6,5	0,7	0,13	78000	3,7	3,5	190	21	3,7
Other Petroleum Products	13901	1084	0,05	0,05	2,8	0,3	0,05	78000	3,6	3,5	200	25	3,6
Liquefied Petroleum Gas	644	41	0,00	0,00	0,0	0,0	0,00	64000	2,5	1,5	60	10	2,5
Refinery Gas	17089	1025	0,04	0,03	1,4	0,2	0,04	60000	2,4	1,5	82	11	2,4
Gas Works Gas / Coke Oven Gas	19993	932	0,03	0,03	2,0	0,8	0,03	46600	1,5	1,5	101	38	1,5
Blast Furnace Gas	3553	355	0,00	0,01	0,2	0,0	0,02	100000	0,0	1,5	63	11	4,8
Natural Gas	76785	4223	0,05	0,12	8,6	2,3	0,05	55000	0,7	1,5	111	29	0,7

Quelle: Umweltbundesamt

F 17 Standard Data Table: **1 Energy**

1 A 1 a Electricity and Heat Production **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 1 Electricity and Heat Production (excl. heat production of industr. powerplants)													
Hard Coal	15487	1440	0,12	0,06	2,4	1,36	0,12	93000	7,9	4,0	155	88	7,9
Lignite	1189373	133804	2,50	4,16	233	80	2,50	112500	2,1	3,5	196	67	2,1
Industrial Waste	8051	757	0,32	0,02	2,0	0,67	0,24	94000	40	3,0	245	84	29
Diesel Oil	156	11	0,00	0,00	0,1	0,02	0,00	73000	3,5	1,5	420	105	3,5
Gas Oil	1257	92	0,00	0,00	0,1	0,02	0,00	73000	2,5	1,5	81	13	2,5
Residual Oil	28971	2260	0,11	0,10	5,5	0,63	0,11	78000	3,7	3,5	190	22	3,7
Refinery Gas	1244	75	0,00	0,00	0,1	0,03	0,00	60000	0,5	1,5	107	22	0,5
Gas Works Gas / Coke Oven Gas	10395	509	0,01	0,02	1,1	0,22	0,01	49000	0,6	1,5	103	21	0,6
Blast Furnace Gas	3553	355	0,00	0,01	0,2	0,04	0,02	100000	0,0	1,5	63	11	4,8
Natural Gas	66326	3648	0,03	0,10	7,3	1,65	0,03	55000	0,5	1,5	110	25	0,5

Quelle: Umweltbundesamt

F 18 Standard Data Table: **1 Energy**

1 A 1 b + c Transformation Industry **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A I b+c Transformation Industry													
Coke Oven Coke	60	6	0,00	0,00	0,0	0,01	0,00	100000	0,5	4,0	140	100	0,5
Lignite	154350	17442	0,23	0,54	31	15	0,23	113000	1,5	3,5	200	100	1,5
Residual Oil	5329	416	0,02	0,02	1,0	0,09	0,02	78000	3,8	3,5	190	18	3,8
Other Petroleum Products	13901	1084	0,05	0,05	2,8	0,35	0,05	78000	3,6	3,5	200	25	3,6
Liquefied Petroleum Gas	644	41	0,00	0,00	0,0	0,01	0,00	64000	2,5	1,5	60	10	2,5
Refinery Gas	15845	951	0,04	0,02	1,3	0,16	0,04	60000	2,5	1,5	80	10	2,5
Gas Works Gas / Coke Oven Gas	9598	422	0,02	0,01	0,9	0,54	0,02	44000	2,5	1,5	98	56	2,5
Natural Gas	10459	575	0,02	0,02	1,2	0,61	0,02	55000	1,5	1,5	118	58	1,5

Quelle: Umweltbundesamt

F 19 Standard Data Table: 1 A 2 Industry

1 Energy — Detailed Technology Based Calculation

Former GDR Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 2 Industry (incl. heat production of industr. powerplants)													
Hard Coal	37947	3529	0,43	0,15	7,6	12	0,43	93000	11	4,0	201	306	11
Coke Oven Coke[1]	32259	3226	0,10	0,06	3,4	34	0,10	100000	3,0	2,0	107	1056	3,0
Lignite	297781	31595	2,71	1,04	57	104	2,71	106100	9,1	3,5	193	351	9,1
Industrial Waste	10633	1000	0,79	0,03	2,4	1,06	0,15	94000	74	3,0	223	100	14
Gas Oil	2457	179	0,01	0,00	0,2	0,02	0,01	73000	2,5	1,5	70	10	2,5
Residual Oil	20373	1589	0,06	0,06	4,7	0,22	0,06	78000	3,1	2,8	233	11	3,1
Other Petroleum Products	301	23	0,00	0,00	0,1	0,00	0,00	78000	4,0	3,5	200	10	4,0
Liquefied Petroleum Gas	2396	153	0,01	0,00	0,1	0,02	0,01	64000	2,5	1,5	60	10	2,5
Refinery Gas	2752	165	0,01	0,00	0,2	0,03	0,01	60000	2,5	1,5	80	10	2,5
Gas Works Gas / Coke Oven Gas	26140	1281	0,07	0,04	3,5	0,26	0,07	49000	2,5	1,5	134	10	2,5
Blast Furnace Gas[2]	9804	980	0,00	0,01	1,7	0,10	0,05	100000	0,0	1,5	171	10	5,0
Natural Gas	96214	5292	0,14	0,14	14	2,78	0,12	55000	1,5	1,5	145	29	1,2

Quelle: Umweltbundesamt
[1] Incl. coke oven coke for pig iron production - acc. to UBA methodology
[2] EF CO_2 acc. to UBA methodology

F 20 Standard Data Table: 1 A 3 Transport

1 Energy — Detailed Technology Based Calculation

Former GDR Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 3 Transport													
Hard Coal, excl. Coke Oven Coke	576	54	0,0	0,00	0,1	0,3	0,0	93000	15	4,0	120	500	15
Motor Gasoline	170537	12279	24	0,29	68	929	350	72000	140	1,7	400	5450	2050
Diesel Oil	99591	7270	0,7	0,34	94	75	36	73000	7,3	3,4	940	753	358
Jet Kerosene / Aviation Gasoline	1174	129	0,0	0,00	0,5	0,6	0,1	74000	1,0	1,5	260	350	73

Quelle: Umweltbundesamt

F 21 Standard Data Table: **1 Energy**

1 A 3 b Road Transportation **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 3 b Road Transportation													
Motor Gasoline	170535	12279	29	0,2	92	1262	595	72000	172	1	537	7400	3486
Diesel Oil	78470	5728	0,3	0,4	52	22	9	73000	4	5	657	282	115

Quelle: Umweltbundesamt

F 22 Standard Data Table: **1 Energy**

1 A 3 a,c,d,e Other Transportation **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A a Civil Aviation													
Jet Kerosene / Aviation Gasoline	1744	129	0,0	0,00	0,5	0,6	0,1	74000	1,0	1,5	260	350	73
1 A 3 c Railways													
Hard Coal	576	54	0,0	0,00	0,1	0,3	0,0	93000	15	4,0	120	500	15
Diesel Oil	20351	1486	0,1	0,07	24	9,6	4,6	73000	5,0	3,4	1170	470	225
1 A 3 d Navigation (incl. fishing)													
Diesel Oil	763	56	0,0	0,00	0,7	0,3	0,1	73000	3,0	3,4	940	330	137
1 A 3 e Pipeline Transportation													
Natural Gas	1405	77	0,0	0,00	1,6	0,7	0,3	55000	5,0	3,4	1170	470	225

Quelle: Umweltbundesamt

F 23 Standard Data Table: **1 Energy**

1 A 4 Small Combustion **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 Small Combustion (incl. mobile sources military, excl. fishing)													
Hard Coal	8795	818	1,00	0,04	1,0	11	0,17	93000	114	4,5	116	1287	19
Coke Oven Coke	5883	588	0,01	0,03	0,6	12	0,00	100000	2,0	4,4	105	1992	0,5
Lignite	540218	53968	77	1,40	56	1553	77	99900	142	2,6	103	2875	142
Motor Gasoline	3437	247	0,48	0,01	1,4	19	7,05	72000	140	2,1	400	5450	2050
Diesel Oil	41125	3002	0,33	0,14	36	34	16	73000	8,0	3,4	880	830	395
Gas Oil	1059	77	0,00	0,00	0,0	0,04	0,00	73000	3,5	1,5	45	40	1,5
Residual Oil	807	63	0,00	0,00	0,2	0,01	0,00	78000	4,0	3,5	190	10	4,0
Other Petroleum Products	1205	94	0,02	0,00	0,1	0,07	0,01	77600	13	3,4	51	56	5,8
Liquefied Petroleum Gas	3916	251	0,02	0,01	0,3	0,23	0,05	64000	5,4	1,5	75	60	13
Gas Works Gas / Coke Oven Gas	52048	2550	0,40	0,08	2,6	3,12	0,40	49000	7,7	1,5	50	60	7,7
Natural Gas	18283	1006	0,09	0,03	0,9	1,10	0,09	55000	5,1	1,5	50	60	5,1

Quelle: Umweltbundesamt

F 24 Standard Data Table: **1 Energy**

1 A 4 a Commercial / Institutional **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 a Commercial / Institutional (incl. stationary sources of Agriculture)													
Hard Coal	6860	638	0,13	0,03	0,9	1,65	0,07	93000	19	4,3	135	240	11
Coke Oven Coke	3612	361	0,00	0,01	0,5	0,36	0,00	100000	0,5	4,0	140	100	0,5
Lignite	212914	21930	3,19	0,57	23	80	3,19	103000	15	2,7	108	377	15
Gas Oil	1059	77	0,00	0,00	0,0	0,04	0,00	73000	3,5	1,5	45	40	1,5
Residual Oil	807	63	0,00	0,00	0,2	0,01	0,00	78000	4,0	3,5	190	10	4,0
Other Petroleum Products	86	6	0,00	0,00	0,0	0,00	0,00	73000	2,5	1,5	70	10	2,5
Liquefied Petroleum Gas	553	35	0,00	0,00	0,0	0,03	0,00	64000	1,5	1,5	75	60	3,5
Gas Works Gas / Coke Oven Gas	15926	780	0,04	0,02	0,8	0,96	0,04	49000	2,5	1,5	50	60	2,5
Natural Gas	11827	650	0,03	0,02	0,6	0,71	0,03	55000	2,5	1,5	50	60	2,5

Quelle: Umweltbundesamt

F 25 Standard Data Table: **1 Energy**

1 A 4 b Residential **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 b Residential													
Hard Coal	1935	180	0,87	0,01	0,1	9,68	0,10	93000	450	5,0	50	5000	50
Coke Oven Coke	2271	227	0,01	0,01	0,1	11,4	0,00	100000	4,5	5,0	50	5000	0,5
Lignite	372304	31978	74	0,82	33	1473	74	97700	225	2,5	100	4500	225
Other Petroleum Products	1119	87	0,02	0,00	0,1	0,07	0,01	78000	14	3,5	50	60	6,0
Liquefied Petroleum Gas	3363	215	0,02	0,01	0,3	0,20	0,05	64000	6,0	1,5	75	60	14
Gas Works Gas / Coke Oven Gas	36122	1770	0,36	0,05	1,8	2,17	0,36	49000	10	1,5	50	60	10
Natural Gas	6456	355	0,06	0,01	0,3	0,39	0,06	55000	10	1,5	50	60	10

Quelle: Umweltbundesamt

F 26 Standard Data Table: **1 Energy**
1 A 4 c Agriculture / Forestry / Fishing **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 4 c Agriculture / /Forestry / Fishing (incl. mobile sources military, excl. stationary sources agriculture and fishing)													
Motor Oil	3437	247	0,5	0,01	1,4	19	7,0	72000	140	2,1	400	5450	2050
Diesel Oil	41125	3002	0,3	0,14	36	34	16	73000	8	3,4	880	830	395

Quelle: Umweltbundesamt

F 27 Standard Data Table: **1 Energy**
1 A 5 Other (Military) **Detailed Technology Based Calculation** **Former GDR Year: 1990**

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	Quantities Emitted (Gg of Full Mass of Pollutant)						Emission Factor (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 5 Other (Military) (excl. mobile sources (Off-road) military)													
1 A 5 a Stationary													
Hard Coal	620	58	0,0	0,0	0,1	0,1	0,0	93000	15,0	4,0	160	100	15
Lignite	38129	3805	0,6	0,1	5,3	3,8	0,6	99800	15,0	3,5	140	100	15
Gas Works Gas / Coke Oven Gas	743	36	0,0	0,0	0,0	0,0	0,0	49000	2,5	1,5	50	60	2,5
Natural Gas	1708	94	0,0	0,0	0,1	0,1	0,0	55000	2,5	1,5	50	60	2,5
1 A 5 b Off-road and other Machinary													
Jet Kerosene / Aviation Gasoline	6078	450	0,0	0,0	2,4	2,9	0,6	74000	2	1,5	400	485	98

Quelle: Umweltbundesamt

F 28 Standard Data Table: 1 Energy

1 A 6 Traditional Biomass Burned for Energy — Detailed Technology Based Calculation — Former GDR Year: 1990

Source and Sink Categories	Activity Data	Emission Estimates						Aggregate Emission Factors					
	Consumption (TJ)	**Quantities Emitted** (Gg of Full Mass of Pollutant)						**Emission Factor** (kg Pollutant / TJ)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Fuelwood	23541	0	5,6	0,1	1,2	118	8,5	0	240	5,0	50	5000	360
Biogas	1027	0	0,0	0,0	0,1	0,1	0,0	0	2,5	1,5	50	60	2,5

Quelle: Umweltbundesamt

F 29 Standard Data Table: 1 Energy
1 B Fugitive Emissions from Fuel
1 B 1 Solid Fuel
1 B 1a Coal Mining **Year: 1990**

Source Categories	Activity Data	Emissions	Emission Factor
	Production (Mt)	CH_4 (Gg)	(kg/Mg)
Former GDR			
1 B 1 a Coal Mining			
Hard Coal	NO		
Mining activities			
gas production			
gas use			
gas release			
Post mining activities			
Closed-down mines		2*)	
Lignite			
Surface mines	249,3	18	0,072
Former FRG			
1 B 1 a Coal Mining			
Hard Coal			
Mining activities	70,2		
gas production		(1298)	(18,5)
gas use		(229)	
gas release		1069	
Post mining activities	70,2	40	0,58
Closed-down mines		85*)	
Lignite			
Surface mines	107,6	8	0,072

*) Only estimates of these emissions are available
NO Not occuring
Quelle: Umweltbundesamt

F 30 Standard Data Table: 1 Energy
1 B Fugitive Emissions from Fuel
1 B 1 Solid Fuel
1 B 1a Coal Mining **Germany** **Year: 1991 – 1994**

Source Categories	Activity Data	Emissions	Emission Factor
	Production (Mt)	CH_4 (Gg)	(kg/Mg)
1991			
1 B 1 a Coal Mining			
Hard Coal			
Mining activities	66,5		
gas production		(1230)	(18,5)
gas use		(260)	
gas release		970	
Post mining activities	66,5	36	0,576
Closed-down mines		87*)	
Lignite			
Surface mines	279,6	20	0,072
1992			
1 B 1 a Coal Mining			
Hard Coal			
Mining activities	65,9		
gas production		(1219)	(18,5)
gas use		(300)	
gas release		919	
Post mining activities	65,9	36	0,576
Closed-down mines		87*)	
Lignite			
Surface mines	241,8	17	0,072
1993			
1 B 1 a Coal Mining			
Hard Coal			
Mining activities	63,0		
gas production		(1166)	18,5
gas use		(360)	
gas release		806	
Post mining activities	63,0	36	0,576
Closed-down mines		87*)	
Lignite			
Surface mines	230,0	17	0,072
1994 (Preliminary)			
1 B 1 a Coal Mining			
Hard Coal			
Mining activities	60,0		
gas production		(1110)	(18,5)
gas use		(400)	
gas release		710	
Post mining activities	60,0	35	0,576
Closed-down mines		87*)	
Lignite			
Surface mines	200,0	14	0,072

*) Only estimates of these emissions are available
Quelle: Umweltbundesamt

F 31 **Standard Data Table:** **1 Energy**
1 B **Fugitive Emissions from Fuels**
1 B 2 **Oil and Gas** **Former FRG** **Year: 1990**

Source Categories		Activity		Emission Estimates			Aggregate Emission Factors			
		Unit	Fuel Quantity	CH_4	NMVOC (Gg)	CO	Unit	CH_4	NMVOC	CO
1 B 2	a Oil									
	Exploration	Gg	3606	4,0			kg / Gg	1,1		
	Distribution of Oil Products									
	Gasoline	Gg	27258		171,7		kg / Gg		6,3	
1 B 2	b1 Natural Gas									
	Production	TJ	480832	13,0			kg / TJ	27		
	Processing	TJ	488207	30,3			kg / TJ	62		
	Long-distance transport/Storage	TJ	2011821	18,1			kg / TJ	9		
	Local gas-distribution networks									
	Low-pressure network									
	Cast steel / ductile cast iron	km	97915	63,0			kg / km	643		
	Gray cast iron	km	8600	50,1			kg / km	5820		
	PVC	km	23377	1,6			kg / km	70		
	Medium-pressure network									
	Cast steel / ductile cast iron	km	40116	39,0			kg / km	971		
	PVC	km	43064	2,9			kg / km	67		
	High-pressure network									
	Cast steel / ductile cast iron	km	26433	6,4			kg / km	241		
	PVC	km	789	0,0			kg / km	44		
	Use in households	TJ	807386	33,9			kg / TJ	42		
1 B 2	b2 Town Gas									
	Processing	TJ	15802	1,2		0,5	kg / TJ	76		31
	Use in households	TJ	15802	0,4			kg / TJ	25		

Quelle: Umweltbundesamt

F 32 Standard Data Table: 1 Energy
1 B Fugitive Emissions from Fuels
1 B 2 Oil and Gas Former GDR Year: 1990

Source Categories		Activity		Emission Estimates			Aggregate Emission Factors			
		Unit	Fuel Quantity	CH_4	NMVOC (Gg)	CO	Unit	CH_4	NMVOC	CO
1 B 2	a Oil									
	Exploration	Gg	54	0,4			kg / Gg	8		
	Distribution of Oil Products									
	Gasoline	Gg	3999		48,0		kg / Gg		12	
1 B 2	b1 Natural Gas									
	Production	TJ	75175	3,0			kg / TJ	40		
	Processing	TJ	75175	6,0			kg / TJ	80		
	Long-distance transport/Storage	TJ	280959	4,2			kg / TJ	15		
	Local gas-distribution networks									
	Low-pressure network									
	Cast steel / ductile cast iron	km	3325	2,1			kg / km	643		
	Gray cast iron	km	1317	29,2			kg / km	22200		
	PVC	km	72	0,0			kg / km	70		
	Medium-pressure network									
	Cast steel / ductile cast iron	km	255	0,3			kg / km	1300		
	PVC	km	8	0,0			kg / km	90		
	High-pressure network									
	Cast steel / ductile cast iron	km	1447	0,3			kg / km	241		
	PVC	km	2	0,0			kg / km	44		
	Use in households	TJ	18283	0,8			kg / TJ	42		
1 B 2	b2 Town Gas									
	Processing	TJ	52048	4,0		6,9	kg / TJ	76		133
	Local gas-distribution networks									
	Low-pressure network									
	Cast steel / ductile cast iron	km	18552	0,4		0,7	kg / km	20		40
	Gray cast iron	km	7344	10,9		11,8	kg / km	1480		1600
	PVC	km	395	0,0		0,0	kg / km	18		20
	Medium-pressure network									
	Cast steel / ductile cast iron	km	1418	0,4		0,4	kg / km	250		300
	Gray cast iron	km	8	0,0		0,0	kg / km	2960		3000
	PVC	km	36	0,0		0,0	kg / km	35		35
	High-pressure network									
	Cast steel / ductile cast iron	km	8076	0,5		0,8	kg / km	60		100
	PVC	km	13	0,0		0,0	kg / km	11		11
	Use in households	TJ	52048	1,3		6,0	kg / TJ	25		115

Quelle: Umweltbundesamt

F 33 Standard Data Table: 1 Energy
1 B Fugitive Emissions from Fuels
1 B 2 Oil and Gas Germany Year: 1991

Source and Sink Categories		Activity		Emissions Estimates			Aggregate Emission Factors			
		Unit	Fuel Quantity	CH_4 (Gg)	NMVOC (Gg)	CO (Gg)	Unit	CH_4	NMVOC	CO
1 B 2	a Oil									
	Exploration	Gg	3487	4,3			kg / Gg	1,2		
	Distribution of Oil Products									
	Petrol	Gg	31206		198,1		kg / Gg		6,3	
1 B 2	b1 Natural Gas									
	Production	TJ	548177	15,5			kg / TJ	28,3		
	Processing	TJ	555713	35,5			kg / TJ	63,9		
	Long-distance transport/Storage	TJ	2409094	23,2			kg / TJ	9,6		
	Local gas-distribution networks									
	Low-pressure network									
	Cast steel / ductile cast iron	km	109099	70,2			kg / km	643,0		
	Gray cast iron	km	10350	88,5			kg / km	8550,7		
	PVC	km	21856	1,5			kg / km	70,0		
	Medium-pressure network									
	Cast steel / ductile cast iron	km	41755	40,7			kg / km	974,4		
	PVC	km	49004	3,3			kg / km	67,3		
	High-pressure network									
	Cast steel / ductile cast iron	km	29865	7,2			kg / km	241,0		
	PVC	km	869	0,0			kg / km	44,0		
	Use in households	TJ	978284	41,1			kg / TJ	42,0		
1 B 2	b2 Town Gas									
	Processing	TJ	63416	4,8		6,6	kg / TJ	76,0		104
	Local gas-distribution networks									
	Low-pressure network									
	Cast steel / ductile cast iron	km	17083	0,3		0,7	kg / km	20,0		40
	Gray cast iron	km	6357	8,5		9,2	kg / km	1335,0		1450
	PVC	km	1391	0,0		0,0	kg / km	18,0		20
	Medium-pressure network									
	Cast steel / ductile cast iron	km	1391	0,3		0,4	kg / km	250,0		300
	Gray cast iron	km	-							
	PVC	km	1788	0,1		0,1	kg / km	35,0		35
	High-pressure network									
	Cast steel / ductile cast iron	km	7399	0,4		0,7	kg / km	60,0		100
	PVC	km	11	0,0		0,0	kg / km	11,0		11
	Use in households	TJ	63416	1,6		5,2	kg / TJ	25,0		83

Quelle: Umweltbundesamt

F 34 Standard Data Table: 1 Energy
1 B Fugitive Emissions from Fuels
1 B 2 Oil and Gas Germany Year: 1992

Source and Sink Categories	Activity		Emissions Estimates			Aggregate Emission Factors			
	Fuel Quantity		CH_4	NMVOC	CO		CH_4	NMVOC	CO
	Unit		(Gg)			Unit			
1 B 2 a Oil									
Exploration	Gg	3303	4,2			kg / Gg	1,3		
Distribution of Oil Products									
Gasoline	Gg	31430		179,3		kg / Gg		5,7	
1 B 2 b1 Natural Gas									
Production	TJ	556617	15,7			kg / TJ	28,2		
Processing	TJ	563670	35,9			kg / TJ	63,6		
Long-distance transport/Storage	TJ	2381857	23,0			kg / TJ	9,6		
Local gas-distribution networks									
Low-pressure network									
Cast steel / ductile cast iron	km	113040	72,3			kg / km	640,0		
Gray cast iron	km	11458	118,9			kg / km	10377,0		
PVC	km	21837	1,5			kg / km	70,0		
Medium-pressure network									
Cast steel / ductile cast iron	km	45400	44,4			kg / km	978,0		
PVC	km	59904	4,1			kg / km	67,9		
High-pressure network									
Cast steel / ductile cast iron	km	33202	8,0			kg / km	241,0		
PVC	km	1230	0,1			kg / km	44,0		
Use in households	TJ	1000943	41,0			kg / TJ	41,0		
1 B 2 b2 Town Gas									
Processing	TJ	48142	3,7		4,7	kg / TJ	76,0		98
Local gas-distribution networks									
Low-pressure network									
Cast steel / ductile cast iron	km	11534	0,2		0,5	kg / km	20,0		40
Gray cast iron	km	4086	4,9		5,3	kg / km	1190,0		1300
PVC	km	1516	0,0		0,0	kg / km	18,0		20
Medium-pressure network									
Cast steel / ductile cast iron	km	988	0,2		0,3	kg / km	250,0		300
Gray cast iron	km	-							
PVC	km	2308	0,1		0,1	kg / km	35,0		35
High-pressure network									
Cast steel / ductile cast iron	km	4920	0,3		0,5	kg / km	60,0		100
PVC	km	10	0,0		0,0	kg / km	11,0		11
Use in households	TJ	48142	1,2		3,6	kg / TJ	25,0		76

Quelle: Umweltbundesamt

F 35 Standard Data Table: 1 Energy
1 B Fugitive Emissions from Fuels
1 B 2 Oil and Gas Germany Year: 1993

Source and Sink Categories	Activity		Emission Estimates			Aggregate Emission Factors			
	Unit	Fuel Quantity	CH_4 (Gg)	NMVOC (Gg)	CO (Gg)	Unit	CH_4	NMVOC	CO
1 B 2 a Oil									
Exploration	Gg	3150	4,1			kg / Gg	1,3		
Distribution of Oil Products									
Gasoline	Gg	31800		117,7		kg / Gg		3,7	
1 B 2 b1 Natural Gas									
Production	TJ	563000	14,1			kg / TJ	25,0		
Processing	TJ	570000	34,2			kg / TJ	60,0		
Long-distance transport/Storage	TJ	2520407	22,7			kg / TJ	9,0		
Local gas-distribution networks									
Low-pressure network									
Cast steel / ductile cast iron	km	120925	75,0			kg / km	620,0		
Gray cast iron	km	14930	104,5			kg / km	7000,0		
PVC	km	25000	1,8			kg / km	70,0		
Medium-pressure network									
Cast steel / ductile cast iron	km	47329	44,0			kg / km	930,0		
PVC	km	71092	4,9			kg / km	68,5		
High-pressure network									
Cast steel / ductile cast iron	km	38553	9,3			kg / km	241,0		
PVC	km	2503	0,1			kg / km	44,0		
Use in households	TJ	1020000	38,8			kg / TJ	38,0		
1 B 2 b2 Town Gas									
Processing	TJ	35000	2,7		3,3	kg / TJ	76,0		95
Local gas-distribution networks									
Low-pressure network									
Cast steel / ductile cast iron	km	5200	0,1		0,2	kg / km	20,0		40
Gray cast iron	km	1755	2,0		2,0	kg / km	1145,0		1150
PVC	km	936	0,0		0,0	kg / km	18,0		20
Medium-pressure network									
Cast steel / ductile cast iron	km	520	0,1		0,2	kg / km	250,0		300
Gray cast iron	km	-							
PVC	km	1560	0,1		0,1	kg / km	35,0		35
High-pressure network									
Cast steel / ductile cast iron	km	2780	0,2		0,3	kg / km	60,0		100
PVC	km	200	0,0		0,0	kg / km	11,0		11
Use in households	TJ	40000	1,0		2,8	kg / TJ	25,0		70

Quelle: Umweltbundesamt

F 36 — Standard Data Table: — 1 Energy

1 B — Fugitive Emissions from Fuels

1 B 2 — Oil and Gas — Germany (Preliminary) — Year: 1994

Source and Sink Categories		Activity		Emissions Estimates			Aggregate Emission Factors			
		Unit	Fuel Quantity	CH_4 (Gg)	NMVOC (Gg)	CO (Gg)	Unit	CH_4	NMVOC	CO
1 B 2	a Oil									
	Exploration	Gg	3150	4,1			kg / Gg	1,3		
	Distribution of Oil Products									
	Gasoline	Gg	32000		88,3		kg / Gg		2,8	
1 B 2	b1 Natural Gas									
	Production	TJ	563000	14,1			kg / TJ	25,0		
	Processing	TJ	570000	34,2			kg / TJ	60,0		
	Long-distance transport/Storage	TJ	2600000	23,4			kg / TJ	9,0		
	Local gas-distribution networks									
	Low-pressure network									
	Cast steel / ductile cast iron	km	120925	72,6			kg / km	600,0		
	Gray cast iron	km	14930	89,6			kg / km	6000,0		
	PVC	km	24093	1,7			kg / km	70,0		
	Medium-pressure network									
	Cast steel / ductile cast iron	km	47329	42,6			kg / km	900,0		
	PVC	km	71092	4,9			kg / km	68,5		
	High-pressure network									
	Cast steel / ductile cast iron	km	38553	9,3			kg / km	241,0		
	PVC	km	2503	0,1			kg / km	44,0		
	Use in households	TJ	1020000	36,7			kg / TJ	36,0		
1 B 2	b2 Town Gas									
	Processing	TJ	35000	2,7		3,3	kg / TJ	76,0		95
	Local gas-distribution networks									
	Low-pressure network									
	Cast steel / ductile cast iron	km	5200	0,1		0,2	kg / km	20,0		40
	Gray cast iron	km	1755	2,0		2,0	kg / km	1145,0		1150
	PVC	km	936	0,0		0,0	kg / km	18,0		20
	Medium-pressure network									
	Cast steel / ductile cast iron	km	520	0,1		0,2	kg / km	250,0		300
	Gray cast iron	km	-							
	PVC	km	1560	0,1		0,1	kg / km	35,0		35
	High-pressure network									
	Cast steel / ductile cast iron	km	2780	0,2		0,3	kg / km	60,0		100
	PVC	km	200	0,0		0,0	kg / km	11,0		11
	Use in households	TJ	40000	1,0		2,8	kg / TJ	25,0		70

Quelle: Umweltbundesamt

F 37 **Standard Data Table:** **2 Industrial Processes**
Former FRG
Year: 1990

Source Categories	Activity Data	Emissions Estimates									Aggregate Emission Factors								
	Produktion Quantity	Full Mass of Pollutant									Tonne of pollutant per tonne of Product								
	(Gg)	CO	CO_2	CH_4	N_2O	NO_x	NMVOC	HFCs	PFCs	SF_6	CO	CO_2	CH_4	N_2O	NO_x	NMVOC	HFCs	PFCs	SF_6
		(Gg)									(Mg/Mg)								
A Iron and Steel																			
Cast iron and steel, melleable cast iron	3590			0,1			1,3						0,00004			0,00036			
Rolled steel	29729						1,2									0,00004			
Pig iron	30097	36									0,00118								
Coke *)	17961	18		5,6			5,6				0,00100		0,00031			0,00031			
Steel (electric and blow steel)	38434	442				3,1					0,01150				0,00008				
B Non-ferrous Metals																			
Primary aluminium pig	720	108	880						0,347		0,15000	1,222						0,00048	
C Inorganic Chemicals (excepting solvent use)																			
Nitric acid	1750				9,6	8,8								0,0055	0,005				
Nitrous oxide	5				0,0									0,0030					
Ammonia synthesis	1671		1153									0,690							
Soot	394	1,9									0,00480								
Soda	1436		546									0,380							
D Organic Chemicals																			
Adipic acid	200				67									0,333					
Ethene	3072						15,4									0,00500			
Propene	1827						4,6									0,00250			
1, 2 dichlorethane	1505						3,8									0,00250			
Vinyl chloride	1444						3,6									0,00250			
Vinyl chloride (bal. proc.)	699						5,6									0,00800			
Polyethylene (low pressure)	777						4,7									0,00600			
Polyethylene (high pressure)	1321						2,0									0,00150			
PVC	549						0,0												
Styrene	1290						0,3									0,00025			
Polystyrene	445						0,4									0,00100			
Styrene butadiene latex	321						1,6									0,00500			
Styrene butadiene SBR	272						1,4									0,00500			
Ethylene oxide	628						3,1									0,00500			
Formaldehyde	680						3,4									0,00500			
Ethylbenzene	1253						0,0												
Phtalic anhydride	230						1,2									0,00500			
Acrylonitrile	279						1,4									0,00500			
E Non-metallic mineral products																			
Cement	22871		12922									0,565							
Lime	6893		5239									0,760							
Glass	5536		1107			4,4						0,200			0,0008				
F Others																			
Refining (crude oil) *)	88293			2,6			25						0,00003			0,00029			
Lignite Coke *)																			
Bitumen-coated materials	41000						2,9									0,00007			
Bread	4090						12									0,00300			
Beer	10139						2,0									0,00020			
Wine	851						0,4									0,00050			
Sugar	3376						3,4									0,00100			
Partical board	4976						4,5									0,00090			

*) To be assigned to I B
Quelle: Umweltbundesamt

F 38 **Standard Data Table:** **2 Industrial Processes**

Former GDR **Year: 1990**

Source Categories	Activity Data	Emissions Estimates									Aggregate Emission Factors								
	Produktion Quantity	Full Mass of Pollutant									Tonne of pollutant per tonne of Product								
		CO	CO_2	CH_4	N_2O	NO_x	NMVOC	HFCs	PFCs	SF_6	CO	CO_2	CH_4	N_2O	NO_x	NMVOC	HFCs	PFCs	SF_6
	(Gg)	(Gg)									(Mg/Mg)								
A Iron and Steel																			
Cast iron and steel, melleable cast iron	400			0,0			0,2						0,00005			0,00042			
Rolled steel	4500						0,2									0,00004			
Pig iron	2166	4,3									0,00200								
Coke *)	965	1,5		0,5			0,5				0,00160		0,00050			0,00050			
Steel (electric and blow steel)	4275	68				0,9					0,01600				0,00020				
B Non-ferrous Metals																			
Primary aluminium pig	20	3,0	24						0,022		0,15000	1,222						0,0011	
C Inorganic Chemicals (excepting solvent use)																			
Nitric acid	1000				5,5	13								0,0055	0,013				
Nitrous oxide	1				0,0									0,0030					
Ammonia synthesis	861		594									0,690							
Soot	7	0,0									0,00480								
Soda	500		190									0,380							
D Organic Chemicals																			
Adipic acid	1,8				0,6		0,0							0,333					
Ethene	295						1,5									0,00500			
Propene	220						0,6									0,00250			
1, 2 dichlorethane	160						0,4									0,00250			
Vinyl chloride	202						0,5									0,00250			
Vinyl chloride (bal. proc.)	362						0,1									0,00025			
Polyethylene (low pressure)	31						0,2									0,00800			
Polyethylene (high pressure)	174						1,0									0,00600			
PVC	317						0,5									0,00150			
Styrene	68						0,0									0,00025			
Polystyrene	53						0,1									0,00100			
Styrene butadiene SBR	140						0,7									0,00500			
Acrylonitril butadiene styrene	6						0,0									0,00500			
Ethylene oxide	103						0,5									0,00500			
Formaldehyde	18						0,1									0,00500			
Phtalic anhydride	16						0,1									0,00500			
Acrylonitrile	60						0,3									0,00500			
E Non-metallic mineral products																			
Cement	5706		3224									0,565							
Lime	1550		1178									0,760							
Glass	480		96			1,9						0,200			0,0040				
F Others																			
Refining (crude oil) *)	18765			3,6			32						0,00019			0,00171			
Lignite Coke *)	4500			1,4									0,00031						
Bitumen-coated materials	9000						0,6									0,00007			
Bread	869						2,6									0,00300			
Beer	1589						0,3									0,00020			
Wine	3						0,0									0,00050			
Sugar	830						0,8									0,00100			
Partical board	460						0,4									0,00090			

*) To be assigned to I B

Quelle: Umweltbundesamt

F 39 Standard Data Table: 2 Industrial Processes Germany

Year: 1991

Source Categories	Activity Data	Emission Estimates									Aggregate Emission Factors								
	Produktion Quantity	Full Mass of Pollutant									Tonne of pollutant per tonne of Product								
	(Gg)	CO	CO_2	CH_4	N_2O	NO_X	NMVOC	HFCs	PFCs	SF_6	CO	CO_2	CH_4	N_2O	NO_X	NMVOC	HFCs	PFCs	SF_6
		(Gg)									(Mg/Mg)								
A Iron and Steel																			
Cast iron and steel, melleable cast iron	3678			0,1			1,3						0,00004			0,00037			
Rolled steel	32742						1,3									0,00004			
Pig iron	30989	37									0,00120								
Coke *)	16639	17		4,7			4,7				0,00102		0,00028			0,00028			
Steel (electric and blow steel)	42169	485				3,4					0,01150				0,00008				
B Non-ferrous Metals																			
Primary aluminium pig	690	104	843						0,316		0,15000	1,222						0,00046	
C Inorganic Chemicals (excepting solvent use)																			
Nitric acid	2173				12	14								0,0055	0,007				
Nitrous oxide	6				0,0									0,0030					
Ammonia synthesis	2123		1465									0,690							
Soot	382	1,7									0,00458								
Soda	1673		636									0,380							
D Organic Chemicals																			
Adipic acid	214				71									0,333					
Ethene	3546						17,7									0,00500			
Propene	2178						5,4									0,00250			
1, 2 dichlorethane	1662						4,2									0,00250			
Vinyl chloride	1529						1,5									0,00100			
Vinyl chloride (bal. proc.)	796						6,4									0,00800			
Polyethylene (low pressure)	865						5,2									0,00600			
Polyethylene (highpressure)	1495						0,7									0,00050			
PVC	576						4,6									0,00800			
Styrene	1253						0,3									0,00025			
Polystyrene	520						0,5									0,00100			
Styrene butadiene latex	307						1,5									0,00500			
Styrene butadiene SBR	275						1,4									0,00500			
Ethylene oxide	695						3,5									0,00500			
Formaldehyde	679						3,4									0,00500			
Ethylbenzene	1227						0,7									0,00060			
Phtalic anhydride	234						1,2									0,00500			
Acrylonitrile	346						1,7									0,00500			
E Non-metallic mineral products																			
Cement	25670		14504									0,565							
Lime	7532		5724									0,760							
Glass	6637		1327			8,0						0,200			0,0012				
F Others																			
Refining (crude oil) *)	105139			5,3			48,0						0,00005			0,00046			
Lignite Coke *)	2000			0,6									0,00030						
Bitumen-coated materials	55500						3,9									0,00007			
Bread	5208						16,0									0,00300			
Beer	11489						2,3									0,00020			
Wine	1017						0,5									0,00050			
Sugar	3528						3,5									0,00100			
Partical board	5464						5,0									0,00091			

*) To be assigned to I B

Quelle: Umweltbundesamt

F 40 Standard Data Table: 2 Industrial Processes Germany Year: 1992

Source Categories	Activity Data	Emission Estimates									Aggregate Emission Factors								
	Produktion Quantity	Full Mass of Pollutant									Tonne of pollutant per tonne of Product								
		CO	CO_2	CH_4	N_2O	NO_X	NMVOC	HFCs	PFCs	SF_6	CO	CO_2	CH_4	N_2O	NO_X	NMVOC	HFCs	PFCs	SF_6
	(Gg)	(Gg)									(Mg/Mg)								
A Iron and Steel																			
Cast iron and steel, melleable cast iron	3467			0,1			1,2						0,00004			0,00035			
Rolled steel	31400						1,3									0,00004			
Pig iron	28548	34									0,00119								
Coke *)	15296	15		3,7			3,7				0,00101		0,00024			0,00024			
Steel (electric and blow steel)	39712	459				3,2					0,01155				0,00008				
B Non-ferrous Metals																			
Primary aluminium pig	603	90	737						0,283		0,15000	1,222						0,00047	
C Inorganic Chemicals (excepting solvent use)																			
Nitric acid	2001				11	10								0,0055	0,005				
Nitrous oxide	6				0,0									0,0030					
Ammonia synthesis	2113		1458									0,690							
Soot	377	1,7									0,00439								
Soda	1489		566									0,380							
D Organic Chemicals																			
Adipic acid	245				82									0,333					
Ethene	3726						18,6									0,00500			
Propene	2308						5,8									0,00250			
1, 2 dichlorethane	1658						4,1									0,00250			
Vinyl chloride	1413						0,3									0,00020			
Vinyl chloride (bal. proc.)	863						6,9									0,00800			
Polyethylene (low pressure)	780						4,7									0,00600			
Polyethylene (high pressure)	1353						0,7									0,00050			
PVC	602						4,8									0,00800			
Styrene	1147						0,3									0,00025			
Polystyrene	542						0,5									0,00100			
Styrene butadiene latex	293						1,5									0,00500			
Styrene butadiene SBR	137						0,7									0,00500			
Ethylene oxide	659						3,3									0,00500			
Formaldehyde	660						3,3									0,00500			
Ethylbenzene	1200						0,7									0,00060			
Phtalic anhydride	221						1,1									0,00500			
Acrylonitrile	352						1,8									0,00500			
E Non-metallic mineral products																			
Cement	26983		15245									0,565							
Lime	7542		5732									0,760							
Glass	6637		1327			8,0						0,200			0,0012				
F Others																			
Refining (crude oil) *)	101563			4,7			42						0,00005			0,00042			
Lignite Coke *)	1000			0,3									0,00030						
Bitumen-coated materials	65000						4,6									0,00007			
Bread	5120						15									0,00300			
Beer	11735						2,3									0,00020			
Wine	1338						0,7									0,00050			
Sugar	3730						3,7									0,00100			
Partical board	5364						4,8									0,00090			

*) To be assigned to I B
Quelle: Umweltbundesamt

F 41 Standard Data Table:

2 Industrial Processes
Germany (preliminary)

Year: 1993

Source Categories	Activity Data	Emission Estimates									Aggregate Emission Factors								
	Produktion Quantity	Full Mass of Pollutant									Tonne of pollutant per tonne of Product								
		CO	CO_2	CH_4	N_2O	NO_X	NMVOC	HFCs	PFCs	SF_6	CO	CO_2	CH_4	N_2O	NO_X	NMVOC	HFCs	PFCs	SF_6
	(Gg)	(Gg)									(Mg/Mg)								
A Iron and Steel																			
Cast iron and steel, melleable cast iron	3467			0,1			1,2						0,00004			0,00035			
Rolled steel	31400						1,3									0,00004			
Pig iron	28548	34									0,00119								
Coke *)	15296	15		3,7			3,7				0,00101		0,00024			0,00024			
Steel (electric and blow steel)	39500	456				3,2					0,01155				0,00008				
B Non-ferrous Metals																			
Primary aluminium pig	603	90	737						0,262		0,15000	1,222						0,00043	
C Inorganic Chemicals (excepting solvent use)																			
Nitric acid	2001				11	10								0,0055	0,005				
Nitrous oxide	6				0,0									0,0030					
Ammonia synthesis	2113		1458									0,690							
Soot	377	1,7									0,00439								
Soda	1489		566									0,380							
D Organic Chemicals																			
Adipic acid	220				73									0,333					
Ethene	3905						19,5									0,00500			
Propene	2439						6,1									0,00250			
1, 2 dichlorethane	1655						4,1									0,00250			
Vinyl chloride	1296						3,2									0,00250			
Vinyl chloride (bal. proc.)	929						7,4									0,00800			
Polyethylene (low pressure)	694						4,2									0,00600			
Polyethylene (high pressure)	1210						1,8									0,00150			
PVC	629						0,0												
Styrene	1042						0,3									0,00025			
Polystyrene	564						0,6									0,00100			
Styrene butadiene latex	279						1,4									0,00500			
Ethylene oxide	623						3,1									0,00500			
Formaldehyde	641						3,2									0,00500			
Ethylbenzene	1174						0,0												
Phtalic anhydride	209						1,0									0,00500			
Acrylonitrile	359						1,8									0,00500			
E Non-metallic mineral products																			
Cement	26983		15245									0,565							
Lime	7542		5732									0,760							
Glass	6637		1327			8,0						0,200			0,0012				
F Others																			
Refining (crude oil) *)	101563			4,7			42						0,00005			0,00042			
Lignite Coke *)	1000			0,3									0,00030						
Bitumen-coated materials	65000						4,6									0,00007			
Bread	5120						15									0,00300			
Beer	11735						2,3									0,00020			
Wine	1338						0,7									0,00050			
Sugar	3730						3,7									0,00100			
Partical board	5364						4,8									0,00090			

*) To be assigned to I B
Quelle: Umweltbundesamt

F 42 Standard Data Table: 2 Industrial Processes Germany (preliminary) Year: 1994

Source Categories	Activity Data	Emission Estimates									Aggregate Emission Factors								
	Produktion Quantity	Full Mass of Pollutant									Tonne of pollutant per tonne of Product								
		CO	CO_2	CH_4	N_2O	NO_x	NMVOC	HFCs	PFCs	SF_6	CO	CO_2	CH_4	N_2O	NO_x	NMVOC	HFCs	PFCs	SF_6
	(Gg)	(Gg)									(Mg/Mg)								
A Iron and Steel																			
Cast iron and steel, melleable cast iron	3467			0,1			1,2						0,00004			0,00035			
Rolled steel	31400						1,3									0,00004			
Pig iron	28548	34									0,00119								
Coke *)	15296	15		3,7			3,7				0,00101		0,00024			0,00024			
Steel (electric and blow steel)	39500	456				3,2					0,01155				0,00008				
B Non-ferrous Metals																			
Primary aluminium pig	603	90	737						0,23		0,15000	1,222						0,00038	
C Inorganic Chemicals (excepting solvent use)																			
Nitric acid	2001				11	10								0,0055	0,005				
Nitrous oxide	6				0,0									0,0030					
Ammonia synthesis	2113		1458									0,690							
Soot	377	1,7									0,00439								
Soda	1489		566									0,380							
D Organic Chemicals																			
Adipic acid	220				73									0,333					
Ethene	3905						19,5									0,00500			
Propene	2439						6,1									0,00250			
1, 2 dichlorethane	1655						4,1									0,00250			
Vinyl chloride	1296						3,2									0,00250			
Vinyl chloride (bal. proc.)	929						7,4									0,00800			
Polyethylene (low pressure)	694						4,2									0,00600			
Polyethylene (high pressure)	1210						1,8									0,00150			
PVC	629						0,0												
Styrene	1042						0,3									0,00025			
Polystyrene	564						0,6									0,00100			
Styrene butadiene latex	279						1,4									0,00500			
Ethylene oxide	623						3,1									0,00500			
Formaldehyde	641						3,2									0,00500			
Ethylbenzene	1174						0,0												
Phtalic anhydride	209						1,0									0,00500			
Acrylonitrile	359						1,8									0,00500			
E Non-metallic mineral products																			
Cement	26983		15245									0,565							
Lime	7542		5732									0,760							
Glass	6637		1327			8,0						0,200			0,0012				
F Others																			
Refining (crude oil) *)	101563			4,7			42						0,00005			0,00042			
Lignite Coke *)	1000			0,3									0,00030						
Bitumen-coated materials	65000						4,6									0,00007			
Bread	5120						15									0,00300			
Beer	11735						2,3									0,00020			
Wine	1338						0,7									0,00050			
Sugar	3730						3,7									0,00100			
Partical board	5364						4,8									0,00090			

F 43 Standard Data Table: 3 Solvent and Other Product Use

Year: 1990

Source Categories			Activity Data	Emission Estimates		Aggregate Emission Factors	
			Quantity Consumed	Full Mass of Pollutant		Tonne of pollutant per tonne of Product	
				N_2O	NMVOC	N_2O	NMVOC
			(Gg)	(Gg)		(Mg/Mg)	
Former GDR							
A	**Paint Application**		105		95		0,900
B	**Degreasing and Dry Cleaning**		NE		NE		NE
C	**Chemical Products Manufacture/Processing**		36		35		0,985
D	**Other Solvent Use**		NE		NE		NE
E	**Other Products**	Laughing gas	1	1,0		1,000	
Former FRG							
A	**Paint Application**		550		440		0,800
B	**Degreasing and Dry Cleaning**		166		110		0,660
C	**Chemical Products Manufacture/Processing**		72		70		0,975
D	**Other Solvent Use**		494		410		0,830
E	**Other Products**	Laughing gas	5	5,0		1,000	

Quelle: Umweltbundesamt

F 44 Standard Data Table: 3 Solvent and Other Product Use Germany

Year: 1991 – 1994

Source Categories			Activity Data	Emission Estimates		Aggregate Emission Factors	
			Quantity Consumed	**Full Mass of Pollutant**		**Tonne of pollutant per tonne of Product**	
				N_2O	NMVOC	N_2O	NMVOC
			(Gg)	(Gg)		(Mg/Mg)	
1991							
A	**Paint Application**		595		505		0,850
B	**Degreasing and Dry Cleaning**		166		110		0,660
C	**Chemical Products Manufacture/Processing**		112		110		0,980
D	**Other Solvent Use**		494		410		0,830
E	**Other Products**	Laughing gas	6	6,0		1,000	
1992							
A	**Paint Application**		555		470		0,850
B	**Degreasing and Dry Cleaning**		166		110		0,660
C	**Chemical Products Manufacture/Processing**		102		100		0,980
D	**Other Solvent Use**		494		410		0,830
E	**Other Products**	Laughing gas	6	6,0		1,000	
1993	**preliminary**						
A	**Paint Application**		555		470		0,850
B	**Degreasing and Dry Cleaning**		166		110		0,660
C	**Chemical Products Manufacture/Processing**		102		100		0,980
D	**Other Solvent Use**		494		410		0,830
E	**Other Products**	Laughing gas	6	6,0		1,000	
1994	**preliminary**						
A	**Paint Application**		555		470		0,850
B	**Degreasing and Dry Cleaning**		166		110		0,660
C	**Chemical Products Manufacture/Processing**		102		100		0,980
D	**Other Solvent Use**		494		410		0,830
E	**Other Products**	Laughing gas	6	6,0		1,000	

Quelle: Umweltbundesamt

F 45 **Standard Data Table:** **4 Agriculture**
4 A & B **Enteric Fermentation & Manure Mangement** **Year: 1990**

Source and Sink Categories			Activity Data	Emission Estimates			Aggregate Emission Factors		
			Number of Animals	Enteric Fermentation	Manure Management	Manure Management	Enteric Fermentation	Manure Management	Manure Management
			(1000)	CH_4 (Gg)		N_2O (Gg)	CH_4	CH_4 (kg per head per year)	N_2O
Former GDR									
1	**Cattle**		4947	352	120	1,98		24,35	0,40
	a	Dairy	1585	151			95,00		
	b	Non-Dairy	3362	202			60,00		
2	**Buffalo**		NO						
3	**Sheep**		1455	12		0,04	8,00		0,03
4	**Goats**		20	0		0,00	8,00		0,03
5	**Camels and Llamas**		NO						
6	**Horses**		31	1		0,01	18,00		0,20
7	**Mules / Asses**		incl. in 6						
8	**Swine**		4947	7	25	0,49	1,50	5,15	0,10
9	**Poultry**		32824	4	5	0,13	0,13	0,15	0,004
10	**Other**		NO						
Former FRG									
1	**Cattle**		14541	991		5,82		23,45	0,40
	a	Dairy	4770	453			95,00		
	b	Non-Dairy	9771	537			55,00		
2	**Buffalo**		NO						
3	**Sheep**		1784	14		0,05	8,00		0,03
4	**Goats**		70	1		0,00	8,00		0,03
5	**Camels and Llamas**		NO						
6	**Horses**		406	7		0,08	18,00		0,20
7	**Mules / Asses**		incl. in 6						
8	**Swine**		22036	33		2,20	1,50	4,50	0,10
9	**Poultry**		81055	11		0,32	0,13	0,13	0,004
10	**Other**		NO						

NO: Not occuring
Quelle: Umweltbundesamt
Statistisches Bundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 46 **Standard Data Table:** **4 Agriculture**

4 A & B **Enteric Fermentation & Manure Mangement** **Germany** **Year: 1991**

Source and Sink Categories			Activity Data	Emission Estimates			Aggregate Emission Factors		
			Number of Animals	Enteric Fermentation	Manure Management	Manure Management	Enteric Fermentation	Manure Management	Manure Management
			(1000)	CH_4 (Gg)		N_2O (Gg)	CH_4 (kg per head per year)	CH_4	N_2O
1	**Cattle**		17134	1225	417	6,85		24,35	0,40
	a	Dairy	5632	535			95,00		
	b	Non-Dairy	11502	690			60,00		
2	**Buffalo**		NO						
3	**Sheep**		2488	20		0,07	8,00		0,03
4	**Goats**		83	1		0,00	8,00		0,03
5	**Camels**		NO						
6	**Horses**		505	9		0,10	18,00		0,20
7	**Mules / Asses**		incl. in 6						
8	**Swine**		26063	39	134	2,61	1,50	5,15	0,10
9	**Poultry**		105900	14	16	0,42	0,13	0,15	0,004
10	**Other**		NO						

NO: Not occuring
Quelle: Umweltbundesamt
Statistisches Bundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 47 **Standard Data Table:** **4 Agriculture**

4 A & B **Enteric Fermentation & Manure Mangement** **Germany** **Year: 1992**

Source and Sink Categories		Activity Data	Emission Estimates			Aggregate Emission Factors		
		Number of Animals	Enteric Fermentation	Manure Management	Manure Management	Enteric Fermentation	Manure Management	Manure Management
		(1000)	CH_4 (Gg)		N_2O (Gg)	CH_4	CH_4 (kg per head per year)	N_2O
1	**Cattle**	16207	1160	395	6,48		24,35	0,40
	a Dairy	5365	510			95,00		
	b Non-Dairy	10842	651			60,00		
2	**Buffalo**	NO						
3	**Sheep**	2386	19		0,07	8,00		0,03
4	**Goats**	88	1		0,00	8,00		0,03
5	**Camels**	NO						
6	**Horses**	531	10		0,11	18,00		0,20
7	**Mules / Asses**	incl. in 6						
8	**Swine**	26514	40	137	2,65	1,50	5,15	0,10
9	**Poultry**	104014	14	16	0,42	0,13	0,15	0,004
10	**Other**	NO						

NO: Not occuring
Quelle: Umweltbundesamt
Statistisches Bundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 48 Standard Data Table: 4 Agriculture

4 A & B Enteric Fermentation & Manure Mangement Germany Year: 1993

Source and Sink Categories		Activity Data	Emission Estimates			Aggregate Emission Factors		
		Number of Animals	**Enteric Fermentation**	**Manure Management**	**Manure Management**	**Enteric Fermentation**	**Manure Management**	**Manure Management**
		(1000)	CH_4 (Gg)		N_2O (Gg)	CH_4 (kg per head per year)	CH_4	N_2O
1	**Cattle**	15897	1139	387	6,36		24,35	0,40
	a Dairy	5301	504			95,00		
	b Non-Dairy	10596	636			60,00		
2	**Buffalo**	NO						
3	**Sheep**	2369	19		0,07	8,00		0,03
4	**Goats**	89	1		0,00	8,00		0,03
5	**Camels**	NO						
6	**Horses**	565	10		0,11	18,00		0,20
7	**Mules / Asses**	incl. in 6						
8	**Swine**	26075	39	134	2,61	1,50	5,15	0,10
9	**Poultry**	106946	14	16	0,43	0,13	0,15	0,004
10	**Other**	NO						

NO: Not occuring
Quelle: Umweltbundesamt
Statistisches Bundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 49 Standard Data Table: 4 Agriculture

4 A & B Enteric Fermentation & Manure Mangement Germany Year: 1994

Source and Sink Categories		Activity Data	Emission Estimates			Aggregate Emission Factors		
		Number of Animals	Enteric Fermentation	Manure Management	Manure Management	Enteric Fermentation	Manure Management	Manure Management
		(1000)	CH_4 (Gg)		N_2O (Gg)	CH_4	CH_4 (kg per head per year)	N_2O
1	**Cattle**	15962	1142	389	6,38		24,35	0,40
	a Dairy	5273	501			95,00		
	b Non-Dairy	10689	641			60,00		
2	**Buffalo**	NO						
3	**Sheep**	2340	19		0,07	8,00		0,03
4	**Goats**	89	1		0,00	8,00		0,03
5	**Camels**	NO						
6	**Horses**	599	11		0,12	18,00		0,20
7	**Mules / Asses**	incl. in 6						
8	**Swine**	24698	37	127	2,47	1,50	5,15	0,10
9	**Poultry**	109878	14	16	0,44	0,13	0,15	0,004
10	**Other**	NO						

NO: Not occuring
Quelle: Umweltbundesamt
Statistisches Bundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 50 Standard Data Table: 4 Agriculture
4 D Agricultural Soils

Year: 1990 – 1994

	Activity Data		Emission	Emission Factor
	Amount of Nitrogen Applied Fertiliser[1)]	Amount of Nitrogen Applied Annimal Waste[2)]		
	N (Gg)	N (Gg)	N_2O (Gg)	(kg N_2O/kg N)
1990 Former FRG	1368	904	62	
Former GDR	500	325	23	
1991 Germany	1751	1076	77	0,0314
1992 Germany	1660	1041	74	
1993 Germany	1612	1027	72	
1994 Germany	1786	1021	77	

[1)] Only 90% are relevant for emission, 10% are losses
[2)] Only 80% are relevant for emission, 20% are losses
Quelle: Umweltbundesamt
Statistisches Bundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 51 Standard Data Table: 5 Land Use Change & Forestry
5 A Changes in Forest and Other Woody Biomass Stocks – Annual Growth Increment (Sheet 1)

Year: 1990 – 1994

Source and Sink Categories	Activity Data	Uptake Estimates	Emission Factor
	Area of Forest	Total Carbon Uptake Increment	Carbon Uptake Factor
	(kha)	(Gg C)	(Mg C/ha)
Annual data for 1990 – 1994			
Temperate Forests			
Former FRG	7700	15400	2,0
Former GDR	3100	6200	2,0

Quelle: Umweltbundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 52 Standard Data Table: 5 Land Use Change & Forestry
5 A Changes in Forest and Other Woody Biomass Stocks – Annual Harvest
(Sheet 2) **Year: 1990 – 1994**

Source and Sink Categories	Activity Data	Carbon Emission Estimates	Aggregate Emission Factor
	Amount of Biomass Removed	Carbon Emission	Carbon Emission Factor
	(Gg dm)	(Gg C)	(Mg C/Mg dm)
Annual data for 1990 – 1994			
Total Biomass Consumption			
Former FRG	19 250	9 625	0,50
Former GDR	7 750	3 875	0,50

Quelle: Umweltbundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 53 Standard Data Table: 5 Land Use Change & Forestry
5 A Changes in Forest and Other Woody Biomass Stocks – Net CO_2 Emission/Uptake
(Sheet 3 **Year: 1990 – 1994**

Source and Sink Categories	Emission	Emission
	C (Gg)	CO_2 (Gg)
Annual data for 1990 – 1994		
Total Annual Growth Increment		
Former FRG	- 15 400	- 56 467
Former GDR	- 6 200	- 22 733
Total Annual Harvest		
Former FRG	9 625	35 292
Former GDR	3 875	14 208
NET EMISSIONS (+) OR UPTAKE (-)		
Former FRG	- 5 775	-21 175
Former GDR	- 2 325	- 8 525

Quelle: Umweltbundesamt
Bundesministerium für Ernährung, Landwirtschaft und Forsten

F 54 Standard Data Table: 6 Waste

6 A Solid Waste Disposal on Land

Preliminary data

Year: 1990 – 1994

Source Categories	Activity	Gas produced	Production factor	Gas use	Gas release
	(Gg)	(Gg)	CH_4 (kg/Mg Waste)	CH_4 (%)	CH_4 (Gg)
Landfill (municipal waste)					
1990					
Former GDR	3600	265	73,5	0	265
Former FRG	25221	1854	73,5	30	1298
1991					
Germany	27500	2021	73,5	26,5	1486
1992					
Germany	28500	2095	73,5	27	1529
1993					
Germany	29700	2183	73,5	28	1572
1994					
Germany	30600	2249	73,5	29	1597
Landfill (sewage sludge)					
1990					
Former GDR	129	12	95,0	0	12
Former FRG	2688	255	95,0	30	179
1991					
Germany	3200	304	95,0	26,5	223
1992					
Germany	3300	314	95,0	27	229
1993					
Germany	3400	323	95,0	28	233
1994					
Germany	3500	333	95,0	29	236

Quelle: Umweltbundesamt

F 55 Standard Data Table: 6 Waste

6 B Wastewater Treatment – N_2O Preliminary data Year: 1990 – 1994

Source Categories	Activity Amount of sewage sludge treated	Emission Estimates	Aggregate Emission factor
	(Gg DM)	CH_4 (Gg)	CH_4 (kg/Mg)
Wastewater Treatment			
1990			
Former GDR	255	54	210
Former FRG	4000	60	15
1991			
Germany	4250	106	25
1992			
Germany	5300	127	24
1993			
Germany	5700	114	20
1994			
Germany	6000	120	20

Quelle: Umweltbundesamt

F 56 Standard Data Table: 6 Waste

6 B Wastewater Treatment – CH_4 Preliminary data Year: 1990 – 1994

Source Categories	Activity Wastewater Volume	Emission Estimates	Aggregate Emission factor
	(million of m^3)	N_2O (Gg)	N_2O (kg/1000 m^3)
Wastewater Treatment			
1990			
Former GDR	0	0	0,65
Former FRG	6590	4	0,65
1991			
Germany	6600	4	0,65
1992			
Germany	6600	4	0,65
1993			
Germany	6600	4	0,65
1994			
Germany	6600	4	0,65

Quelle: Umweltbundesamt